



EU PVSEC 2019

**36th European
Photovoltaic Solar Energy
Conference and Exhibition**

**The Innovation Platform
for the global PV Solar Sector**

Conference Programme Exhibition Catalogue

09 - 13 September 2019

Marseille Chanot

**Convention and Exhibition Centre,
Marseille, France**

www.photovoltaic-conference.com

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INSTITUTIONAL SUPPORT



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WCRE – World Council
for Renewable Energy

COORDINATION OF THE TECHNICAL PROGRAMME



INSTITUTIONAL PV INDUSTRY COOPERATION



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TABLE OF CONTENTS

Chair's Message	1
Message from the Technical Programme Chair	3
Conference Programme	5
Monday, 09 September	6
Tuesday, 10 September	25
Wednesday, 11 September	43
Thursday, 12 September	67
Friday, 13 September	85
Visual Presentations	95
Authors Index	185
Parallel Events	239
French National Day - Highlighting French PV Innovation	243
Trends in PV Development – Self-Consumption and Innovative Distributed Applications	244
Eco-Design, Eco Labeling, Green Public Procurement – Sustainability Leadership for the Terawatt Age	247
Research meets Business – Solar Industry Forum	248
Photovoltaics Forms Landscapes - Energy as a Landscape Infrastructure	251
Research meets Business – Solar Industry Forum	252
New Solutions of Energy	254
Innovations in Photovoltaic Materials	256
Research meets Business – Solar Mobility Forum	258
Probabilistic PV Production Forecasts: Technics and Use-Cases	261
The EU Support Instruments – Unlocking Developing Markets . .	262
BIPV – Moving into the Next Phase	264
Standardization of the Protocols for Emerging PV Technologies. .	266
Advanced PV Energy Rating for Emerging Technologies	269
Exhibition	273
List of Exhibitors · alphabetical	275
Exhibition Layout with Exhibitors by stand number	315
General Information	323
Venue	324
Access	327
Conference Proceedings	328
Prizes & Awards	329
Networking	333
Services	334
Instructions for Authors and Presenters	334
Acknowledgements	337
Committees	338
Supporters	348
Sponsors	351
Media Partners	352
Conference Programme Outline of the week	inside back cover

Please note: The explanation of the Session Code used for the Conference Programme is available together with the Programme Outline on the inside of the back cover of this booklet

The content represents the status as of 14 August 2019

Welcome

WELCOME

Conference Programme

PROGRAMME

Parallel Events

PARALLEL EVENTS

Exhibition

EXHIBITION

Information

INFORMATION

Acknowledgements

ACKNOWLEDGEMENTS

CHAIR'S MESSAGE

Photovoltaics: Writing the next chapter

EU PVSEC has a special meaning for me as it was my first experience of an international conference as a PhD student more than 20 years ago. It also has a special meaning for the Photovoltaic Energy actors as the unique European crossroad in between different specialties: scientific, technical, financial, policy and markets.



This 36th conference in Marseille of what has become a truly world-class event will be rich with opportunities to discover the latest research results and data and gain insights into one of the most promising advances in PV technologies- all in one of France's sunniest climates.

The transition to a sustainable energy future will not be possible without a carbon-free energy sector dominated by renewables. As a major contributor to a cleaner and safer future for the planet, PV technologies will play a key role in transforming our energy systems while enabling a massive shift to carbon-free energy. As costs have come down, renewable energy is being rolled out at record levels. However, because emission levels are still far from reaching the targets set in the Paris Agreement, there is still much progress to be made to get renewables into the energy mix at an even faster pace.

Global investment in renewable-energy projects dropped slightly in 2018. And yet, the same year, more than 100 GWp of PV power was installed worldwide, evidence of the maturity of PV technologies. To continue to speed up the energy transition, PV must be addressed holistically alongside grid-integration technologies. These include tools to enable greater grid flexibility, battery-based or hydrogen storage, and digital systems. The goal is to provide the backbone for tomorrow's massive "smart-grid-ready" PV power plants. Consumers will benefit from cost reductions, of course. But so will high-added-value applications like advanced building-integrated photovoltaics and emerging transportation concepts.

This expanded vision for the next chapter in PV history will call for innovative approaches beyond just PV production. The entire value chain will have to be addressed, from new materials through to system-level advances. Currently, the primary challenges are high-efficiency cells, modules offering extended lifespans, efficient power electronics, multiscale smart grid modelling, and, finally, eco-design to ensure recyclability and more economical use of critical materials.

A strong and coordinated worldwide industry needs to be the collector of all these innovation subjects and Europe has the challenge to play a role again. And the previously described technology ruptures should be an opportunity. Thus, more than an energy solution for the future PV production, integration and related services will represent a considerable worldwide potential for jobs and for increasing prosperity for all the countries.

EU PVSEC 2019 will be the place to start new conversations on these and other topics and get the latest updates on the PV advanced world.

I am looking forward to an impressive programme of this 36th EU PVSEC conference and I am confident that you will find ample learning and networking opportunities at an event orchestrated to unlock your creativity and broaden your vision.

Dr. Florence Lambert
EU PVSEC 2019 General Chair
Director of CEA Liten
(the Laboratory for Innovation in new
Energy Technologies and Nanomaterials)

WELCOME FROM THE TECHNICAL PROGRAMME CHAIR

I am pleased to welcome you to the 36th European Photovoltaic Solar Energy Conference. This week follows closely from a record-breaking hot summer in much of the world which has provided a timely reminder of the urgency of our task to rapidly grow the renewable energy sector. I hope you have all had a relaxing break and are refreshed and ready to take up the challenge once again. Personally, I attended a competition for masters (read older) sports enthusiasts, and can humbly vouch for the truth in the adage 'you can't teach an old dog new tricks'. Let us all together this week show the out-of-date carbon emitting power industry that we have all the new tricks and it is time for them to retire.



The conference programme was updated in this year's call for abstracts, with some additions. From the perspective of materials and devices, we have added topics to encourage further input in the fields of perovskite materials and tandem device concepts. At the system scale, we have included new topics on storage, professional applications of PV and grid integration issues. As well as closely following your own field's oral and visual sessions, I also encourage you all to attend the plenary sessions that cover the broad range of all the thematic topics of the conference.

We have also introduced some novelties in the poster and student awards. To further highlight the importance of visual presentations, there will be a poster awards opening on Monday at which Poster Awards Committee members welcome and inform presenters. Additionally, a visual closing session on Thursday will provide delegates with the opportunity to follow short presentations of the winning posters. The student awards nominees have been shortlisted and the final selection of winners this year will be made taking the presentation delivery into consideration as well as the scientific content. Both awards ceremonies will be held during the closing session on Friday as usual.

I look forward to meeting you during an informative and stimulating week in Marseille.

Dr. Robert Kenny
European Commission Joint Research Centre
EU PVSEC Technical Programme Chair



CONFERENCE PROGRAMME

Plenary, Oral and Visual Sessions

CONFERENCE PROGRAMME

Please note, that this Programme may be subject to alteration and the organisers reserve the right to do so without giving prior notice. The current version of the Programme is available at www.photovoltaiic-conference.com.

(i) = invited

Monday, 09 September 2019

CONFERENCE OPENING

08:30 - 09:30 Scientific Opening

PLENARY SESSION 1AP.1

08:30 - 09:30 Routes to High Efficiency in Photovoltaics

Chairpersons:

Robert Kenny
European Commission Joint Research Centre, Italy

Antonio Martí Vega
UPM, Spain

1AP.1.1 III-V//Si Three-Junction Solar Cells Reaching 30% Efficiency Using Smart Stack Technology

K. Makita, H. Mizuno, T. Tayagaki, T. Aihara, R. Oshima, Y. Shoji, H. Takato & T. Sugaya
AIST, Tsukuba, Japan
R. Müller, P. Beutel, D. Lackner, J. Benick, M. Hermle & F. Dimroth
Fraunhofer ISE, Freiburg, Germany

1AP.1.2 Interconnection 1, 2, 3, 4.0: Buildup towards a PV Technology Hero?

T. Borgers, J. Govaerts, A.S.H. van der Heide, E. Voroshazi, P. Manganiello, J. Szlufcik, J. Poortmans, L. Vastmans, R. Moors & G. Doumen
imec, Genk, Belgium
R. Van Dyck & I. El -Chami
KULeuven, Belgium
P. Nivelles
UHasselt, Diepenbeek, Belgium
R. Bervoets
IPTE, Genk, Belgium

1AP.1.3 Approaching Maximum Efficiency of Colored Opaque Photovoltaics with Real Photonic Structures

J. Halme & P. Mäkinen
Aalto University, Finland

09:30 - 10:00 Becquerel Prize Ceremony

Chaired by

Joachim Luther
Chair Becquerel Prize Committee

Becquerel Prize Winner 2019

Pierre Verlinden
Consultant, Non-Executive Director to PV companies, Visiting Professor at Sun Yat-sen University (Guangzhou)

Laudatio

Stefan Glunz
Fraunhofer ISE, Freiburg, Germany

Delivery of the Prize by

Piotr Szymanski
European Commission Joint Research Centre, Director of Energy, Transport and Climate

10:00 - 11:00 Opening Addresses

- **Florence Lambert**
EU PVSEC General Chair
Director of CEA Liten,
the Laboratory for Innovation in new Energy
Technologies and Nanomaterials, France
- **Laurent Michel**
Director General of Energy and Climate, Ministry for
the Ecological and Inclusive Transition, France
- **Piotr Szymanski**
European Commission Joint Research Centre,
Director of Energy, Transport and Climate
- **Walburga Hemetsberger**
Chief Executive Officer, SolarPower Europe

11:00 - 12:15 Moderated Panel Discussion (page 8)

11:00 - 12:15 **Moderated Panel Discussion**

Topic: The Future of PV Manufacturing in Europe

Panellists

- **Andreas Bett**
Director, Fraunhofer ISE, Germany
- **Roch Drozdowski-Strehl**
General Director, IPVF, France
- **Paolo Frankl**
Head of Renewable Energy Division, IEA -
International Energy Agency
- **Philippe Malbranche**
General Director, CEA INES
- **Stefan Rinck**
CEO, Singulus, Germany
- **Eicke Weber**
prel. Chair ESMC (European Solar Manufacturing
Council)
- **Heinz Ossenbrink,**
Former European Commission Joint Research
Centre
- **Representative French Industry / Developer (i)**

This programme reflects confirmations as of 26 August 2019. For the latest programme news please check www.photovoltaic-conference.com



Opening			
Scientific Opening 1AP.1 (60 min plenary) <i>Auditorium 1</i> Becquerel Prize Ceremony			
Opening Addresses			
Moderated Panel Discussion			
Lunch			
1AO.1 T1.1 <i>Audit 3</i>	2AO.4 T2.1 <i>Audit 4</i>	3AO.7 T3.2 <i>Audit 1</i>	Poster Awards Kick-off
Break			
1AO.2 T1.1 <i>Audit 3</i>	2AO.5 T2.1 <i>Audit 4</i>	3AO.8 T3.2 <i>Audit 1</i>	4AV.1 T4.1 <i>Poster Area</i>
Break			
1AO.3 T1.2 <i>Audit 3</i>	2AO.6 T2.1/4 <i>Audit 4</i>	3AO.9 T3.2 <i>Audit 1</i>	4AV.2 T4.1/2/3 <i>Poster Area</i>

1 New Materials and Concepts for Photovoltaic Devices

- T1.1 Fundamental Studies
- T1.2 New Materials and Concepts for Cells and Modules

2 Silicon Materials and Cells

- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices

- T3.1 Perovskites Based Photovoltaics
- T3.2 Cl(G)S, CdTe and Related Thin Film Solar Cells
- T3.3 Organic and Dye-Sensitised Devices
- T3.4 III-V and Related Compound Semiconductor Based Devices
- T3.5 Tandems

4 Photovoltaic Modules and BoS Components

- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

ORAL PRESENTATIONS 1AO.1

13:30 - 15:00 Energy Conversion Mechanisms and Materials Characterisation

Chairpersons:

Daniel Ory
EDF R&D, France

Masafumi Yamaguchi
Toyota Technological Institute, Japan

1AO.1.1 From the Hot Carrier Solar Cell to the Intermediate Band Solar Cell, Passing through the Multiple-Exciton Generation Solar Cell and Then Back to the Hot Carrier Solar Cell: The Dance of the Electro-Chemical Potentials

A. Martí Vega
UPM, Madrid, Spain

1AO.1.2 Electrical Multi-Probe Investigation of Nanowires for Solar Energy Conversion

A. Nägelein, C. Timm, M. Steidl, P. Kleinschmidt & T. Hannappel
Ilmenau University of Technology, Germany

1AO.1.3 Simple Thermionic Model of Hot Carrier Solar Cell with Semi-Infinite Energy Filtering

I. Konovalov & B. Ploss
University of Applied Science, Jena, Germany

1AO.1.4 Carrier-Resolved Photo-Hall

O. Gunawan, D.M. Bishop, Y. Virgus & Y.S. Lee
IBM, Yorktown Heights, United States
S.R. Pae & B. Shin
KAIST, Daejeon, Republic of Korea
J.H. Noh
Korea University, Seoul, Republic of Korea
N.J. Jeon
KRICT, Daejeon, Republic of Korea

1AO.1.5 GaAs Subcell with Hybrid Quantum Objects for Triple-Junction Solar Cells

M.A. Mintairov, V.V. Evstropov, S.A. Mintairov, M.Z. Shvarts & N.A. Kalyuzhnyy
RAS / Ioffe, St. Petersburg, Russia

1AO.1.6 A Thermophotovoltaic (TPV) Micro-Combustor Using Selective Emitters

Y.-H. Li
NCTU, Tainan, Taiwan
P. Parashar, P. Yu & A. Lin
NCTU, Hsinchu, Taiwan
K.-H. Pen
NCKU, Tainan, Taiwan

ORAL PRESENTATIONS 2AO.4

13:30 - 15:00 Defects in Crystalline Silicon

Chairpersons:

Anis Jouini
CEATECH-INES, France

Ronald Sinton
Sinton Instruments, United States

2AO.4.1 Insights on the Electronic Parameterisation of Defects in Silicon Obtained from the Formation of the Defect Repository

M.K. Juhl & F.E. Rougieux
UNSW Australia, Sydney, Australia
F.D. Heinz, T. Niewelt & M.C. Schubert
Fraunhofer ISE, Freiburg, Germany
G. Coletti
ECN part of TNO, Petten, The Netherlands
C. Sun & D. Macdonald
ANU, Canberra, Australia
J.J. Krich
University of Ottawa, Canada

2AO.4.2 Investigating Defect States in Monocrystalline Silicon with Temperature and Injection Dependent Lifetime Spectroscopy

M. Syre Wiig, R. Søndena, E.S. Marstein & H. Haug
Institute for Energy Technology, Kjeller, Norway

2AO.4.3 Assessing a Two-Step Approach to Eliminate LeTID in p-Type PERC Solar Cells

C. Sen, C. Chan, P. Hamer, M. Wright, U. Varshney, S. Liu, A. Samadi, A. Ciesla, C.M. Chong, B. Hallam & M. Abbott
UNSW Australia, Sydney, Australia

2AO.4.4 Student Award Finalist Presentation: Impact of Silicon Nitride Film Properties on Hydrogen In-Diffusion into Crystalline Silicon

D. Bredemeier, D.C. Walter & J. Schmidt
ISFH, Emmerthal, Germany
R. Heller
HZDR, Dresden, Germany

2AO.4.5 On the Influence of Advection Cooling during Degradation and Regeneration of Boron-Oxygen Defects Using High Intensity Illumination

A. Herguth, A. Graf & G. Hahn
University of Konstanz, Germany

2AO.4.6 Light-Induced Degradation in Boron-Doped Cz Silicon PERC: Excessive Enhancement by Dark Annealing

F. Fertig, R. Lantzsich, F. Kersten, F. Frühauf, J. Lindroos,
C. Taubitz, M. Schütze & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

ORAL PRESENTATIONS 3AO.7

13:30 - 15:00 Progress in CIGS Modules

Chairpersons:

Alessandro Romeo
University of Verona, Italy

Bernhard Dimmler
NICE Solar Energy, Germany

3AO.7.1 Absorber Optimization in CIGSSe Modules with a Sputtered ZnOS Buffer Layer at 19 % Efficiency

M. Stölzel, M. Algasinger, A. Zelenina, A. Weber, M. Sode,
C. Schubbert, P. Eraerds, R. Lechner, T. Dalibor & J. Palm
Avancis, Munich, Germany

3AO.7.2 ZnMgO Buffer Deposition in Commercial-Size CIGS PV Modules

P. Kratzert, T. Henke, J. Nowoczin, V.R. Gutlapalli,
I. Ratschinski, S. Jander & R. Hunger
Solibro, Bitterfeld-Wolfen, Germany
O. Lundberg, J. Joel & L. Stolt
Solibro Research, Uppsala, Sweden

3AO.7.3 Alkali Incorporation in High-Efficiency Cu(In,Ga)Se₂ Solar Cells on Flexible Substrates

R. Carron, S. Nishiwaki, T. Feurer, R. Hertwig, E. Avancini,
J. Löckinger, S.-C. Yang, S. Buecheler & A.N. Tiwari
EMPA, Dubendorf, Switzerland

3AO.7.4 Development of an Industrially Compatible Process for Light Weight CIGS Modules on Polymer Substrates by Optimizing Deposition Parameters

V. Achard, M. Jubault, F. Donsanti & D. Cammilleri
IPVF, Palaiseau, France
R. Würz & F. Kessler
ZSW, Stuttgart, Germany
D. Lincot
CNRS, Palaiseau, France

3AO.7.5 Fabrication of High-Efficient and Flexible Cu(In,Ga)Se₂ Thin-Film Photovoltaics on Stainless Steel Substrates: Impacts of Various Impurity Barriers and Their Structures on Device Performances

D. Shin, K. Kim, I. Jeong, Y.-J. Eo, S. Song, A. Cho,
J.S. Yoo, S.K. Ahn, J.-S. Cho, J.H. Park, S.J. Ahn, Y. Cho,
J.H. Yun & J. Gwak
KIER, Daejeon, Republic of Korea

3AO.7.6 Humidity Barriers and Environmentally Stable Front Contacts for Flexible Thin Film Modules

P.J. Bolt, F.J. van den Bruele, D. Roosen-Melsen,
H. Steijvers & H. Linden
TNO, Eindhoven, The Netherlands
G. Torres Sevilla & Y.E. Romanyuk
EMPA, Dubendorf, Switzerland

13:30 - 15:00 POSTER AWARDS KICK-OFF

ORAL PRESENTATIONS 1AO.2

15:15 - 16:45 Conversion Efficiency Limits and Materials Characterisation

Chairpersons:

Jean-Francois Guillemoles
CNRS, France

Thomas Hannappel
Ilmenau University of Technology, Germany

1AO.2.1 Student Award Finalist Presentation: The Ultimate Potential of Reconfigurable Modules for Increasing the Energy Yield of Partially Shaded Urban Photovoltaics Systems
A. Calcabrini, R. Weegink, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

1AO.2.2 Efficiency Limits and Performance Limiting Factors of Inorganic, Organic and Hybrid Perovskite Solar Cells
Y. Kato, S. Fujimoto, M. Kozawa & H. Fujiwara
Gifu University, Japan

1AO.2.3 Effects of High Photon Gas Density and Radiative Efficiency on Upper Bounds of Energy Conversion Efficiency in Single-Crystal Solar Cells
S.J. Babcock, N.P. Irvin, C.B. Honsberg & R.R. King
Arizona State University, Tempe, United States

1AO.2.4 Multi-Dimensional Luminescence Imaging: Accessing to Transport Properties
D. Ory, A. Bercegol, O. Fournier & J. Rousset
EDF R&D, Palaiseau, France
D. Suchet & J.-F. Guillemoles
CNRS, Palaiseau, France
M. Legrand, J.-B. Puel, A. Michaud, A. Ben Slimane, S. Collin, S. Cacovich, A. Rebai & L. Lombez
IPVF, Palaiseau, France

1AO.2.5 Photocurrent Spectra and Transport Characterizations on Halide Perovskites Thin Films
H.-J. Lin, A. Rebai & S. Cacovich
IPVF, Palaiseau, France
J. Rousset
EDF R&D, Palaiseau, France
C. Longeaud
CNRS, Gif-sur-Yvette, France

1AO.2.6 C-AFM and KPFM Characterization of poly-Si/SiO_x/c-Si Passivated Contact Structure
C. Marchat
IPVF, Palaiseau, France
A. Morisset & R. Cabal
CEA, Le Bourget du Lac, France
J. Alvarez, M.E. Gueunier-Farret & J.-P. Kleider
CNRS, Gif-sur-Yvette, France

ORAL PRESENTATIONS 2AO.5

15:15 - 16:45 Crystallizing Silicon for Photovoltaics

Chairpersons:

Brett Hallam
UNSW Australia, Australia

João M. Serra
University of Lisbon, Portugal

2AO.5.1 Silicon Ingot Growth from Nitride Crucibles Made from Kerf-Loss Silicon during Diamond Wire Sawing
C.-E. Liu, H.-T. Yu, H.-L. Yang & C.-W. Lan
NTU, Taipei, Taiwan

2AO.5.2 Solid State Diffusion of Metallic Impurities from Crucible and Coating Material into Crystalline Silicon Ingots for PV Application
F. Sturm, M. Trempa, S. Schwanke, K. Schuck, C. Reimann & J. Friedrich
Fraunhofer IISB, Erlangen, Germany
C. Kranert
Fraunhofer THM, Freiberg, Germany

2AO.5.3 Enhanced Material Quality in SMART mono-Si Block Cast Ingots by Introduction of Functional Defects
S. Riepe, P. Krenckel, A. Hess, T. Trötschler, Y. Hayama, K. Kutsukake, F. Schindler & N. Usami
Fraunhofer ISE, Freiburg, Germany

2AO.5.4 Adopting Continuous Czochralski (CCz) Process in Production by Retrofitting Czochralski (Cz) Monocrystalline Puller in the Field
J. He & D. Wang
JA Solar, Xingtai, China
R. Malen, S. Keohane & H. Xu
GT Advanced Technologies, Hudson, United States

2AO.5.5 On the Progress in Data Science Approaches for High-Quality Multicrystalline Silicon Ingot for Solar Cells

N. Usami, K. Tajima, S. Kamibeppu, A.E. Boucetta,
T. Kojima, T. Matsumoto, H. Kudo, Y. Noda & T. Yokoi
Nagoya University, Japan
K. Kutsukake
RIKEN, Tokyo, Japan
Y. Shimizu & Y. Ohno
Tohoku University, Sendai, Japan

2AO.5.6 Combined Experimental and Numerical Investigation of Cz Growth Conditions on Thermal Donors Generation

M. Albaric, M. Chatelain, J. Veirman, D. Pelletier &
M. Benmansour
CEA, Le Bourget du Lac, France

ORAL PRESENTATIONS 3AO.8

15:15 - 16:45 New Concepts in Chalcogenides

Chairpersons:

Wiltraud Wischmann
ZSW, Germany

Marc Meuris
imec, Belgium

3AO.8.1 Ultrathin CIGS Solar Cells with Passivated and Highly Reflective Back Contacts – Results from the ARCIGS-M Consortium

M. Edoff & W.-C. Chen
Uppsala University, Sweden
I. Gordon
imec, Leuven, Belgium
B. Vermang
imec, Genk, Belgium
P.J. Bolt, J. van Deelen & M. Simor
TNO, Eindhoven, The Netherlands
D. Flandre & J. Lontchi
UCL, Louvain-la-Neuve, Belgium
M. Kovacic & J. Krc
University of Ljubljana, Slovenia
L. Guillard, S. Collin & N. Naghavi
CNRS, Palaiseau, France
M. Jubault
EDF R&D, Palaiseau, France
R. Kotipalli & L. Fourdrinier
AC&CS, Liège, Belgium

Y. Zhou
Obducat Technologies, Malmö, Sweden
R. Vignal
Arcelor Mittal, Maizières-lès-Metz, France
V. Gusak
Solibro Research, Uppsala, Sweden
E. Niemi & K. Takei
Midsummer, Järfälla, Sweden
S. Bose, J.M.V. Cunha, T.S. Lopes, P.A. Fernandes,
P. Anacleto, S. Sadewasser & P.M.P. Salomé
INL, Braga, Portugal

3AO.8.2 Student Award Finalist Presentation: Submicron CIGS Solar Cells: Feasibly towards the Absorption Limit

N. Rezaei, O. Isabella, P. Procel Moya & M. Zeman
Delft University of Technology, The Netherlands
Z. Vroon
TNO, Geleen, The Netherlands

3AO.8.3 Direct Fabrication of Ultrathin Cu(In,Ga)Se₂ Solar Cells on Ag-Based Reflective Back Contacts

L. Guillard, A. Cattoni, J. Goffard, N. Naghavi & S. Collin
CNRS, Palaiseau, France
W.-C. Chen, L. Riekehr, J. Keller & M. Edoff
Uppsala University, Sweden
M. Jubault
EDF R&D - IPVF, Palaiseau, France

3AO.8.4 Time-Resolved Photoluminescence Study of the Influence of Na on the Non-Radiative Recombination in Cu-Poor, Thermally Co-Evaporated Cu(In,Ga)Se₂ Solar Cells

M. Morawski, M. Maiberg & R. Scheer
Martin Luther University Halle-Wittenberg, Halle (Saale),
Germany

3AO.8.5 Co-Evaporated Cu(In,Ga)S₂ Thin Films: Process Issues, Material Properties and Device Performance

A. Thomere & R. Bodeux
EDF R&D, Palaiseau, France
C. Guillot-Deudon, N. Barreau, M.T. Caldes & A. Lafond
University of Nantes, France

3AO.8.6 invited

VISUAL PRESENTATIONS 4AV.1

15:15 - 16:45 **PV Module Design, Manufacture, Performance and Reliability (I)**

Detailed information on this Session is presented in the section entitled 'Visual Presentations'.

ORAL PRESENTATIONS 1AO.3

17:00 - 18:30 **Light Management and Spectral Conversion**

Chairpersons:

Igor Konovalov
University of Applied Sciences Jena, Germany

James Patrick Connolly
CNRS/GeePs, France

1AO.3.1 **Front Side Structures in TiO₂ for Crystalline Silicon Solar Cells: Which Effects Can They Achieve?**

L. Stevens, H. Hauser, O. Höhn, N. Tucher, C. Wellens & B. Bläsi
Fraunhofer ISE, Freiburg, Germany
C. Stauch & R. Jahn
Fraunhofer ISC, Würzburg, Germany
C. Müller
University of Freiburg, Germany

1AO.3.2 **80% Average Absorption in Ultrathin Hot Carriers Solar Cells with Tetrahedron Nanostructures**

J. Goffard, M. Giteau, A. Cattoni, N. Bardou, L. Lombez, J.-F. Guillemoles & S. Collin
CNRS, Palaiseau, France
S. Boyer-Richard, A. Beck, A. Le Corre & O. Durand
INSA-Rennes, France

1AO.3.3 **Surface Nanostructuring and Physical Properties of In₂S₃ Films Using Argon Plasma Treatment**

V.F. Gremenok & E.P. Zaretskaya
NASB, Minsk, Belarus
S.P. Zimin, A.S. Pipkova & L.A. Mazaletskiy
Yaroslavl State University, Russia
A.N. Pyatlitski, V.A. Saladukha & T.V. Piatlitskaya
JSC "INTEGRAL", Minsk, Belarus

1AO.3.4 **Inkjet-Printed Three-Dimensional Colloidal Photonic Crystals for Structural Coloration of Solar Cells**

R. Speranza, T. Huhtamäki, S. Lepikko, R.H.A. Ras & J. Halme
Aalto University, Finland

1AO.3.5 **Indoor Energy Micro-Sources for Energetically Autonomous Nomadic Devices**

B. Politi, S. Parola, A. Gademer, Y. Cuminal, A. Foucaran & N. Camara
IES, Montpellier, France
M. Piquemil
Bureaux A Partager, Paris, France

1AO.3.6 **Characterization of Spectral Conversion Layer Comprising Luminescent Down-Shifting Eu-Doped Phosphors Enhanced by Plasmonics Silver Nanoparticles**

X.-Y. Chen, W.-J. Ho, J.-C. Chen, J.-J. Liu, D.-L. Lin, B.-Y. Pan & Y.H. Chen
NTUT, Taipei, Taiwan

ORAL PRESENTATIONS 2AO.6

17:00 - 18:30 **Thin Silicon Solar Cells**

Chairpersons:

Paola Delli Veneri
ENEA, Italy

Martin P. Bellmann
SINTEF, Norway

2AO.6.1 **Sawing Damage Control for Thin Flexible Si Solar Cells**

K. Onishi, R. Yokogawa, T. Nishihara, T. Kamioka & A. Ogura
Meiji University, Kawasaki, Japan
K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
T. Kawatsu & T. Nagai
Komatsu NTC, Nanto, Japan
N. Yamada & Y. Miyashita
Nagaoka University of Technology, Japan

2AO.6.2 **Correlating Template Properties with the Quality of Epitaxially Grown Silicon Wafers**

M. Drießen, T. Fehrenbach, L. Kirste, C. Weiss & S. Janz
Fraunhofer ISE, Freiburg, Germany

- 2AO.6.3 Dopant-Free Asymmetric Thin Film Crystalline Silicon Heterojunction Solar Cells**
J. He, W. Wang, S. Karuturi & Y. Wan
ANU, Canberra, Australia
- 2AO.6.4 Bifacial Amorphous Si Quintuple-Junction Solar Cells for IoT Devices with High Open-Circuit Voltage of 3.5V under Low Illuminance**
M. Konagai & R. Sasaki
Tokyo City University, Japan
- 2AO.6.5 The Fabrication of Thin Film Silicon Radial Junction Solar Cells Built on the VLS Grown Silicon Nanowire Array**
M. Müller, J. Stuchlik, M. Ledinsky, A. Fejfar & J. Kocka
ASCR, Prague, Czech Republic
- 2AO.6.6 Highly Efficient Transparent a-Si:H Solar Cells for Light Harvesting under Indoor Illumination using Collection Enhancing Layer**
G. Kim, M.A. Park, S.H. Jang & J.W. Lim
ETRI, Daejeon, Republic of Korea
M. Shin
Korea Aerospace University, Goyang, Republic of Korea

ORAL PRESENTATIONS 3AO.9

17:00 - 18:30 Buffers, Absorbers and Interfaces in CIGS Devices

Chairpersons:

Thomas Dalibor
Avancis, Germany

Takahiro Wada
Ryukoku University, Japan

- 3AO.9.1 Special Introductory Presentation: Recent CIGS Photovoltaics Research Activity at AIST**
S. Ishizuka, J. Nishinaga, Y. Kamikawa-Shimizu, S. Kim, T. Koida & H. Shibata
AIST, Tsukuba, Japan
N. Taguchi
AIST, Ikeda, Japan
S. Niki
NEDO, Kawasaki, Japan

- 3AO.9.2 Post-Sulfurization of Cu(In,Ga)Se₂ Absorbers: General Observations and Effect of Cu Content on Solar Cell Performance**
J. Keller, M. Edoff & C. Platzer-Björkman
Uppsala University, Sweden
O. Bilousov & O. Lundberg
Solibro Research, Uppsala, Sweden
- 3AO.9.3 Zn(O,S) Buffer Layers for Cu(In,Ga)Se₂ Thin Film Solar Cells by Magnetron Sputtering**
M. Zutter, J. Virtuoso, P. Anacleto, D. Colombara, L. Yasin, M. Alves, O. Bondarchuk & S. Sadewasser
INL, Braga, Portugal
D. Fuster, J.M. Garcia & F. Briones
CSIC, Madrid, Spain
R. Wächter
NICE Solar Energy, Schwäbisch Hall, Germany
O. Kiowski & D. Hariskos
ZSW, Stuttgart, Germany
- 3AO.9.4 Characterization of High Bandgap CIGS Solar Cells and Corresponding Absorber/Buffer Interfaces: Results of the EFFCIS Project**
W. Witte, D. Hariskos, O. Kiowski, S. Paetel & M. Powalla
ZSW, Stuttgart, Germany
M. Maiberg, S. Zahedi-Azad, P. Pistor & R. Scheer
Martin Luther University, Halle, Germany
D. Hauschild, V. van Maris, L. Weinhardt, C. Heske, X. Jin, R. Schneider, D. Gerthsen, J. Seeger & M. Hetterich
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany
J. Keutgen & O. Cojocaru-Miréidin
RWTH Aachen University, Germany
E. Ghorbani & K. Albe
Technical University of Darmstadt, Germany
A. Nikolaeva, J. Marquez-Prieto, M. Krause, S. Schäfer, C.J. Hages, D. Abou-Ras, T. Unold & R. Mainz
HZB, Berlin, Germany
P. Eraerds, T.P. Niesen, R. Lechner, T. Dalibor & J. Palm
Avancis, Munich, Germany
M. Schweiger & B. Dimmler
NICE Solar Energy, Schwäbisch Hall, Germany
R. Hunger, T. Henke & P. Kratzert
Solibro, Bitterfeld-Wolfen, Germany
- 3AO.9.5 Modified Three-Stage Coevaporation Process for High Efficiency High-Ga Content CIGS Solar Cells**
W. Li, J. Zheng, S. Xu, M. Chen, G. Zhong, W. Li, Y. Feng, H. Luo & C. Yang
CAS, Shenzhen, China

VISUAL PRESENTATIONS 4AV.2

17:00 - 18:30 PV Module Design, Manufacture, Performance and Reliability/ Inverters and Balance of System Components/ Sustainability and Recycling

Detailed information on this Session is presented in the section entitled 'Visual Presentations'.

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2BO.1 T2.2 Audit 1	5BO.5 T5.3 Audit 2	1BO.9 T1.2 Audit 3	4BO.13 T4.1 Audit 4	3BV.1 T3.2/4 Poster Area
Break				
10:30 2BP.1 (100 min plenary) Auditorium 1 12:10				
Lunch				
2BO.2 T2.2/3 Audit 1	5BO.6 T5.3 Audit 2	1BO.10 T1.2 Audit 4	3BV.2 T3.1/3/5 Poster Area	
Break				
2BO.3 T2.2/3 Audit 1	5BO.7 T5.3 Audit 2	4BO.11 T4.1 Audit 4	1BV.3 T1.1/2 Poster Area	
Break				
2BO.4 T2.2/3 Audit 1	3BO.8 T3.4/5.5 Audit 2	4BO.12 T4.1 Audit 4	6BV.4 T6.1/2 Poster Area	

- 1 New Materials and Concepts for Photovoltaic Devices**
 - T1.1 Fundamental Studies
 - T1.2 New Materials and Concepts for Cells and Modules
- 2 Silicon Materials and Cells**
 - T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
 - T2.2 Homojunction Solar Cells
 - T2.3 Heterojunction Solar Cells
 - T2.4 Thin Film and Foil-Based Si Solar Cells
 - T2.5 Characterisation & Simulation of Si Cells
 - T2.6 Manufacturing & Production of Si Cells
- 3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices**
 - T3.1 Perovskites Based Photovoltaics
 - T3.2 Cl(G)S, CdTe and Related Thin Film Solar Cells
 - T3.3 Organic and Dye-Sensitised Devices
 - T3.4 III-V and Related Compound Semiconductor Based Devices
 - T3.5 Tandems
- 4 Photovoltaic Modules and BoS Components**
 - T4.1 PV Module Design, Manufacture, Performance and Reliability
 - T4.2 Inverters and Balance of System Components
 - T4.3 Sustainability and Recycling
- 5 PV Systems and Storage – Modelling, Design, Operation and Performance**
 - T5.1 Solar Resource and Forecasting
 - T5.2 Design and Installation of PV Systems
 - T5.3 Operation, Performance and Maintenance of PV Systems
 - T5.4 Storage
 - T5.5 Concentrators and PV for Space Applications
- 6 PV Applications and Integration**
 - T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
 - T6.2 Professional Applications of PV
 - T6.3 PV Driven Energy Management and System Integration

PROGRAMME

PROGRAMME

ORAL PRESENTATIONS 2BO.1

08:30 - 10:00 PERX Silicon Solar Cells

Chairpersons:

Marco Ernst
ANU, Australia

Ralf Preu
Fraunhofer ISE, Germany

2BO.1.1 Optimization of Rear Al Fire-Through Contacts for Bifacial p-Type PERC with AlO_x/SiN_x Rear Passivation

D. Ourinson, T. Javid, T. Fellmeth, M. Pospischil,
G. Emanuel, F. Clement & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany
M. Dhamrin
Toyo Aluminium, Shiga, Japan

2BO.1.2 Deep Level Transient Spectroscopic Investigation of Carrier Trap Defects in p-Type mc-Si PERC Solar Cells After Elevated Temperature Light Soaking

C. Zhou, S. Zhou, F. Ji & W.J. Wang
CAS, Beijing, China

2BO.1.3 Impact of POCl₃ Diffusion Process Parameters on Oxygen Precipitates and Impurity Gettering in Crystalline Silicon

S. Maus, S. Lohmüller, J. Schön & A. Wolf
Fraunhofer ISE, Freiburg, Germany

2BO.1.4 Towards 23% Screen-Printed Rear-Emitter Bifacial n-PERT Cells

P. Choulat, S. Singh, L. Tous, F. Duerinckx, I. Gordon &
J. Szlufcik
imec, Leuven, Belgium
J. Chen & Z. Liu
Jolywood, Taizhou, China

2BO.1.5 APCVD Based Stacked Co-Diffusion for Multicrystalline Silicon p-PERT Solar Cells

F. Koschnick, J. Fichtner, A. Zuschlag & G. Hahn
University of Konstanz, Germany
H. Zunft
Gebr. Schmid, Freudenstadt, Germany

2BO.1.6 Undoped LPCVD PolySi Passivating Layer to Reduce Recombination Loss for Screen-Printed Contacts on Top of an Uniform Shallow Boron Emitter

X. Lu, M.K. Stodolny & J. Löffler
ECN part of TNO, Petten, The Netherlands
B.W.H. van de Loo & P.R. Venema
Tempress, Vaassen, The Netherlands

ORAL PRESENTATIONS 5BO.5

08:30 - 10:00 Performance of PV Systems

Chairpersons:

Gerhard Mütter
Alteso, Austria

Christian Thiel
European Commission JRC, Italy

5BO.5.1 International Collaboration Framework for the Calculation of Performance Loss Rates: Data Quality, Benchmarks, and Trends

D. Moser & S. Lindig
Eurac Research, Bolzano, Italy
D. Bertani
RSE, Milan, Italy
A.J. Curran & R.H. French
Case Western Reserve University, Cleveland, United States
M. Herz
TÜV Rheinland Energy, Cologne, Germany
G. Makrides
University of Cyprus, Nicosia, Cyprus
B. Müller
Fraunhofer ISE, Freiburg, Germany
M. Richter
3E, Brussels, Belgium
M. Van Iseghem
EDF R&D, Moret-sur-Loing, France
W.G.J.H.M. van Sark
Utrecht University, The Netherlands
J.S. Stein
Sandia National Laboratories, Albuquerque, United States

5BO.5.2 Performance Analysis of Mechanistic and Machine Learning Models for Photovoltaic Energy Yield Prediction

A. Livera, M. Theristis, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
J. Sutterlueti
Gantner Instruments, Schruns, Austria
S. Ransome
Steve Ransome Consulting, Kingston upon Thames, United Kingdom

5BO.5.3 PV O&M Optimization by AI Practice

M.Y. Chang, K.H. Chen, T.P. Hsu, K. Wei & K. Chuang
Sinogreenenergy, Taipei, Taiwan
C.-C. Hsu
YunTech, Douliou, Taiwan

5BO.5.4 General, Robust and Scalable Methods for String Level Monitoring in Utility Scale PV Systems

A. Skomedal, M.B. Øgaard, J.H. Selj, H. Haug & E.S. Marstein
Institute for Energy Technology, Kjeller, Norway

5BO.5.5 Automated Performance Monitoring of Multiple Rooftop Systems Using a Single Machine Learning Algorithm

K. Shetty, Y. Kaushal, R. Dhavan & V. Murthy
Tata Power Solar Systems, Bangalore, India

5BO.5.6 Review of PV Array Interconnection Schemes for Maximum Power Operation under Partial Shading

M. Etarhouni, B. Chong & L. Zhang
The University of Leeds, United Kingdom

ORAL PRESENTATIONS 1BO.9

08:30 - 10:00 Novel Concepts for PV Modules

Chairpersons:

Francesco Roca
ENEA, Italy

Richard King
Arizona State University, United States

1BO.9.1 Preparation of 8.5% Sub-Module out of 5% Dye Sensitized Solar Cells by Omnidirectional Light Trapping and 3D Cell Array

Y.H.C. Sim
University of Science and Technology, Daejeon, Republic of Korea
M.J. Yun, S.I. Cha & D.Y. Lee
KERI, Changwon, Republic of Korea

1BO.9.2 Student Award Finalist Presentation: Wearable and Washable Photovoltaic Fabrics

A. Satharasinghe, T. Hughes-Riley & T. Dias
Nottingham Trent University, United Kingdom

1BO.9.3 Automation of Silicone Solar Module Production with Low-Cost Tape Interconnection Method

J. Buddgård, T. Lagerstedt & A. Machirant
JB EcoTech, Lidingö, Sweden

1BO.9.4 Accelerated Test Method of Environment-Induced PID for Encapsulation Materials of PV Modules

L.-C. Yu, Y.-T. Li, H.-L. Wu & H.-H. Hsieh
ITRI, Hsin-Chu, Taiwan

- 1BO.9.5 Lightweight PV Module Approach - Field Test Study and Yield Evaluation**
S. Schindler, D. Götz & D. Daßler
Fraunhofer CSP, Halle (Saale), Germany
- 1BO.9.6 Modelling and Optimization of Phase Change Materials (PCM) for Photovoltaic Module Cooling**
J.C. Ortiz Lizcano, C. van Nierop y Sanchez, Z. Haghighi, P. Luscuere, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

ORAL SESSION 4BO.13

08:30 - 10:00 Module Aging and Degradation

Chairpersons:

Christos Monokroussos
TÜV Rheinland, China

Stefan Winter
PTB, Germany

- 4BO.13.1 Photovoltaic Climate Zones: The Global Distribution of Climate Stressors Affecting Photovoltaic Degradation**
T. Karin & A. Jain
Lawrence Berkeley National Laboratory, United States
C. Birk Jones
Sandia National Laboratories, Albuquerque, United States
- 4BO.13.2 Durable PV Modules - Requirements for the Module Design and Aspects of Reliability Testing Techniques**
G. Mathiak, W. Herrmann & F. Reil
TÜV Rheinland Energy, Cologne, Germany
A. Morlier & M. Köntges
ISFH, Hamelin, Germany
S. Großer, M. Pander, S. Schindler, M. Turek & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany
- 4BO.13.3 Error Analysis of Aged Modules with Cracked Backsheets**
G.C. Eder & Y. Voronko
OFI, Vienna, Austria
W. Mühleisen & C. Hirschl
CTR, Villach, Austria
G. Oreski
PCCL, Leoben, Austria
H. Sonnleitner
ENcome Energy Performance, Klagenfurt, Austria

- 4BO.13.4 Measurement of the Changes in Elastic Properties of Polymeric Layers in a PV Module After Accelerated Aging Using Nanoindentation and Scanning Acoustic Microscopy**
D.E. Mansour, L. Verissimo Mesquita, D. Philipp & L. Pitta Bauermann
Fraunhofer ISE, Freiburg, Germany
P. Christoeffl
PCCL, Leoben, Austria
- 4BO.13.5 Weathering Stability of Alternative Polyolefin Encapsulants in Glass-Glass Modules**
A. Omazic & G. Oreski
PCCL, Leoben, Austria
G.C. Eder
OFI, Vienna, Austria
L. Neumaier & C. Hirschl
CTR, Villach, Austria
M. Edler
ISOVOLTAIC Solinex, Lebring, Austria
G. Pinter
University of Leoben, Austria
M. Erceg
University of Split, Croatia
- 4BO.13.6 Development of Inhomogeneities in Multi-Crystalline Silicon PV Modules over Two Years of Real Operating Conditions**
M. Bokalic, K. Brecl & M. Topič
University of Ljubljana, Slovenia

VISUAL PRESENTATIONS 3BV.1

08:30 - 10:00 CI(G)S, CdTe and Related Thin Film Solar Cells / III-V and Related Compound Semiconductor Based Devices

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

PLENARY SESSION 2BP.1

10:30 - 12:10 Silicon PV Highlights

Chairpersons:

Francesca Ferrazza
eni spa, Italy

Giso Hahn
University of Konstanz, Germany

2BP.1.1 Bulk Defects in Monocrystalline Silicon, Multicrystalline Silicon and Mono-Like Silicon Materials

H.C. Sio, S.P. Phang, H.T. Nguyen & D. Macdonald
ANU, Canberra, Australia

2BP.1.2 The Versatility of Passivating Carrier-Selective Silicon Thin Films for Diverse High-Efficiency Heterojunction-Based Solar Cells

A. Descoedres, J. Horzel, B. Paviet-Salomon,
L.-L. Senaud, G. Christmann, J. Geissbühler, P. Wyss,
N. Badel, J.-W. Schüttauf, C. Allebé, A. Faes, S. Nicolay,
C. Ballif & M. Despeisse
CSEM, Neuchâtel, Switzerland

2BP.1.3 Both Sides Contacted Silicon Solar Cells: Options for Approaching 26% Efficiency

A. Richter, J. Benick, F. Feldmann, A. Fell, B. Steinhäuser,
J.-I. Polzin, N. Tucher, J.N. Murthy, M. Hermle & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

2BP.1.4 Approaching 23 % and Mass Production of Bifacial p-Cz Q.ANTUM PERC Solar Cells

F. Stenzel, B.G. Lee, J. Cieslak, A. Schwabedissen,
D. Wissen, S. Geißler, T. Rudolph, B. Faulwetter-Quandt,
R. Hönig, R. Bakowskie, M. Schaper, A. Mette & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

2BP.1.5 Development of Industrial n-Type Bifacial TOPCon Solar Cells and Modules

W. Wu, H. Xia, S. Huang, J. Bao, L. Ma, X. Yuan, C. Chen,
J. Chen, N. Yang, R. Liu, Z. Qiao, J. Chen & Z. Liu
Jolywood, Taizhou, China

ORAL PRESENTATIONS 2BO.2

13:30 - 15:00 PolySi Passivating Contacts (I)

Chairpersons:

Yukimi Ichikawa
Tokyo City University, Japan

Jean-Paul Kleider
CNRS/GeePs, France

2BO.2.1 Efficiency Potential of the “Both Polarities Poly-Si Front Side Structured” (Boss) Cell and Its Elegant Realization by LPCVD

R. Peibst, C. Kruse, S. Schäfer, V. Mertens, T. Dullweber &
R. Brendel
ISFH, Emmerthal, Germany

2BO.2.2 Industrial Solar Cells Featuring Carrier Selective Front Contacts

J. Stuckelberger, D. Yan, P. Phang & D. Macdonald
ANU, Canberra, Australia
J. Yang, P. Zheng & X. Zhang
Jinko Solar, Haining, China

2BO.2.3 Electrical and Mechanical Characterization of Plated Ni/Cu/Ag Contacts on Polysilicon

B. Grübel, G. Cimiotti, V. Arya, F. Feldmann,
B. Steinhäuser & S. Kluska
Fraunhofer ISE, Freiburg, Germany

2BO.2.4 Integration Avenues in Solar Cells Implementing Passivating Contacts

J.J. Diaz Leon, C. Allebé, J. Horzel, G. Nogay,
A. Descoedres, G. Christmann, L. Ding, N. Badel,
M. Despeisse & S. Nicolay
CSEM, Neuchâtel, Switzerland
A. Ingenito & C. Ballif
EPFL, Neuchâtel, Switzerland

2BO.2.5 High Quality Passivating Contacts with Very Thin p+ or n+ Polysilicon Layers for Large-Area Crystalline Silicon Solar Cells

P.C.P. Bronsveld, A. Gutjahr, S.L. Luxembourg, E.G. Hoek,
M.K. Stodolny, A.A. Mewe & J. Löffler
ECN part of TNO, Petten, The Netherlands

2BO.2.6 Screen Printed Double-Side Contacted POLO-Cells with Ultra-Thin Poly-Si Layers

Y. Larionova, H. Schulte-Huxel, B. Min, M. Turcu,
R. Brendel & R. Peibst
ISFH, Emmerthal, Germany
T. Kluge & H. Mehlich
Meyer Burger, Hohenstein-Ernstthal, Germany

ORAL PRESENTATIONS 5BO.6

13:30 - 15:00 Imaging and Fault Detection in PV Systems

Chairpersons:

Peter Lechner
ZSW, Germany

Ulrike Jahn
TÜV Rheinland Energy, Germany

5BO.6.1 Field Experience of UVFL Inspection with Drone

J. Lin, B. Ku & S. Chen
PV Guider, Taipei, Taiwan

5BO.6.2 Photovoltaic Defect Classification through Thermal Infrared Imaging Using a Deep Learning Approach

C.W. Dunderdale, W.J. Brettenny, C.M. Clohessy &
E.E. van Dyk
Nelson Mandela University, Port Elizabeth, South Africa

5BO.6.3 Quantification of Yield Losses in Large-Scale Photovoltaic Power Plants Using Infrared Thermography

A. Chaudron, Q. van Nieuwenhoven, A. Lambert &
S. Scheerlinck
ENGIE Laborelec, Linkebeek, Belgium
T.-L. de Lophem & V. Punamiya
Sitemark, Leuven, Belgium

5BO.6.4 Student Award Finalist Presentation: Automatic Fault Detection of Photovoltaic Array by Convolutional Neural Networks during Aerial Infrared Thermography

A.K. Vidal de Oliveira & R. Rüter
UFSC, Florianópolis, Brazil
M. Aghaei
Albert-Ludwigs-University, Freiburg, Germany

5BO.6.5 Real-Time Fault Detection in Massive Multi-Array PV Plants Based on Machine Learning Techniques

C.-C. Hsu & J.-L. Li
YunTech, Douliou, Taiwan
Y.-S. Chen
Reforecast, Taichung, Taiwan

5BO.6.6 New Four-Stage Classification Method for Fault Detection and Diagnosis Applied to Photovoltaic Power Plants

A. Migan-Dubois & D. Diallo
GeePs, Gif-sur-Yvette, France
C. Delpha
University of Paris Sud, France

ORAL PRESENTATIONS 1BO.10

13:30 - 15:00 Novel Concepts for Materials and Solar Cells

Chairpersons:

Jozef (Jef) Poortmans
imec, Belgium

Pere Roca I Cabarrocas
CNRS, France

1BO.10.1 Direct Growth of III-V on Si for Tandem Solar Cells: Fabrication and Characterization of a GaAs Nanowire Top-Cell

R. de Lépinau, O. Lafont, B. Berenguer & L. Lombez
IPVF, Palaiseau, France
A. Scaccabarozzi, F. Oehler, H.-L. Chen, S. Collin &
A. Cattoni
CNRS, Marcoussis, France

1BO.10.2 Selective Passivation and Doping at Surfaces and Grain-Boundaries of Polycrystalline Ga_{0.37}In_{0.63}P

A. Chikhalkar, N.M. Kumar & R.R. King
Arizona State University, Tempe, United States

1BO.10.3 High Open-Circuit Voltage CuSbS₂ Solar Cells Achieved through the Formation of Epitaxial Growth of CdS/CuSbS₂ Hetero-Interface by Post-Annealing Treatment

Y. Zhang, J. Huang, M.A. Green & X. Hao
UNSW Australia, Sydney, Australia

1BO.10.4 2D Transition Metal Dichalcogenide MoS₂ for Fingerless Cell Application

T. Kamioka, T. Nishihara, Y. Hibino & A. Ogura
Meiji University, Kawasaki, Japan
Y. Hayashi, H. Lee, K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan

1BO.10.5 Naturally Formed Nanostructured Cu-In-Se Bulk Pn Homojunctions for Photovoltaic Devices

S. Menezes
InterPhases Solar, Moorpark, United States
A. Samantilleke
University of Minho, Braga, Portugal

1BO.10.6 Silicon Nanowire Based Hybrid Nanomaterials as Counter Electrodes for Dye-Sensitized Solar Cells

J. Kim, S.H. Jung, G.S. Choi, Y.B. Kim & S.M. Kim
GERI, Gumi, Republic of Korea

VISUAL PRESENTATIONS 3BV.2

13:30 - 15:00 **Perovskites Based Photovoltaics / Organic and Dye-Sensitised Devices / Tandems**

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

ORAL PRESENTATIONS 2BO.3

15:15 - 16:45 **PolySi Passivating Contacts (II)**

Chairpersons:

Arthur W. Weeber
ECN part of TNO, The Netherlands

Rasit Turan
METU, Turkey

2BO.3.1 **Modelling of Passivation and Conductivity of n-Type Poly-Si Layers Adapting Machine Learning**

S. Bordihn, B. Min, R. Peibst & R. Brendel
ISFH, Emmerthal, Germany

2BO.3.2 **LPCVD in-Situ n-Type Doped Polysilicon Process Throughput Optimization and Implementation into an Industrial Solar Cell Process Flow**

R.C.G. Naber & J.M. Luchies
Tempress, Vaassen, The Netherlands

2BO.3.3 **Polysilicon Layers Doped by Plasma Immersion Ion Implantation (PIII): New Paths for Industrial Processing of Passivated Contacts Solar Cells**

A. Veau, T. Desrues, C. Oliveau, A. Morisset, B. Martel & S. Dubois
CEA, Le Bourget-du-Lac, France
F. Torregrosa & L. Roux
Ion Beam Services, Peynier, France
A. Kaminski-Cachopo & Q. Rafhay
IMEP-LAHC, Grenoble, France

2BO.3.4 **Inkjet-Printing of Phosphorus and Boron Dopant Sources for Tunnel Oxide Passivating Contacts**

Z. Kiaee, C. Reichel, M. Nazarzadeh, R. Keding, F. Feldmann, J.D. Huyeng, M. Jahn, R. Singh, M. Hermle & F. Clement
Fraunhofer ISE, Freiburg, Germany

2BO.3.5 **SiOxNyB and SiNxP for Ex-Situ Doping of Poly-Si Passivated Contacts**

R. Cabal, A. Morisset, B. Grange & S. Dubois
CEA, Le Bourget du Lac, France

2BO.3.6 **The Roles of Poly-Si Layer in Poly-Si Passivating Contact Solar Cells**

H. Park, S.J. Park, S.H. Bae, J.Y. Hyun, C.H. Lee, D. Choi, D. Kang, H. Han, Y. Kang, H.-S. Lee & D.H. Kim
Korea University, Seoul, Republic of Korea

ORAL PRESENTATIONS 5BO.7

15:15 - 16:45 **Soiling, Degradation and Failure Diagnosis PV Systems**

Chairpersons:

Franck Al-Shakarchi
CEATECH-INES, France

Steve Ransome
Steve Ransome Consulting, United Kingdom

5BO.7.1 **Soiling Reduction by Modified PV Tracker**

B. Figgis
QEERI, Doha, Qatar
K. Ilse
Fraunhofer CSP, Halle (Saale), Germany

5BO.7.2 **SOLEIL Inno-PV Project Outputs: PV Modules Soiling Assessment and Development of Innovative Low Cost Cleaning Solutions**

A. Barhdadi, D. Dahlioui, B. Laarabi, S.M. Alaoui, M. Rhourri, Y. Rouas & A. Said
Mohammed V University, Rabat, Morocco
J. Boardman, G. Dambrine & E. Menard
HeliosLite, Le Bourget-du-Lac, France

5BO.7.3 **Improving Soiling Extraction: From Yearly to Monthly Soiling Rates**

L. Micheli, F. Almonacid & E.F. Fernández
University of Jaén, Spain

5BO.7.4 **Evaluation of Risk for Potential-Induced Degradation in Floating PV Systems**

H. Liu, W. Luo, A. Kumar & T. Reindl
SERIS, Singapore, Singapore
P. Hacke
NREL, Golden, United States

5BO.7.5 Degradation in PV Power Plants: Theory and Practice

K. Kiefer, B. Farnung & B. Müller
Fraunhofer ISE, Freiburg, Germany
K. Reinartz & I. Rauschen
Pohlen Solar, Geilenkirchen, Germany

5BO.7.6 Analysis of Digitized PV-Module/System Data for Failure Diagnosis

C. Buerhop-Lutz, T. Pickel, J. Teubner & J. Hauch
HI ERN, Erlangen, Germany
C.J. Brabec
FAU, Erlangen, Germany

ORAL PRESENTATIONS 4BO.11

15:15 - 16:45 PV Module Design / Wind Load / Soiling

Chairpersons:

Ana Rosa Lagunas
CENER, Spain

Eszter (Esther) Voroshazi
imec, Belgium

4BO.11.1 Thermomechanical Evaluation of New PV Module Designs by FEM Simulations

A.J. Beinert, P. Romer, M. Heinrich, M. Mittag & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany
J. Aktaa
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany

4BO.11.2 Digital Prototyping – Application of Numerical Methods in Module Development

M. Pander, U. Zeller, B. Jaeckel & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4BO.11.3 Boosting PV Module Efficiency Beyond the Efficiency of Its Solar Cells – An Optical Simulation Study

M.R. Vogt, R. Witteck, T. Gewohn, H. Schulte-Huxel,
M. Köntges, K. Bothe & R. Brendel
ISFH, Emmerthal, Germany
C. Schinke
Leibniz University of Hannover, Germany

4BO.11.4 Non-Uniform Wind Loads Test for Photovoltaic Module

S.-T. Hsu, W.-Y. Lin & C.F. Hsieh
ITRI, Hsinchu, Taiwan

4BO.11.5 Student Award Finalist Presentation: Physics of Soiling and Dust Adhesion - Lessons Learnt from Laboratory Soiling Tests

K. Ilse, M.Z. Khan, V. Naumann & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany

4BO.11.6 Test Protocol for PV Module Cleaning Equipment

N. Ferretti, A. El-Issa & L. Podlowski
PI Berlin, Germany

VISUAL PRESENTATIONS 1BV.3

15:15 - 16:45 Fundamental Studies / New Materials and Concepts for Cells and Modules

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

ORAL PRESENTATIONS 2BO.4

17:00 - 18:30 Advanced Concepts for Si-based Solar Cells

Chairpersons:

Joachim John
imec, Belgium

Ronald C.G. Naber
Tempress, The Netherlands

2BO.4.1 Diffused Thin LPCVD poly-Si Emitter and Surface Field for High Efficiency c-Si Solar Cell

G. Yang, A.W. Weeber, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

2BO.4.2 Electrode Design for Wire Interconnected Back Contact Solar Cells

A. Spribille, J.D. Huyeng, T. Schweigstill, I. Franzetti,
L.C. Rendler & F. Clement
Fraunhofer ISE, Freiburg, Germany

2BO.4.3 High-Resolution THz Imaging for Optimized polySi Patterning Process

A. Mewe, M. Stodolny, P. Manshanden, A. Gutjahr,
I. Cesar & J. Löffler
ECN part of TNO, Petten, The Netherlands

2BO.4.4 Development of Very Thin Rib Structure Si Hetero-Junction Solar Cells

Y. Ichikawa, Y. Osawa, H. Noge & M. Konagai
Tokyo City University, Setagaya-ku, Japan

2BO.4.5 Tunnel Contact IBC Cells: An Industrial Process Using Shadow Masking

B. Legradic, D. Lachenal, D.L. Bätzner, P. Papet, R. Kramer, T. Kössler, L. Andreetta, S. Pitteloud, N. Holm, C. Aeby, W. Frammelsberger & B. Strahm
Meyer Burger Research, Hauterive, Switzerland

2BO.4.6 Implementation and Characterization of Tunnel-Oxide Passivating Contacts for Single Junction c-Si and Perovskite/c-Si Tandem Solar Cells

A. Ingenito, F. Mayer, P. Wyss, M. Lehmann, A. Savoy, F. Sahli, J. Werner, Q. Jeangros, F.-J. Haug & C. Ballif
EPFL, Neuchâtel, Switzerland
C. Allebé, G. Nogay, J.J. Diaz Leon, J. Horzel, S. Nicolay & M. Despeisse
CSEM, Neuchâtel, Switzerland
S. Eswara, N. Valle & T. Wirtz
LIST, Belvaux, Luxembourg

ORAL PRESENTATIONS 3BO.8

17:00 - 18:30 III-V Cells for Space and Terrestrial Applications

Chairpersons:

Carsten Baur
European Space Agency, The Netherlands

Gianluca Timò
RSE, Italy

3BO.8.1 Bragg Reflector within Triple-Junction Solar Cells for Spectrum Splitting Applications

Y. Jiang, M.J. Keevers, N. Ekins-Daukes & M.A. Green
UNSW Australia, Sydney, Australia
P. Pearce
Imperial College London, United Kingdom
A. Berg, F. Wolf, W. Guter & M. Meusel
Azur Space, Heilbronn, Germany

3BO.8.2 Growth and Structure Optimization of 1.73eV MBE-Grown AlGaAs/InGaP Heterostructure Solar Cells

A. Ben Slimane, A. Bercegol, L. Lombez, J.-B. Puel & A. Julien
IPVF, Palaiseau, France
A. Michaud
Total New Energies, Palaiseau, France
O. Mauguin & X. Lafosse
CNRS, Paris, France
J.-F. Guillemoles, J.-C. Harmand & S. Collin
CNRS, Palaiseau, France

3BO.8.3 Status and Recent Results from the Development of Dynamic Hydride Vapor Phase Epitaxy toward Low-Cost, High-Efficiency III-V Solar Cells

A.J. Ptak, J. Simon, K.L. Schulte, W. Metaferia & A. Cavalli
NREL, Golden, United States

3BO.8.4 MIS Structures for Solar Cells Perimeter Passivation

A. Delamarre & J.-F. Guillemoles
CNRS, Palaiseau, France
H. Sodabanlu, K. Watanabe & M. Sugiyama
University of Tokyo, Japan

3BO.8.5 Overview of Concentrator Solar Cells and Analysis for Their Non-Radiative Recombination

M. Yamaguchi, K. Araki, K.-H. Lee & N. Kojima
Toyota Technological Institute, Nagoya, Japan

3BO.8.6 Photovoltaic Operation in the Low Atmosphere and at the Surface of Venus

J. Grandier, P. Gogna & J.A. Cutts
NASA, Pasadena, United States
A.P. Kirk & M.L. Osowski
MicroLink Devices, Niles, United States
P. Jahelka & H.A. Atwater
Caltech, Pasadena, United States
M.A. Stevens & T.E. Vandervelde
Tufts University, Medford, United States

ORAL PRESENTATIONS 4BO.12

17:00 - 18:30 Induced Degradation

Chairpersons:

Hartmut Nussbaumer
ZHAW, Switzerland

Roland Einhaus
Apollon Solar, France

4BO.12.1 Special Introductory Presentation: Prediction of Potential Power/Yield Loss from LeTID Susceptible Modules

M. Pander, B. Jaeckel, D. Daßler, U. Zeller & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany

4BO.12.2 LeTID - A Comparison of Test Methods on Module Level

E. Fokuhl, T. Naeem, A. Schmid, P. Gebhardt, T. Geipel & D. Philipp
Fraunhofer ISE, Freiburg, Germany

4BO.12.3 Field Performance of the Industrial Si Mono-Crystalline PERC Solar Module Arrays with the Use of Advanced Hydrogenation Technologies

S. Wang & K.N. Lim
NTU Singapore, Singapore
C.M. Chong
UNSW Australia, Sydney, Australia
M. Tan
CEC Energy, Singapore, Singapore

4BO.12.4 Towards a Complete Prediction of PID in Crystalline Silicon Modules in Real Field Conditions

E. Annigoni, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland

4BO.12.5 Potential-Induced Degradation of n-Type Front-Emitter Crystalline Silicon Photovoltaic Modules with Different Degradation Stages

K. Ohdaira, Y. Komatsu, T. Suzuki & S. Yamaguchi
JAIST, Ishikawa, Japan
A. Masuda
AIST, Tsukuba, Japan

VISUAL PRESENTATIONS 6BV.4

17:00 - 18:30 PV on/in Buildings, Infrastructure, Landscape, Water and Nature / Professional Applications of PV

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

4CO.1 T4.1 Audit 1	3CO.5 T3.1 Audit 3	2CO.9 T2.2/3 Audit 4	5CO.13 T5.2/3 Audit 2	6CV.1 T6.3 Poster Area
Break				
10:30 3CP.1 (90 min plenary) Auditorium 1 12:00				
Lunch				
4CO.2 T4.1 Audit 1	3CO.6 T3.1 Audit 2	2CO.10 T2.3 Audit 4	5CO.14 T5.4 Audit 3	12:45 2CV.2 T2.1/4/5/6 Poster Area
Break				
4CO.3 T4.1 Audit 1	3CO.7 T3.3/5 Audit 2	2CO.11 T2.3 Audit 4	6CO.15 T6.3 Audit 3	5CV.3 T5.1/2/4/5 Poster Area
Break				
4CO.4 T4.1 Audit 1	3CO.8 T3.5 Audit 2	2CO.12 T2.5 Audit 4	6CO.16 T6.3 Audit 3	5CV.4 T5.3 Poster Area

2 Silicon Materials and Cells

- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices

- T3.1 Perovskites Based Photovoltaics
- T3.2 Cl(G)S, CdTe and Related Thin Film Solar Cells
- T3.3 Organic and Dye-Sensitised Devices
- T3.4 III-V and Related Compound Semiconductor Based Devices
- T3.5 Tandems

4 Photovoltaic Modules and BoS Components

- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

5 PV Systems and Storage – Modelling, Design, Operation and Performance

- T5.1 Solar Resource and Forecasting
- T5.2 Design and Installation of PV Systems
- T5.3 Operation, Performance and Maintenance of PV Systems
- T5.4 Storage
- T5.5 Concentrators and PV for Space Applications

6 PV Applications and Integration

- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

ORAL PRESENTATIONS 4CO.1

08:30 - 10:00 Imaging Techniques and Characterisation

Chairpersons:

Yoshihiro Hishikawa
AIST, Japan

Henning Nagel
Fraunhofer ISE, Germany

4CO.1.1 Quantitative Mapping of PV Modules Performance Using Electroluminescence-Based Imaging

G. El Hajje, J. Dupuis, D. Binesti & P. Dupeyrat
EDF R&D, Ecuelles, France

4CO.1.2 Applying Deep Learning Algorithms to EL-Images for Predicting the Module Power

C. Buerhop-Lutz, T. Pickel & J. Hauch
HI ERN, Erlangen, Germany
M. Hoffmann, L. Reeb, C.J. Brabec & A. Maier
FAU, Erlangen, Germany

4CO.1.3 Method for Automatic Calculation of the Exposure Time in Electroluminescence Imaging of Photovoltaic Modules

S.V. Spataru, D. Sera & H.R. Parikh
Aalborg University, Denmark
G.A. dos Reis Benatto, C. Mantel, P.B. Poulsen & S. Forchhammer
Technical University of Denmark, Roskilde, Denmark

4CO.1.4 Application of Suns-Photoluminescence to Extract Implied I-V Curves of Individual Cells in Modules Installed in the Field

R. Bhoopathy, O. Kunz, R. Dumbrell, T. Trupke & Z. Hameiri
UNSW Australia, Sydney, Australia

4CO.1.5 Procedures for Angular Mismatch Correction – Development of an International Standard Proposal

F. Plag & S. Winter
PTB, Braunschweig, Germany

4CO.1.6 Test Method for Current-Voltage Performance Measurement and the Analysis of Hysteresis Effect of Perovskite PV Modules

J.Q. Gao, E. Lee, C. Monokroussos & C. Zou
TÜV Rheinland, Shanghai, China

ORAL PRESENTATIONS 3CO.5

08:30 - 10:00 Perovskite Based Photovoltaics (I)

Chairpersons:

Blagovest Mihaylov
CSIRO, Australia

Christopher Case
Oxford PV, United Kingdom

3CO.5.1 The Physics of Ion Migration in Perovskite Solar Cells: Insights into Hysteresis, Device Performance and Characterisation

D. Lan & M.A. Green
UNSW Australia, Sydney, Australia

3CO.5.2 Student Award Finalist Presentation: Multidimensional Luminescence Imaging of Electron/Hole Transport in Triple Cation Perovskite

A. Bercegol, S. Cacovich & L. Lombez
IPVF, Palaiseau, France
D. Ory, S. Jutteau & J. Rousset
EDF R&D, Palaiseau, France
C. Longeaud
CNRS, Gif-sur-Yvette, France
J.-F. Guillemoles
CNRS, Palaiseau, France

3CO.5.3 Textured Perovskite Single-Junction Solar Cells for Improved Optics

P. Fiala, J. Werner, F. Fu, T.-C. Yang, M. Bräuninger, F. Sahli, R. Razera, Q. Jeangros & C. Ballif
EPFL, Neuchâtel, Switzerland
B. Ruhstaller
ZHAW, Winterthur, Switzerland

3CO.5.4 Pb Free and Pb Less Perovskite Solar Cells with Narrow Band Gap- Aiming at High Efficiency and All Perovskite Tandem Solar Cells

S. Hayase, K.M. Akmal, K. Nishimura, D. Hirotsu, C.H. Ng, K. Hamada & S. Iikubo
Institute of Technology, Kitakyushu, Japan
G. Kapil & H. Segawa
University of Tokyo, Japan
Q. Shen
University of Electro-Communication, Chofu, Japan
T. Minemoto
Ritsumeikan University, Kusatsu, Japan
K. Yoshino
University of Miyazaki, Japan

3CO.5.5 Slot-Die Coating of Double-Cation Perovskite Solar Cells from Ink Tuning to High Efficiency Devices

M. Fievez, C. Roux, M. Manceau, F. Ardiaca, S. Cros & S. Berson
CEA, Le Bourget du Lac, France

3CO.5.6 Methylammonium-Free, High-Performance, and Stable Perovskite Solar Cells on a Planar Architecture

S.H. Turren Cruz
HZB, Berlin, Germany
A. Hagfeldt
EPFL, Lausanne, Switzerland
M. Saliba
Adolphe Merkel Institute, Fribourg, France

ORAL PRESENTATIONS 2CO.9

08:30 - 10:00 TCOs and Surface Passivation

Chairpersons:

Yoshio Ohshita
Toyota Technological Institute, Japan

Stefan W. Glunz
Fraunhofer ISE, Germany

2CO.9.1 Student Award Finalist Presentation: Fired Hydrogenated AZO Layers: A New Passivation Approach for High Temperature Passivated Contact Solar Cells

E. Bruhat, T. Desrues, B. Martel, R. Cabal & S. Dubois
CEA, Le Bourget du Lac, France
D. Blanc-Pélissier
INSA Lyon, France

2CO.9.2 Phosphorus Oxide / Aluminum Oxide Stacks: A Highly Promising Passivation Scheme for n-Type Si Regions in Solar Cells

J. Melskens, R.J. Theeuwes, S.H. Tempel, M. Dielen, L.E. Black, W.-J.-H. Berghuis, B. Macco & W.M.M. Kessels
Eindhoven University of Technology, The Netherlands
E. Hoek & P.C.P. Bronsveld
ECN part of TNO, Petten, The Netherlands

2CO.9.3 Field-Effect Passivation Enhancement by Introducing Nanopyramid Gratings for Light Management in Homo Junction Silicon Solar Cells

A. Razaq, V. Depauw, J. John, I. Gordon, J. Szlufcik & J. Poortmans
imec, Leuven, Belgium

2CO.9.4 Impact of TCO Sputtering Parameters on Silicon Heterojunction Solar Cell Passivation Properties

A. Cruz, A.B. Morales-Vilches, E.C. Wang, S. Neubert, R. Schlatmann & B. Stannowski
HZB, Berlin, Germany
B. Szyszka
Berlin University of Technology, Germany

2CO.9.5 Bringing Tungsten-Doped Indium Oxide to Manufacturing Maturity for High Efficiency Silicon Heterojunction Solar Cells

J.-F. Lerat, M. Tomassini, V. Barth & D. Muñoz
CEA, Le Bourget du Lac, France
G. Christmann, L. Ding, J.J. Diaz Leon & S. Nicolay
CSEM, Neuchâtel, Switzerland

2CO.9.6 Improving Organic-Silicon Heterojunction Solar Cells through the Admixture of Sorbitol to PEDOT:PSS

M.-U. Halbich & J. Schmidt
ISFH, Emmerthal, Germany
R. Sauer-Stieglitz & W. Lövenich
Heraeus, Leverkusen, Germany

ORAL PRESENTATIONS 5CO.13

08:30 - 10:00 Microgrids, Grid Integration and Simulation of PV Systems

Chairpersons:

Mauricio Richter
3E, Belgium

Dirk Stellbogen
ZSW, Germany

5CO.13.1 Full-Scale Simulation and Experimentation Platforms for PV-Diesel Microgrid Control and Design: From Design to Stability Studies

T.-P. Do, X. Le Pivert & F. Bourry
CEA, Le Bourget-du-Lac, France
J. Colas
Cap Vert Energie, Marseille, France

5CO.13.2 Sizing of a PV/Battery System through Stochastic Control and Plant Aggregation

T. Carriere, F.-P. Neirac & G. Kariniotakis
Mines ParisTech, Sophia-Antipolis, France
C. Vernay & S. Pitaval
SOLAIS, Sophia-Antipolis, France

5CO.13.3 Ramp Rate Control for PV Plant Integration: Experience from Karratha Airport's PV Farm

G. Dickeson, L. McLeod, L. Frearson & B. Herteleer
Ekistica, Alice Springs, Australia
A. Dobb
ARENA, Canberra, Australia

5CO.13.4 Testing of Microgrid Control Systems According to IEEE 2030.8 – Experiences and Learnings from Laboratory Tests

C. Messner, C. Seidl & T.I. Strasser
AIT, Vienna, Austria
J. Jimeno, A. Perez-Basante, J. Merino & E. Rodríguez
Tecnalia, San Sebastián, Spain
J. Hashimoto
AIST, Tsukuba, Japan

5CO.13.5 Photovoltaic (PV) Winter Electricity in the Swiss Energy Strategy 2050

U. Muntwyler, T. Schott & E. Schüpbach
BUAS, Burgdorf, Switzerland

5CO.13.6 Cross-Validation of PV System Simulation Software

A. Driesse & N. Patel
PV Performance Labs, Freiburg, Germany

VISUAL PRESENTATIONS 6CV.1

08:30 - 10:00 PV Driven Energy Management and System Integration

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

PLENARY SESSION 3CP.1

10:30 - 12:00 Perovskite, Organic, CIGS and III-V Multi-Junction Devices

Chairpersons:

Ayodhya Nath Tiwari
EMPA, Switzerland

Christophe Ballif
EPFL, Switzerland

3CP.1.1 Keynote Presentation: Research and Innovation in CIGS and its Alloys - Which are the Next Bottlenecks?

M. Edoff
Uppsala University, Sweden

3CP.1.2 Towards Highly Efficient Monolithic Tandem Devices with Perovskite Top Cells

M. Jost, E. Köhnen, A. Al-Ahouri, L. Korte, B. Stannowski & S. Albrecht
HZB, Berlin, Germany

3CP.1.3 Recent Progress of Solar Cell Development for CPV Applications at AZUR SPACE

R. van Leest, D. Fuhrmann, A. Frey & M. Meusel
Azur Space, Heilbronn, Germany
G. Siefer & S.K. Reichmuth
Fraunhofer ISE, Freiburg, Germany

3CP.1.4 Power Performance and Thermal Operation of Organic Photovoltaic Modules in Real Operating Conditions: Performance of Emerging PV Materials

G. Bardizza, E. Salis & E.D. Dunlop
European Commission JRC, Ispra, Italy
C.A. Toledo Arias
UPCT, Cartagena, Spain

VISUAL PRESENTATIONS 2CV.2

12:45 - 15:00 Feedstock, Crystallisation, Wafering, Defect Engineering / Thin Film and Foil-Based Si Solar Cells / Characterisation & Simulation of Si Cells

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

ORAL PRESENTATIONS 4CO.2

13:30 - 15:00 Outdoor Performance

Chairpersons:

Werner Herrmann
TÜV Rheinland Energy, Germany

Tom Betts
Loughborough University, United Kingdom

4CO.2.1 Performance Assessment of Various PV Module Types under Desert Conditions through Device Simulations and Outdoor Measurements

T. Katsaounis & A. Tzavaras
KAUST, Thuwal, Saudi Arabia
K. Kotsovos, I. Gereige, A. Basaheeh, M. Abdullah,
A. Khaiyat, E. Al Habshi & A. Al Saggaf
Saudi ARAMCO, Thuwal, Saudi Arabia

4CO.2.2 Outdoor Performance Quantification and Understanding of Various PV Technologies using the IEC 61853 Matrix

R.M.E. Valckenborg
SEAC, Eindhoven, The Netherlands
B.B. Van Aken
ECN part of TNO, Petten, The Netherlands

4CO.2.3 Improving the Yield by Designing the Module for a Climatic Region

S. Ramesh, G.J.M. Janssen & B.B. Van Aken
ECN part of TNO, Petten, The Netherlands

4CO.2.4 Thermal Modelling of Photovoltaic Modules in Operation and Production

M. Mittag, L. Vogt, C. Herzog & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4CO.2.5 Energy Yield of Coloured PV Modules in the Field

G. Friesen & R.R. Molinero
SUPSI, Canobbio, Switzerland

4CO.2.6 Assessment of the Rear Irradiance on Bifacial Silicon PV Modules

J. Lopez-Garcia, R.S.R. Gali, E. Grau-Luque, R.P. Kenny & T. Sample
European Commission JRC, Ispra, Italy

ORAL PRESENTATIONS 3CO.6

13:30 - 15:00 Perovskite Based Photovoltaics (II)

Chairpersons:

Giorgio Bardizza
European Commission JRC, Italy

Wolfgang Tress
EPFL, Switzerland

3CO.6.1 Perovskite Meta-Stability Effects in Hysteresis-Free Measurements

B. Mihaylov, B.C. Duck, K.F. Anderson, T.W. Jones,
J. Wang, N.W. Duffy, C.J. Fell & G.J. Wilson
CSIRO, Mayfield West, Australia

3CO.6.2 Energy Rating for Evaluating Performance of Perovskite and Perovskite-on-Silicon Tandem Devices in Real-World Conditions

J.C. Blakesley & G. Koutsourakis
NPL, Teddington, United Kingdom

3CO.6.3 In Situ Metrology for Degradation Studies of Perovskite Solar Cells

G. Koutsourakis, S. Wood, Y. Cao, J.C. Blakesley, S. Ravi & F. Araujo de Castro
NPL, Teddington, United Kingdom
K.D.G. Imalka Jayawardena, I.R.M. Bandara & P. Silva
University of Surrey, Guildford, United Kingdom

3CO.6.4 Processing of Large Area Perovskite-Based Solar Devices: High Efficiency and Stability Assessment

M. Manceau, C. Roux, N. Nguyen, F. Ardiaca, S. Cros,
M. Matheron, N. Lemaître & S. Berson
CEA, Le Bourget du Lac, France

3CO.6.5 Enhancing Performance of CH₃NH₃PbI₃ Perovskite Solar Cell with Low-Pressure Control via Sandwich Evaporation Technique

C.-H. Kuan, P.-T. Kuo, H.-C. Hsu, W.C. Chang & C.-F. Lin
NTU, Taipei, Taiwan

3CO.6.6 Efficient Stable Semi-Transparent p-i-n Perovskite Solar Cells and Module via Up-Scalable Deposition Methods

F. Di Giacomo, V. Zardetto, D. Zhang, H. Fledderus,
I. Dogan, W. Verhees, M. Najafi, H. Lifka, Y. Galagan,
P. Poodt, S.C. Veenstra & R. Andriessen
TNO, Eindhoven, The Netherlands
C. Burgess & M. Creatore
Eindhoven University of Technology, The Netherlands
T. Aernouts
imec, Genk, Belgium

ORAL PRESENTATIONS 2CO.10

13:30 - 15:00 Heterojunction Solar Cells (I)

Chairpersons:

Delfina Muñoz
CEA, France

Barbara Terheiden
University of Konstanz, Germany

2CO.10.1 Final Report of the EU H2020 Project - NextBase: An European Collaboration for Cost Competitive and High Efficiency Interdigitated Back-Contact Silicon Heterojunction Solar Cell Technology

K. Ding, A. Gad, M. Pomaska & S. Haas
Forschungszentrum Jülich, Germany

B. Paviet-Salomon, L.-L. Senaud, N. Badel, A. Faes,
J. Champliand & M. Despeisse
CSEM, Neuchâtel, Switzerland

E. Voroshazi, T. Borgers,
H. Sivaramakrishnan Radhakrishna & I. Gordon
imec, Leuven, Belgium

L. Korte & B. Stannowski
HZB, Berlin, Germany

A. Tomasi, A.N. Fioretti, M. Boccard & C. Ballif
EPFL, Neuchâtel, Switzerland

J. Bartsch & M. Glatthaar
Fraunhofer ISE, Freiburg, Germany

P.A. Procel Moya, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

R. Vasudevan, S. Harrison & D. Muñoz
CEA, Le Bourget du Lac, France

A. Fejfar & M. Ledinsky
FZU, Prague, Czech Republic

D. Lachenal & B. Strahm
Meyer Burger Research, Neuchâtel, Switzerland

A. Canino & D. Proietti
ENEL Green Power, Catania, Italy

I.J. Bennett & J. Gaury
DSM Innovation, Urmond, The Netherlands
S. Senkader

Norwegian Crystals, Oslo, Norway
F. Versluis, I. Claassen & A. Molinari

Uniresearch, Delft, The Netherlands

2CO.10.2 Student Award Finalist Presentation: Bottom-Up vs Top-Down Approaches for Identifying and Mitigating the Transport Losses in High-Efficiency Silicon Heterojunction Solar Cells

L.-L. Senaud, A. Descoedres, G. Christmann,
J. Geissbühler, N. Badel, P. Wyss, J.-W. Schüttauf,
C. Allebé, S. Nicolay, M. Despeisse,
C. Ballif & B. Paviet-Salomon
CSEM, Neuchâtel, Switzerland

2CO.10.3 Passivation vs. Microstructural Properties of Dual Intrinsic a-Si:H Layers for SHJ

J. Temmler, L. Bodlak, A. Moldovan & J. Rentsch
Fraunhofer ISE, Freiburg, Germany

2CO.10.4 Exploring Solar Cell Efficiency Limits Using Thin CZ-Quality Substrates

A. Augusto, P. Balaji, J. Karas, W.J. Dauksher &
S.G. Bowden
Arizona State University, Tempe, United States

2CO.10.5 Impact of Wafer Thickness on Temperature Coefficients in Silicon Heterojunction Solar Cells

H. Sai, T. Oku, Y. Sato, M. Tanabe & T. Matsui
AIST, Tsukuba, Japan

2CO.10.6 Bifaciality Optimization of Silicon Heterojunction Solar Cells

A. Danel, J. Eymard, F. Pernoud, J. Diaz, M. Debourdeau,
A. Bettinelli, L. Basset, S. Harrison, R. Varache,
E. Gerritsen, P.-J. Ribeyron & C. Roux
CEA, Le Bourget du Lac, France

ORAL PRESENTATIONS 5CO.14

13:30 - 15:00 Storage

Chairpersons:

Pascal Lalanne
HydroClapeyron, France

Francesco Dolci
European Commission JRC, The Netherlands

5CO.14.1 Short Term Power Fluctuation Smoothing with a Flywheel Energy Storage System

E. Toutain & J. Callec
EDF R&D, Moret-sur-Loing, France

5CO.14.2 Experience on MW-Sized Hybrid PV, Battery Storage and Genset System; Case Study of St. Eustatius Island
E. Garralaga Rojas, H. Sadri & W. Krueger
SMA Sunbelt Energy, Niestetal, Germany

5CO.14.3 Demonstration of a Novel HBr-Flow Battery for Grid Integration of PV
J. Kester
ECN part of TNO, Petten, The Netherlands
J. Lauret
ELESTOR, Arnhem, The Netherlands
R. van de Kar
Gemeente Noordoostpolder, Emmeloord, The Netherlands
S. Tuinstra
Bij ZON, Spanbroek, The Netherlands
P. Puttkammer
Witteveen+Bos, Deventer, The Netherlands

5CO.14.4 Sizing of Grid-Connected PV-Battery Systems: Technical and Economical Simulator
J.C. Solano
Universidad Nacional de Loja, Ecuador
E. Caamaño-Martín & L. Olivieri
UPM, Madrid, Spain
M.C. Brito
University of Lisbon, Portugal

5CO.14.5 Data-Driven Approach for SOH Estimation and Alarms Generation for Complex On-Grid Energy Storage Systems
F. Karoui, D.-L. Ha & T. Delaplagne
CEA, Le Bourget du Lac, France
M.-F. Bouaziz
Sogeti High-Tech, Montbonnot Saint-Martin, France

5CO.14.6 Everflow® Redox Flow Batteries: Technology Status and Field Experience
M. Schönleber
Schmid-Group, Freudenstadt, Germany

ORAL PRESENTATIONS 4CO.3

15:15 - 16:45 Interconnects and Soldering

Chairpersons:

Tony Sample
European Commission JRC, Italy

Mike Van Iseghem
EDF R&D, France

4CO.3.1 Electrically Optimized Module Concepts to Compensate Transient Shading Situations by Means of Passive Elements
H. Hanifi, C. Reyhe & B. Jaeckel
Fraunhofer CSP, Halle (Saale), Germany
J. Schneider
Fraunhofer IMWS, Halle (Saale), Germany

4CO.3.2 High Efficiency Module Using Improved Anti-Reflective Coating and Based on Multi-Wire Interconnection of Back-Contacted Silicon Heterojunction Solar Cells
A. Faes, B. Paviet-Salomon, L.-L. Senaud, C. Wütrich, P. Wyss, C. Allebé, G. Christmann, A. Descoedres, J. Geissbühler, J. Champlaud, N. Badel, E. Muliqi, M. Despeisse & C. Ballif
CSEM, Neuchâtel, Switzerland
D. Lachenal, P. Papet & B. Strahm
Meyer Burger Research, Huterive, Switzerland
N.E. Voicu & I.J. Bennett
DSM Innovation, Geleen, The Netherlands
B. Bonnet-Eymard & R. Grischke
Meyer Burger, Gwatt, Switzerland

4CO.3.3 Industrialization of the Ribbon Interconnection of Silicon Heterojunction Solar Cells with Electrically Conductive Adhesives
T. Geipel, V. Nikitina, L. Pitta Bauermann, E. Fokuhl, E. Schnabel, D. Erath, A. Krieg & A. Kraft
Fraunhofer ISE, Freiburg, Germany
T. Fischer, R. Lorenz & D. Breitenbücher
teamtechnik, Freiberg, Germany

4CO.3.4 Effect of Solder Configurations on Finger Breakages in Photovoltaic Modules under Thermal Cycling Conditions
S. Kumar, S. Roy & R. Gupta
IIT Bombay, Mumbai, India

4CO.3.5 Quantitative Evaluation of Soldering Contacts during Thermal Cycling Magnetic Field Imaging (MFI)
M. Patzold, K. Kaufmann, C.-M. Lin, M. Rudolph & D. Lausch
DENKweit, Halle (Saale), Germany

- 4CO.3.6 Module Integration of SHJ Cells by Soldering**
B. Commault, P. Lefillastre, S. Bernardis, A. Bettinelli,
J. Diaz, M. Debourdeau & F. Pernoud
CEA, Le Bourget du Lac, France

ORAL PRESENTATIONS 3CO.7

15:15 - 16:45 Organic and Dye-Sensitised Devices / Optimization of Perovskite Silicon Tandems

Chairpersons:

Sjoerd Veenstra
ECN part of TNO, The Netherlands

Hubert Hauser
Fraunhofer ISE, Germany

- 3CO.7.1 Tailoring Indium-Free Electrodes for Increased Intrinsic Absorption in the Active Layer of Organic Solar Cells**

M.A. Cherif, D. Barakel & P. Torchio
Aix Marseille University, France
S. Touihri
ENSIT, Tunis, Tunisia

- 3CO.7.2 Applying Lessons from Leaf Anatomy and Array Structure to the Development of Solar Cells Exhibiting Enhanced Electricity Production**

M.J. Yun, Y.H. Sim, S.I. Cha & D.Y. Lee
KERI, Changwon, Republic of Korea

- 3CO.7.3 Development of Flexible CIGS and Flexible Perovskite-CIGS 4-Terminal Tandem**

M. Simor, V. Zardetto, M. Najafi, M. van der Vleuten,
S. Veenstra & H. Linden
TNO, Eindhoven, The Netherlands
T. Aernouts
imec, Genk, Belgium

- 3CO.7.4 Energy Yield Modelling of Perovskite-Based Tandem Photovoltaics**

M. Langenhorst, R. Schmager, U.W. Paetzold, J. Lehr,
U. Lemmer & B.S. Richards
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany

- 3CO.7.5 Design Rules to Fully Benefit from Bifaciality in Two-Terminal Tandem Solar Cells**

O. Dupré, A. Tuomiranta, Q. Jeangros, M. Boccard &
C. Ballif
EPFL, Neuchâtel, Switzerland
P.-J. Alet
CSEM, Neuchâtel, Switzerland

- 3CO.7.6 Optical Assessment of Perovskite-Enhanced Bifacial Silicon Solar Modules**

K. Jäger, P. Tillmann, L. Korte, E. Unger & C. Becker
HZB, Berlin, Germany
A. Tejada
PUCP, Lima, Peru
A. Karsenti & L. Kreinin
SolAround, Jerusalem, Israel
I. Visoly-Fisher & E.A. Katz
BGU, Beer-Sheva, Israel

ORAL PRESENTATIONS 2CO.11

15:15 - 16:45 Heterojunction Solar Cells (II)

Chairpersons:

Jan Schmidt
ISFH, Germany

Mathieu Despeisse
CSEM, Switzerland

- 2CO.11.1 Design and Characterization of High-Efficiency Silicon Heterojunction Solar Cells**

J. Dréon, M. Boccard, L. Antognini, J. Cattin, O. Dupré,
A.N. Fioretti, J. Haschke, V. Paratte, S. Zhong & C. Ballif
EPFL, Neuchâtel, Switzerland

- 2CO.11.2 Challenges and Performances in SHJ Solar Cell Area Upscaling: Effects of Cell Active Area vs. Aperture Area on IV Parameters and Understanding Edge Losses**

S. Janke, E.C. Wang, A.B. Morales-Vilches, T. Henschel,
A. Cruz, R. Schlatmann & B. Stannowski
HZB, Berlin, Germany

- 2CO.11.3 Developing Low-Cost p-Type Homo-Heterojunction Solar Cells**

D. Chen, A.H. Soeriyadi, M. Kim, M. Wright,
B. Vicari Stefani & B. Hallam
UNSW Australia, Sydney, Australia
J. Shi, W. Weigand & Z.C. Holman
Arizona State University, Tempe, United States

2CO.11.4 Interconnection of Silicon Heterojunction Solar Cells by Infrared Soldering - Solder Joint Analysis and Temperature Study

A. De Rose, T. Geipel, D. Eberlein & A. Kraft
Fraunhofer ISE, Freiburg, Germany
M. Nowotnick
University of Rostock, Germany

2CO.11.5 Development and Manufacturing of Silicon Heterojunction Solar Cells

J. Wang & H. Yan
Beijing University of Technology, China
C. Yu, W. Long, C.-W. Peng, G. Dong, M. Qu, M. Yang,
C.-H. Lu, Y. Li & X. Xu
Hanergy Thin Film Power, Chengdu, China

2CO.11.6 The Race for High Efficiency in Production: Why Heterojunction is Now Ready for Market

D. Muñoz & C. Roux
CEA, Grenoble, France

6CO.15.4 From Solitary Pro-Sumers to Energy Community: Quantitative Assessment of the Benefits of Sharing Electricity

M. Lovati, J. Adami, M. Dallapiccola, L. Maturi & D. Moser
Eurac Research, Bolzano, Italy

6CO.15.5 Self-Consumption Rate Achieved by the Bifacial East West Vertical PV System Compared to the Conventional South Facing System in Nordic Conditions

S. Ranta, H. Huerta & A. Heinonen
TUAS, Turku, Finland
J.S. Stein
Sandia National Laboratories, Albuquerque, United States
E. Whitney
UAF, Fairbanks, United States

6CO.15.6 Long Term EV Parking Spaces for Behind-the-Meter Storage of Solar Energy - A Simulation Study

R. Ghotge & A.J.M. van Wijk
Delft University of Technology, The Netherlands

ORAL PRESENTATIONS 6CO.15

15:15 - 16:45 Smart PV and Prosumers

Chairpersons:

Ingrid Weiss
WIP Renewable Energies, Germany

Bruno Gaiddon
HESPUL, France

6CO.15.1 An Online Multi-Scale Optimization Framework for Smart PV Systems

D. Watari, I. Taniguchi & T. Onoye
University of Osaka, Suita, Japan
P. Manganiello, H. Goverde & F. Catthoor
imec, Heverlee, Belgium

6CO.15.2 Washing with the Sun; Two Residential Smart Grid Pilots in The Netherlands

C. Gerçek & A. Reinders
University of Twente, Enschede, The Netherlands

6CO.15.3 Impact of Behavior on Using Photovoltaics to Charge Electric Vehicles: Systematic Analysis

N. Pflugradt & U. Muntwyler
BUAS, Burgdorf, Switzerland

VISUAL PRESENTATIONS 5CV.3

15:15 - 16:45 Solar Resource and Forecasting / Design and Installation of PV Systems / Storage / Concentrators and PV for Space Applications

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

NOTES

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ORAL PRESENTATIONS 4CO.4

17:00 - 18:30 Module Materials

Chairpersons:

Gernot Oreski
PCCL, Austria

William J. Gambogi
DuPont, United States

4CO.4.1 Special Introductory Presentation: Analysis of Fielded PV-Modules with Backsheet Issues

P. Lechner, H. Wirth, J. Schnepf, S. Hummel & D. Geyer
ZSW, Stuttgart, Germany
B. Weinreich & R. Haas
HaWe Engineering, Gauting-Hausen, Germany

4CO.4.2 Dual Sorption Modelling of Water Ingress in PV Encapsulants Using a Heterogeneous Mesh in Finite Element Simulations

S. Mitterhofer, M. Jankovec & M. Topič
University of Ljubljana, Slovenia
C. Barretta, L.F. Castillon Gandara & G. Oreski
PCCL, Leoben, Austria
D. Moser
Eurac Research, Bolzano, Italy

4CO.4.3 Post-Processing Thickness Variation of PV Module Materials and Its Impact on Temperature, Mechanical Stress and Power

A. Pfreundt, D. Yucebas, A.J. Beinert, P. Romer & M. Mittag
Fraunhofer ISE, Freiburg, Germany

4CO.4.4 Double Layer Encapsulation Film for PV Modules Operating at High Voltage

S.C. Pop
SCP SYS, San Francisco, United States
J. Kapur
DuPont, Wilmington, United States
P. Hacke & M. Kempe
NREL, Golden, United States
R.N. Schulze
Sunrun, San Francisco, United States
X. Wang
Yingli Green Energy, Philadelphia, United States

4CO.4.5 Incidence Angle Modifier Evaluation for DSM Coating Technologies

P. Pasmans & P. Tummers
DSM Materials Science, Geleen, The Netherlands
N. Voicu
DSM Advanced Solar, Geleen, The Netherlands
A. Faes, J. Levrat, J. Champlaud & M. Despeisse
CSEM, Neuchâtel, Switzerland
M. Caccivio
SUPSI, Canobbio, Switzerland
B. Custodio
Enertis Solar, San Francisco, United States
F. Dross
DSM Innovation, Parsippany, United States

ORAL PRESENTATIONS 3CO.8

17:00 - 18:30 Perovskite Silicon Tandem Devices

Chairpersons:

Steve Albrecht
HZB, Germany

Shuzi Hayase
Institute of Technology, Japan

3CO.8.1 High-Efficiency Monolithic Perovskite/Silicon Tandem Solar Cells

F. Sahli, J. Werner, F. Fu, V. Paratte, R. Monnard, P. Fiala, T.-C. Yang, M. Bräuning, R.A.Z. Razera, M. Boccard, A. Ingenito, Q. Jeangros & C. Ballif
EPFL, Neuchâtel, Switzerland
G. Nogay, A. Walter, S. Rafizadeh, B.A. Kamino, M. Despeisse & S. Nicolay
CSEM, Neuchâtel, Switzerland

3CO.8.2 Unravelling Degradation of Perovskite Solar Cells and Long-Term Impact on Perovskite/Silicon Tandem Modules

M. Ernst, J. Qian, N. Wu & A. Blakers
ANU, Canberra, Australia

3CO.8.3 Student Award Finalist Presentation: Capacitance-Voltage Characterization Technique Adapted to Tandem Solar Cell

C. Leon, S. Le Gall, M.E. Gueunier-Farret, A. Brezard-Oudot, A. Jaffré, C. Longeaud & J.-P. Kleider
GeePs, Gif-sur-Yvette, France
L. Vauche, K. Medjoubi & E. Veinberg Vidal
Université Grenoble Alpes, France

3CO.8.4 Perovskite Silicon Photovoltaics: The Joule in the Crown of Low-Cost Electricity
C. Case
Oxford PV, United Kingdom

3CO.8.5 Four-Terminal Bifacial Tandem with 30% Equivalent Efficiency
G. Coletti, L.A.G. Okel, M.J.H. Kloos, S.L. Luxembourg, Y. Wu, J.M. Kroon, F.J.K. Danzl & L.J. Geerligs
ECN part of TNO, Petten, The Netherlands
F. Di Giacomo, M. Najafi, D. Zhang, R.A.J.M. Andriessen & S.C. Veenstra
ECN part of TNO, Eindhoven, The Netherlands
T. Aernouts
imec, Genk, Belgium
J. Hüpkens
Forschungszentrum Jülich, Germany
C. Burgess & M. Creatore
Eindhoven University of Technology, The Netherlands

3CO.8.6 Scale-Up Technologies towards Large Area 2-Terminal Perovskite-Silicon Tandems
B.A. Kamino, A. Paracchino, S.-J. Moon, A. Walter, J.J. Diaz Leon, G. Christmann, M. Dussouillez, L. Ding, H.-Y. Li, S. Rafizadeh, B. Paviet-Salomon, N. Badel, A. Faes, J. Levrat, M. Despeisse, C. Ballif & S. Nicolay
CSEM, Neuchâtel, Switzerland

ORAL PRESENTATIONS 2CO.12

17:00 - 18:30 Characterisation & Simulation of Si Cells (I)

Chairpersons:

Marko Topič
University of Ljubljana, Slovenia

Karsten Bothe
ISFH, Germany

2CO.12.1 Accurate Measurement of Bifacial Solar Cells with Single- and Both-Sided Illumination
M. Rauer, F. Guo & J. Hohl-Ebinger
Fraunhofer ISE, Freiburg, Germany

2CO.12.2 Localized Blistering Defects as Root Cause of Potential Induced Degradation (PID) at the Rear Side of Bifacial PERC Solar Cells
K. Sporleder, J. Bauer, M. Turek, V. Naumann & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany

2CO.12.3 Optimising Fill Factor for Bifacial Energy Yield and LCoE
B.B. Van Aken, S. Ramesh, L.A.G. Okel, K.J.J. Tool, J. Löffler, A.W. Weeber & G.J.M. Janssen
ECN part of TNO, Petten, The Netherlands

2CO.12.4 Advanced Suns-Photoluminescence Technique for the Optimization of Crystalline Silicon Solar Cells
J.P. Seif, A.H.T. Le, R. Dumbrell & Z. Hameiri
UNSW Australia, Sydney, Australia
T.G. Allen
KAUST, Thuwal, Saudi Arabia
C. Samundsett
ANU, Canberra, Australia

2CO.12.5 Upgrade PERC with TOPCon: Efficiency Potential by Taking into Account the Electrical Gains and Optical Losses
C. Messmer
University of Freiburg, Germany
F. Feldmann, A. Fell, J. Schön & M. Hermle
Fraunhofer ISE, Freiburg, Germany

2CO.12.6 On the Correlation between Contact Resistivity and High Efficiency (IBC-) SHJ Solar Cells
P. Procel Moya, H. Xu, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands
L.-L. Senaud, B. Paviet-Salomon & M. Despeisse
CSEM, Neuchâtel, Switzerland
H. Sivaramakrishnan Radhakrishna, M. Filipic, M. Xu & I. Gordon
imec, Leuven, Belgium
M. Boccard, A. Fioretti, R. Monnard & C. Ballif
EPFL, Neuchâtel, Switzerland
J.-C. Stang, P. Wagner, D. Meza & L. Korte
HZB, Berlin, Germany
D. Lachenal & B. Strahm
Meyer Burger Research, Huterive, Switzerland
W. Duan, A. Lambert & K. Ding
Forschungszentrum Jülich, Germany
A. Fejfar
Czech Academy of Sciences, Prague, Czech Republic

ORAL PRESENTATIONS 6CO.16

17:00 - 18:30 PV Systems Optimization

Chairpersons:

Franz P. Baumgartner
ZHAW, Switzerland

Bert Herteleer
KU Leuven, Belgium

6CO.16.1 Machine Learning Approach to a Low-Cost Day-Ahead PV Power Prediction Based on Publicly Available Weather Reports for Automated Energy Management Systems

N. Maitanova, J.-S. Telle, B. Hanke, T. Schmidt,
K. von Maydell & C. Agert
DLR, Oldenburg, Germany
M. Grottko
Hammer Real, Munich, Germany

6CO.16.2 From Day-Ahead PV Forecast to PV Regulation: Imbalance Mitigation Strategies for the Italian Case Study

M. Pierro & D. Moser
Eurac Research, Bolzano, Italy
R. Perez
SUNY, Albany, United States
M. Perez
Pace University, New York, United States
C. Cornaro
University of Rome, Italy

6CO.16.3 Voltage Control in Grids with High PV-Penetration

Q.T. Tran, T. Le, F. Bourry & F. Al-Shakarchi
CEA, Le Bourget du Lac, France

6CO.16.4 Digital System in Order to Evaluate Different Photovoltaic Energy Solutions Taking into Account the Energy Demand of the Critical Industrial Processes Involved

A. Rubio Rico, R. Gero Ciudad & V. Fuster Roig
ITE, Valencia, Spain

6CO.16.5 Optimal Design and Supervision of Wind-PV-Diesel Hybrid Microgrid System

M. Boussetta, R. El Bachtiri, S. Motahhir & M. Khanfara
EST-USMBA, Fez, Morocco
Y. Chaibi
ENSAM, Fez, Morocco

6CO.16.6 Tailoring PV to an Island Supply System - Uncertainties If "Autonomy" Is Requested

H.G. Beyer
University of the Faroe Islands, Torshavn, Faroe Islands

VISUAL PRESENTATIONS 5CV.4

17:00 - 18:30 Operation, Performance and Maintenance of PV Systems

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

EU PVSEC Dinner

4DP.1 (90 min plenary) Auditorium 1 10:00			
Break			
5DP.2 (100 min plenary) Auditorium 1 10:30 12:10			
Lunch			
5DO.1 T5.1 Audit 2	4DO.4 T4.2/3 Audit 4	7DO.7 T7.2 Audit 1	2DV.1 T2.2/3 Poster Area
Break			
5DO.2 T5.1 Audit 2	2DO.5 T2.6 Audit 4	6DO.8 T6.1 Audit 1	7DV.2 T7.1/2 Poster Area
Break			
5DO.3 T5.2 Audit 2	2DO.6 T2.5 Audit 4	6DO.9 T6.1 Audit 1	Poster Awards Winners Session

2 Silicon Materials and Cells

- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

4 Photovoltaic Modules and BoS Components

- T4.1 PV Module Design, Manufacture, Performance and Reliability
- T4.2 Inverters and Balance of System Components
- T4.3 Sustainability and Recycling

5 PV Systems and Storage – Modelling, Design, Operation and Performance

- T5.1 Solar Resource and Forecasting
- T5.2 Design and Installation of PV Systems
- T5.3 Operation, Performance and Maintenance of PV Systems
- T5.4 Storage
- T5.5 Concentrators and PV for Space Applications

6 PV Applications and Integration

- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

7 Finance, Markets and Policies

- T7.1 Costs, Economics, Finance and Markets
- T7.2 Policies and Scenarios for Renewables, Societal and Global Challenges

PLENARY SESSION 4DP.1

08:30 - 10:00 Measurement, Reliability and Sustainability

Chairpersons:

Karsten Wambach
Wambach-Consulting, Germany

Claudia Buerhop-Lutz
HI ERN, Germany

4DP.1.1 Keynote Presentation: From Sunlight to Power: The History of Achieving a Globally Harmonised Approach to Photovoltaic Measurement

H. Müllejans, W. Zaaiman & E.D. Dunlop
European Commission JRC, Ispra, Italy

4DP.1.2 Keynote Presentation: An Overview of Module Reliability

M. Van Iseghem
EDF R&D, Moret-sur-Loing, France

4DP.1.3 Keynote Presentation: PV in the Circular Economy: A Research Agenda

G. Heath
NREL, Golden, United States

PLENARY SESSION 5DP.2

10:30 - 12:10 PV Systems and Storage

Chairpersons:

Heinz Ossenbrink
Band Gap, Germany

Laurent Torcheux
EDF R&D, France

5DP.2.1 Keynote Presentation: Status of Battery Energy Storage

F. Lambert
CEA, Grenoble, France

5DP.2.2 Keynote Presentation: Next Generation Tools for Accurate Energy Yield Estimation of Bifacial PV Systems – Best Practices, Improvements and Challenges

I.T. Horvath, H. Goverde, A.S.H. van der Heide & J. Govaerts
imec, Genk, Belgium
P. Manganiello, E. Voroshazi, F. Catthoor & J. Poortmans
imec, Leuven, Belgium
G.H. Yordanov & J. Moschner
KU Leuven, Belgium
I. Oroutzoglou & D. Soudris
NTUA, Athens, Greece
L.A. Radkar
University of Twente, Enschede, Belgium
N.-P. Harder
Total New Energies, San Jose, United States
T. Mueller, A. Lambert & S. Scheerlinck
ENGIE Laborelec, Linkebeek, Belgium
B. Aldalali
Kuwait University, Khaldiya, Kuwait
A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands

5DP.2.3 Performance Optimization through Advanced Data Analytics - Practical Applications Covering More Than 2GWp in Europe and India

G. Mütter & B. Eizinger
Alteso, Vienna, Austria

5DP.2.4 Development and Outdoor Characterization of Hybrid Bifacial HCPV Module

J.F. Martinez Sanchez, M. Steiner, M. Wiesenfarth,
T. Fellmeth, T. Doersam, M. Wiese, S.W. Glunz & F. Dimroth
Fraunhofer ISE, Freiburg, Germany

VISUAL PRESENTATIONS 2DV.1

12:45 - 15:00 Homojunction Solar Cells / Heterojunction Solar Cells

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

ORAL PRESENTATIONS 5DO.1

13:30 - 15:00 Solar Resource

Chairpersons:

Christos Protopogeropoulos
EEPS, Greece

Jan Remund
Meteotest, Switzerland

5DO.1.1 Assessing Spectral Mismatch Factors from Solar Spectral Measurements under Clear and Hazy Conditions

G. López
UHU, Huelva, Spain
C.A. Gueymard
Solar Consulting, Colebrook, United States
J. Polo, N. Martín Chivelet & N. Vela
CIEMAT, Madrid, Spain
J. Alonso-Montesinos, F.J. Batlles & J. Barbero
UAL, Almeria, Spain
A. Marzo
University of Antofagasta, Chile

5DO.1.2 Constructing 1-Second Resolution Irradiance Datasets Using Clearness Index Samples

G. Dickeson, L. McLeod, B. Herteleer & L. Frearson
Ekistica, Alice Springs, Australia

5DO.1.3 Assessment and Improvement of Ground-Based Irradiance Measurements

F. Mariottini, M. Bliss & T.R. Betts
Loughborough University, United Kingdom
G. Belluardo
Eurac Research, Bolzano, Italy
I.R. Cole
University of Cyprus, Nicosia, Cyprus

5DO.1.4 Comparative Analysis of Albedo Measurements (Plane-of-Array, Horizontal, Satellite) at Multiple Sites Worldwide

S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany
L. Burnham
Sandia National Laboratories, Albuquerque, United States
S.-Y. Oh
Yeungnam University, Gyeongsan, Republic of Korea
A. Benlarabi
IRESEN, Rabat, Morocco
J.-H. Choi
KTL, Seoul, Republic of Korea
M. Ebert & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany

B. Figgis
QEERI, Doha, Qatar
K.S. Kim
KIER, Yuseong-gu, Republic of Korea
T. Reindl
SERIS, Singapore, Singapore
R. Rütther
UFSC, Florianópolis, Brazil

5DO.1.5 Data of Value, Valuing Data: Open-Access Bankable Resource Data Project in Australia's NT

S. Ong, B. Herteleer, L. McLeod, G. Dickeson, H. Norris & L. Frearson
Ekistica, Alice Springs, Australia

5DO.1.6 The Impact of Plane-of-Array Based Tmy's on Solar Resource for PV Applications

M. Sengupta & A. Habte
NREL, Golden, United States

ORAL PRESENTATIONS 4DO.4

13:30 - 15:00 Inverter Design and Integration / Sustainability of PV Systems

Chairpersons:

Andreas Wade
First Solar, Germany

Ralph Gottschalg
Fraunhofer CSP, Germany

4DO.4.1 The Inverter: A Multi-Purpose Control Element

P.-J. Alet
CSEM, Neuchâtel, Switzerland
N. Henze & M. Jung
Fraunhofer IEE, Kassel, Germany
G. Adinolfi & G. Graditi
ENEA, Portici, Italy
G. Barchi
Eurac Research, Bolzano, Italy
R. Bründlinger
AIT, Vienna, Austria
A. Stavrou
Electricity Authority of Cyprus, Nicosia, Cyprus
G. Yang
Technical University of Denmark, Kongens Lyngby, Denmark

4DO.4.2 The Borgna-Converter - A New Topology for Highly Efficient PV Inverters
D. Gfeller, L. Borgna & U. Muntwyler
BFH, Burgdorf, Switzerland

4DO.4.3 Development and Evaluation of Open-Source IEEE 1547.1 Test Scripts for Improved Solar Integration
N. Ninad, E. Apablaza-Arancibia & M. Bui
CanmetENERGY, Varennes, Canada
J. Johnson & S. Gonzalez
Sandia National Laboratories, Albuquerque, United States
T. Moore & R. Heidari
CSIRO Energy Technology, Newcastle, Australia
W. Son
KERI, Gyeongsangnam-do, Republic of Korea
R. Bründlinger, R. Ablinger, C. Messner, C. Seitz & Z. Miletic
AIT, Vienna, Austria
J. Hashimoto & K. Otani
AIST, Fukushima, Japan
I. Vidaurrezaga Temez
Tecnalia, San Sebastián, Spain
F.P. Baumgartner & F. Carigiet
ZHAW, Winterthur, Switzerland
B. Fox
SunSpec Alliance, San Jose, United States
S. Kumar & J. Kumar
Central Power Research Institute, Bangalore, India

4DO.4.4 Active Façades: Life Cycle Environmental Impacts and Savings of Photovoltaic Power Plants Integrated into the Building Envelope
R. Itten & M. Stucki
ZAHW, Wädenswil, Switzerland
A. Clua Longas
EPFL, Lausanne, Switzerland
G. Cattaneo
CSEM, Neuchâtel, Switzerland

4DO.4.5 Combining Region-Specific Supply Chains with Geo-Located PV Electricity Production for Life Cycle Assessment of Worldwide Silicon Photovoltaic Systems in ENVI-PV v2.0
P. Perez-Lopez, B. Gschwind & I. Blanc
MINES ParisTech, Sophia-Antipolis, France
R. Frischknecht & P. Stolz
Treeze, Uster, Switzerland
C. Mehl & M. Payeur
ADEME, Paris, France
G. Heath
NREL, Golden, United States

4DO.4.6 Towards a Circular Supply Chain for PV Modules: Review of Today's Challenges in PV Recycling, Refurbishment and Re-Certification
J.A. Tsanakas, A.S.H. van der Heide, E. Voroshazi & J. Poortmans
imec, Genk, Belgium
E. Lemaire
CEA, Le Bourget du Lac, France
K. Wang
VITO, Mol, Belgium

ORAL PRESENTATIONS 7DO.7

13:30 - 15:00 Lessons from Around the World

Chairpersons:

Philippe Malbranche
CEA, France

Maria Getsiou
European Commission DG RTD, Belgium

7DO.7.1 Student Award Finalist Presentation: Shared Solar Cooperatives in Brazil: Context, Overcoming Barriers and Lessons to Be Drawn from Previous European Countries Experiences
K. Schneider & R. Rütger
UFSC, Florianópolis, Brazil
M.O.M. de Oliveira
OCB, Brasília, Brazil

7DO.7.2 Lessons from Utility-Scale PV in Australia: Experience from ARENA's LSS Portfolio
L. McLeod, G. Dickeson, C. Paynter, B. Herteleer & L. Frearson
Ekistica, Alice Springs, Australia
A. Dobb
ARENA, Canberra, Australia

7DO.7.3 Solar-Era.Net - European Network of National and Regional Research and Innovation Programmes: Latest Developments of Transnational Cooperation, Project Results and Opportunities

S. Nowak, M. Gutschner & T. Biel
NET Nowak Energy & Technology, St. Ursen, Switzerland
S. Oberholzer
Swiss Federal Office of Energy, Bern, Switzerland
C. Hünnekes, R. Horbelt, K. Chakanga & M. Schulte
Forschungszentrum Jülich, Germany
E. Fernández
MINECO, Madrid, Spain
D. Ruiz
FECYT, Coruña, Spain
G. del Rio
CDTI, Madrid, Spain
P.-J. Rigole & T. Walla
Swedish Energy Agency, Eskilstuna, Sweden
O. Bernsen
RVO, Den Haag, The Netherlands
P. Leptos
RPF, Lefkosia, Cyprus
T. Carrere
ADEME, Paris, France
P. Bain
ANR, Paris, France
E. Afentaki
GSRT, Athens, Greece
A. Covello
MIUR, Rome, Italy
G. Friedmann
Ministry of Energy, Jerusalem, Israel
K. Karaösz
TUBITAK, Gebze, Turkey
E. Lutter
Climate and Energy Fund, Vienna, Austria
A. Hipfinger
FFG, Vienna, Austria

7DO.7.4 PV Performance Assessment Methods for the Implementation of European Sustainability Policy Instruments

A.M. Gracia Amillo, E.D. Dunlop, E. Salis, T. Sample & N. Taylor
European Commission JRC, Ispra, Italy
D. Polverini
European Commission DG GROWTH, Brussels, Belgium

7DO.7.5 Development of an Academic Living-Labs as Sociotechnical Imaginaries to Facilitate the Uptake of Solar Technologies in the 2Seas Region

T.E. Motoasca
KU Leuven, Ghent, Belgium

7DO.7.6 Open Science: New Challenges and Opportunities for the PV Sector

A.B. Cristobal Lopez, C. del Cañizo & A. Martí Vega
UPM, Madrid, Spain
G. Revuelta
UPF, Barcelona, Spain
L. Fialho
University of Évora, Portugal
M. Molina
EIC, Madrid, Spain
N. Tyutyundzhiev
Bulgarian Academy of Sciences, Sofia, Bulgaria
M. Ackermann
INSOLIGHT, Lausanne, Switzerland
I. Cuenca Fernández
Consejería de Medio, Seville, Spain
E. Unger
HZB, Berlin, Germany
S. Haas
Reiner Lemoine Institut, Berlin, Germany
R. Zilles
University of São Paulo, Brazil

ORAL PRESENTATIONS 5DO.2

15:15 - 16:45 Forecasting

Chairpersons:

Wilfried G.J.H.M. Van Sark
Utrecht University, The Netherlands

Ana Maria Gracia Amillo
European Commission JRC, Italy

5DO.2.1 Nowcasting of Irradiance Using a Network of All-Sky-Imagers

N. Blum, B. Nouri & S. Wilbert
DLR, Tabernas, Spain
T. Schmidt & D. Heinemann
DLR, Oldenburg, Germany
T. Schmidt
CSP Services, Cologne, Germany
P. Kuhn
Energie Baden-Württemberg, Karlsruhe, Germany
L.F. Zarzalejo
CIEMAT, Madrid, Spain
R. Pitz-Paal
DLR, Cologne, Germany

5DO.2.2 Potential for Crowdsourced Weather Stations to Assess Intra-Hourly Variability of Photovoltaic Systems

J. Lopez Lorente, X. Liu, D.J. Morrow & P. Brogan
Queen's University Belfast, United Kingdom

5DO.2.3 Adjoint Sensitivity of Farms to the Forecasting Variables of WRF-Solar

J. Yang, M. Sengupta & Y. Xie
NREL, Golden, United States
P.A. Jimenez & J.-H. Kim
National Center for Atmospheric Research, Boulder, United States

5DO.2.4 Short-Term Photovoltaic Generation Forecasting Using Multiple Heterogenous Sources of Data

K. Bellinguer, R. Girard & G. Kariniotakis
Mines ParisTech, Sophia-Antipolis, France
G. Bontron
CNR, Lyon, France

5DO.2.5 Performance Test of New PV-Forecasting Models in Realistic Environments

P. Gaisberger, L. Gaisberger & R. Höller
FH-OOE, Wels, Austria
W. Traunmüller
Blue Sky, Attnang, Austria
N. Diewald
Fronius, Wels, Austria
P. Praher
SCCH, Hagenberg, Austria
M. Ehrlinger
Energie AG Trading, Linz, Austria
S. Moser
Energieinstitut an der JKU, Linz, Austria

5DO.2.6 Invited

ORAL PRESENTATIONS 2DO.5

15:15 - 16:45 Production Processes Silicon Solar Cells

Chairpersons:

Peter Fath
RCT-Solutions, Germany

Peter Wohlfart
Singulus Technologies, Germany

2DO.5.1 „Project FINALE“ - Screen and Screen Printing Process Development for Ultra-Fine-Line Contacts below 20µm Finger Width

F. Clement, M. Linse, S. Tepner, N. Wengenmeyr, L. Ney,
K. Krieg, A. Lorenz, M. Pospischil & R. Preu
Fraunhofer ISE, Freiburg, Germany
S. Bechmann
Koenen, Ottobrunn-Riemerling, Germany
K. Oehrle
Kissel + Wolf, Wiesloch, Germany
S. Steckemetz
SolarWorld Innovations, Freiberg, Germany

2DO.5.2 The Influence of Diffusion Condition to Passivation Quality of SiOx/Poly-Silicon Layer

W. Deng, X. An, H. Chen, F. Jiang & G. Xing
Canadian Solar, Suzhou, China

2DO.5.3 PULSION®-Solar, an Efficient and Cost Effective Implantation Solution for High Efficiency Silicon Solar Cells Manufacturing

A. Lanterne, T. Desrues, A. Veau, P. Bellanger,
C. Lorfeuvre & S. Dubois
CEA, Le Bourget du Lac, France
B. Barthe
University Grenoble Alpes, France
F. Torregrosa & L. Roux
Ion Beam Services, Peynier, France

2DO.5.4 Defect Engineering of n-Type Bifacial Silicon Using Dark Annealing

X. Tan, R.L. Chin, D. Chen, R. Chen & F.E. Rougieux
UNSW Australia, Sydney, Australia

2DO.5.5 Selective Patterning of PVD-Metal Stacks by Electrochemical Screen Printing for Back-Contact Solar Cells

K. Gonsowski, M. Kamp, R. Efinger, G. Mikolasch & J. Bartsch
Fraunhofer ISE, Freiburg, Germany
S. Bechmann & R. Weber
KOENEN Solar, Ottobrunn, Germany

2DO.5.6 Interpretable Machine Learning for Production Optimization

S. Wasmer & B. Klöter
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

ORAL PRESENTATIONS 6DO.8

15:15 - 16:45 PV for Buildings

Chairpersons:

Urs Muntwyler
BUAS, Switzerland

Francoise Burgun
CEA, France

6DO.8.1 Investigating the Thermal Behaviour and Degradation Rate of BIPV Modules: Case Study of a High-Rise Office Building under Different Climatic Conditions

J. Goncalves, T. van Hooff & D. Saelens
KU Leuven, Heverlee, Belgium

6DO.8.2 Monitoring the Outdoor Operating Temperature of Glass-Free Lightweight Solar Modules for Building Integrated Photovoltaics

A.C. Oliveira Martins, A. Virtuani & C. Ballif
EPFL, Neuchâtel, Switzerland
V. Chapuis
CSEM, Neuchâtel, Switzerland

6DO.8.3 PV Chimney Concept: Modelling and Demonstration of Photovoltaic Systems Integration in Double Skin Façades

Z. Haghighi, S. Wapperom, J.C. Ortiz Lizcano, C. Infante Ferreira, A. van den Dobbelen, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands

6DO.8.4 Demonstration of a Novel Low Concentration and Solar Control Photovoltaic System for Building Integration

D. Valencia, M. Machado & A. Sanz Martinez
Tecnalia, San Sebastián, Spain
Y.B. Assoa & F. Burgun
CEA, Le Bourget du Lac, France
J. Escribano Troncoso
Acciona Infraestructuras, Madrid, Spain
E. Rico
Onyx Solar Energy, Avila, Spain
T. Reijenga
BEAR-iD, Gouda, The Netherlands
P. Brassier
Nobatek, Anglet, France
P. Surguy & L. Chan
Film Optics, Watchfield, United Kingdom
V. Francisco
CTCV, Coimbra, Portugal
P. Alonso & I. Weiss
WIP Renewable Energies, Munich, Germany

6DO.8.5 Methodology and Tool for the Electrical Layout of BIPV-Modules with Novel Design Features

J. Eisenlohr, S. Gasparotto, A. Mondon,
M. Heinrich & T.E. Kuhn
Fraunhofer ISE, Freiburg, Germany

6DO.8.6 BIM – A Booster for Energy Transition and BIPV Adoption

P. Alamy
Enerbim, Seilh, France
V.K. Nguyen
CADCAMation, Onex, Switzerland
M. Machado
Tecnalia, San Sebastián, Spain
P. Alonso
WIP Renewable Energies, Munich, Germany

VISUAL PRESENTATIONS 7DV.2

15:15 - 16:45 Costs, Economics, Finance and Markets / Policies and Scenarios for Renewables, Societal and Global Challenges

Detailed information on this session is presented in the section entitled 'Visual Presentations'.

ORAL PRESENTATIONS 5DO.3

17:00 - 18:30 Designing Systems for Specific Environments

Chairpersons:

Angèle Reinders
University of Twente, The Netherlands

Daniela Guida
ENEL Green Power, Italy

5DO.3.1 Photovoltaics in the Urban Environment: Towards a Fast, Accurate and Remote 3D-Based Energy Potential Simulation Framework

O. Isabella, A. Calcabrini, H. Ziar & M. Zeman
Delft University of Technology, The Netherlands

5DO.3.2 Analysis and Investigation of BIPV Operating Performance Based on the PV Installations at the ZSW Research Building

D. Geyer, D. Stellbogen, P. Lechner, S. Hummel,
J. Schnepf & D. Huschenhöfer
ZSW, Stuttgart, Germany

5DO.3.3 Half-Cell Module Behaviour and Its Impact on the Yield of a PV Plant

M. Chiodetti, J. Dupuis & P. Dupeyrat
EDF R&D, Moret Loing et Orvanne, France
D. Boubilil & K. Radouane
EDF EN, Paris La Defense, France

5DO.3.4 Bifacial PV System Mismatch Loss Estimation and Parameterization

C. Deline & S. Ayala Pelaez
NREL, Golden, United States
S. MacAlpine
Juwi Solar, Boulder, United States
C. Olalla
URV, Tarragona, Spain

5DO.3.5 A Year in the Life of Vertical Bifacial Systems on Land and Water

A.J. Carr & B.B. Van Aken
ECN part of TNO, Petten, The Netherlands
H. Lok, L.S. Bosma & T. Jansma
Hanze University, Groningen, The Netherlands

5DO.3.6 Student Award Finalist Presentation: Simulation of Performance Differences between Off-Shore and Land-Based Photovoltaic Systems

S.Z. Mirbagheri Golroodbari & W.G.J.H.M. van Sark
Utrecht University, The Netherlands

ORAL PRESENTATIONS 2DO.6

17:00 - 18:30 Characterisation & Simulation of Si Cells (II)

Chairpersons:

Dominic Walter
ISFH, Germany

Ivan Gordon
imec, Belgium

2DO.6.1 Student Award Finalist Presentation: Importance of the Injection Level for Studies on Light- and Elevated Temperature- Induced Degradation in Crystalline Silicon

M. Kim, S. Liu, D. Chen, C. Chan, M. Abbott & B. Hallam
UNSW Australia, Sydney, Australia

2DO.6.2 Extracting Metal and Edge Recombination Parameters which are Compatible with Multi-Dimensional Cell Simulations

P. Saint-Cast, D. Herrmann, P. Baliozian, H. Stolzenburg,
H. Höffler & A. Fell
Fraunhofer ISE, Freiburg, Germany

2DO.6.3 A Simplified Model to Simulate Passivating & Selective Hole-Collecting Contacts

G.J.M. Janssen, M.T.S.K. Ah Sen & P.C.P. Bronsveld
ECN part of TNO, Petten, The Netherlands

2DO.6.4 Vignetting in Luminescence Imaging Setups

G. Dost, H. Höffler & J. Greulich
Fraunhofer ISE, Freiburg, Germany

2DO.6.5 The Angular Distribution of Scattered Reflectance from Textured Silicon

D. Payne, B. Puthen-Veetill & D.M. Bagnall
Macquarie University, Sydney, Australia
M. Abbott, T.H. Fung, M.U. Khan, Y. Zhang, S. Wang,
G. Scardera, B. Hoex & M.E. Pollard
UNSW Australia, Sydney, Australia

2DO.6.6 Electrical Characterization of Micro-Colloids in Si Solar Cell Screen-Printed Contacts by Conductive Atomic Force Microscopy (C-AFM)

K. Ren, D. Han & A. Ebong
UNC Charlotte, United States

ORAL PRESENTATIONS 6DO.9

17:00 - 18:30 PV Integration in Non Conventional Application

Chairpersons:

Alessandra Scognamiglio
ENEA, Italy

Alessandro Virtuani
EPFL, Switzerland

6DO.9.1 Influence of Wave Induced Movements on the Performance of Floating PV Systems

M. Dörenkämper, D. van der Werf, K. Sinapis,
M.M. de Jong & W. Folkerts
TNO-SEAC, Eindhoven, The Netherlands

6DO.9.2 The Performance of a Floating PV Plant at the West Coast of Norway

I.H. Lereng, E.S. Marstein & J.H. Selj
Institute for Energy Technology, Kjeller, Norway
P. De Paoli
UMB, Ås, Norway
S. Bragstad & B. Bjørneklett
Ocean Sun, Lysaker, Norway

6DO.9.3 Dynamic Agrivoltaics: A Breakthrough Innovation

A.-L. Gorge, F. Sourd & J. Garcin
Sun'R, Paris, France
C. Dugué & G. Goer
Photowatt, Lyon, France

6DO.9.4 Lightweight, Flexible and High Efficiency c-Si Photovoltaic Modules for the Stratobus TM

J. Gaume, H. Robin & M. Joanny
CEA, Le Bourget du Lac, France
R. Chaix
Thales Alenia Space, Cannes, France

6DO.9.5 Urban Microclimate in Street Canyons with Façade PV Using ENVI-met

S.R. Freitas
Energy and Environment Agency of Lisbon, Portugal
R. Ferreira & M.C. Brito
University of Lisbon, Portugal

6DO.9.6 Angle-Dependent Optical Performance of Spectrally Selective Solar Cells for Building Integrated Applications

N. Osterthun, N. Neugebohrn, K. Gehrke, M. Vehse &
C. Agert
DLR, Oldenburg, Germany

17:00 - 18:30 POSTER AWARDS WINNERS SESSION

Chairpersons:

Julio Cárabe
CIEMAT, Spain

Detailed information on this session is presented in the section entitled 'Visual Presentations'

2EO.1 T2.6 Audit 1	6EO.2 T6.2 Audit 3	7EO.3 T7.1 Audit 2
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Break

6EP.1 / 7EP.2 (joint session 100 min plenary) Auditorium 1
Closing Session Key note, Highlights of the Conference, Poster Awards, Student Awards, Farewell

2 Silicon Materials and Cells

- T2.1 Feedstock, Crystallisation, Wafering, Defect Engineering
- T2.2 Homojunction Solar Cells
- T2.3 Heterojunction Solar Cells
- T2.4 Thin Film and Foil-Based Si Solar Cells
- T2.5 Characterisation & Simulation of Si Cells
- T2.6 Manufacturing & Production of Si Cells

6 PV Applications and Integration

- T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature
- T6.2 Professional Applications of PV
- T6.3 PV Driven Energy Management and System Integration

7 Finance, Markets and Policies

- T7.1 Costs, Economics, Finance and Markets
- T7.2 Policies and Scenarios for Renewables, Societal and Global Challenges

ORAL PRESENTATIONS 2EO.1

08:30 - 10:00 Manufacturing of Silicon Solar Cells

Chairpersons:

Weiwei Deng
Canadian Solar, China

Martijn Lenes
Tempress, The Netherlands

2EO.1.1 The Vision of Large Scale PV Manufacturing in Europe: A Dream or Chance for Execution?

P. Fath & W. Jooss
RCT-Solutions, Constance, Germany
A.W. Bett, S. Nold & J. Rentsch
Fraunhofer ISE, Freiburg, Germany
J. Trube
VDMA, Frankfurt am Main, Germany

2EO.1.2 Toward 25% Silicon Cell Efficiency in Mass-Production: Strategies and Prospects Based on Industrial Data

Y. Chen, D. Chen, P.P. Altermatt, G. Xu, Z. Wang, C. Liu,
Y. Zou, Y. He, Y. Wang, J. Gong, L. Yuan, W. Liu, Y. Chen,
M. Deng, Y.Y. Hu, S. Chen, J. Xiang, H. Shen, S. Zhang,
L. Wang, X. Zhang, Y. Yang & Z. Feng
Trina Solar Energy, Changzhou, China
P.J. Verlinden
Amrock, McLaren Vale, Australia

2EO.1.3 'HJT 2.0' Performance Improvements and Cost Benefits for Silicon Heterojunction Cell Production

D.L. Bätzner, P. Papet, B. Legradic, D. Lachenal, R. Kramer,
T. Kössler, L. Andreetta, S. Pitteloud, N. Holm, C. Aeby,
J.-P. Cardoso, W. Frammelsberger & B. Strahm
Meyer Burger Research, Huterive, Switzerland

2EO.1.4 Large Area TOPC on Cells Realized by a PECVD Tube Process

F. Feldmann, T. Fellmeth, B. Steinhäuser, J.-I. Polzin,
H. Nagel, S. Mack, J. Benick, A. Richter, A. Moldovan,
M. Bivour, F. Clement, J. Rentsch, M. Hermle & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

2EO.1.5 Characterization of Passivated Contacts Formed with Different Metal Pastes on LPCVD Poly-Si Based monoPoly(TM) Solar Cells

P. Padhamnath, J.K. Buatis, L.M. Ortega, N. Nandakumar,
V. Shanmugam & S. Duttagupta
SERIS, Singapore, Singapore

2EO.1.6 Automatic Defect Detection in Electroluminescence Images for PV Mass Production Using Deep Learning

M. Patzold, K. Kaufmann, C.-M. Lin, M. Rudolph,
T. Burwig & D. Lausch
DENKweit, Halle (Saale), Germany

ORAL PRESENTATIONS 6EO.2

08:30 - 10:00 Professional Applications of PV

Chairpersons:

Gaetan Masson
Becquerel Institute, Belgium

Hubert A. Aulich
SC Sustainable Concepts, Germany

6EO.2.1 A Feasibility Study of Solar PV Powered Electric Cars Using an Interdisciplinary Modeling Approach for the Electricity Balance, CO₂ Emissions and Economic Aspects - The Cases of The Netherlands, Norway and Brazil

T. de Santana & A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands
N.J. Ekins-Daukes
UNSW Australia, Sydney, Australia

6EO.2.2 VIPV: c-Si Modules Design, Manufacturing and Integration on a Solar Car Demonstrator

V. Maneval, T. Duigou, J. Gaume, L. Serra, H. Robin,
S. Guillerez & M. Joanny
CEA, Le Bourget du Lac, France

6EO.2.3 Some Approaches of PV-Powered Vehicles Applications

M. Yamaguchi, K. Araki, K.-H. Lee & N. Kojima
Toyota Technological Institute, Nagoya, Japan
T. Masuda & A. Satou
Toyota, Susono, Japan
M. Hasegawa & H. Yamada
NEDO, Kawasaki, Japan

6EO.2.4 Efficient Si Photovoltaics for Electrically Powered Utility Vehicles – STREET

R. Peibst, F. Haase, H. Schulte-Huxel, S. Blankemeyer,
M. Köntges, C. Hollemann & R. Brendel
ISFH, Emmerthal, Germany
G. Wetzel & J. Krügener
MBE, Hannover, Germany
H.-J. Nonnenmacher & H. Mehlich
Meyer Burger, Hohenstein-Ernstthal, Germany
M. Stein & R. Wecker
a2solar, Erfurt, Germany
A. Schiessl & J. Süß
Continental CPT Group, Regensburg, Germany
F. Metzger & C. Schreibmüller
StreetScooter, Aachen, Germany
K. Ding, A. Lambertz, W. Duan, A. Mikosch & B. Pieters
Forschungszentrum Jülich, Germany
B. Stannowski & L. Korte
HZB, Berlin, Germany

6EO.2.5 Feasibility of Hydroponic Solar Sharing System without Liquid Fertilizer

H. Kubo & K. Okoso
Chiba Institute of Technology, Narashino-city, Japan
S. Maeno
mSe Corporation, Chiba-city, Japan

6EO.2.6 Solar Powered Electrolytic Water Treatment for Industrial Application

S. Shimura
IFSP, São Paulo, Brazil
R. de Paula Diver
UNICAMP, Campinas, Brazil

ORAL PRESENTATIONS 7EO.3

08:30 - 10:00 Economic and Market Analysis

Session Chair:

Silvia Caneva
WIP Renewable Energies, Germany

Izumi Kaizuka
RTS Corporation, Japan

7EO.3.1 A Snapshot of Global PV Markets - The Latest Survey Results on PV Markets and Policies from the IEA PVPS Programme in 2018

G. Masson
Becquerel Institute, Brussels, Belgium
I. Kaizuka
RTS Corporation, Chuo-ku, Japan
J. Lindahl
Swedish PV Association, Stockholm, Sweden
A. Jäger-Waldau
European Commission JRC, Ispra, Italy
J. Donoso Alonso
UNEF, Madrid, Spain

7EO.3.2 Impact of WACC and Other Parameters on Future Utility-Scale PV LCOE

E. Vartiainen
Fortum Growth, Finland
G. Masson
Becquerel Institute, Brussels, Belgium
C. Breyer
LUT University, Lappeenranta, Finland
D. Moser
Eurac Research, Bolzano, Italy
E. Román Medina
Tecnalia, San Sebastian, Spain

7EO.3.3 IPVF's PV Technology Vision 2030

L. Oberbeck
Total Gas, Renewables and Power, Paris, France
K. Alvino & B. Goraya
IPVF, Palaiseau, France
M. Jubault
EDF R&D, Palaiseau, France
D. Lincot
CNRS, Palaiseau, France

7EO.3.4 PV LCOE for Different Market Segments in Italy with and without Storage Systems

E. Veronese & D. Moser
Eurac Research, Bolzano, Italy
G. Manzolini
Polytechnic University of Milan, Italy

7EO.3.5 Analysis for Low Market Uptake of BIPV

S. Broß, E. Grommes, A. Krenz & U. Blieske
Cologne University of Applied Sciences, Germany
F. Flade & G. Becker
Bavarian Association for the Promotion of Solar Energy,
Munich, Germany

7EO.3.6 Modules at a Price of 10 \$ct/Wp - Dream or Reality?

W. Hoffmann
ASE, Hanau, Germany
A. Metz
VDE Renewables, Alzenau, Germany

7EP.2.1 The Role of Photovoltaics in a Sustainable European Energy System under Variable CO2 Emissions Targets, Transmission Capacities, and Costs Assumptions

M. Victoria, K. Zhu, G.B. Andresen & M. Greiner
Aarhus University, Denmark
T. Brown
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany

7EP.2.2 PV Technologies: How Might These Evolve?

M.A. Green
UNSW Australia, Sydney, Australia

7EP.2.3 Mass-Scale Solar Hydrogen: How PV is Set to Become the New Oil

T. Lepercq
Solairesream, Paris, France

PLENARY SESSION 6EP.1 / 7EP.2

10:30 - 12:10 PV Impacting Society

Chairpersons:

Francesco Frontini
SUPSI, Switzerland

Stefan Nowak
NET Nowak Energy & Technology, Switzerland

6EP.1.1 Solar Electricity and Safe Drinking Water: Global Opportunities and Challenges

H.A. Aulich
Sustainable Concepts, Erfurt, Germany
A. Goldmaier & P. Otter
AUTARCON, Kassel, Germany
A.O. Ighodaro
KXN, London, United Kingdom

6EP.1.2 Lesson Learnt from Multi Megawatt Projects Integrated into Landscapes and Buildings

E. Scotto
Akuo Energy, Paris, France

Monday, 09 September 2019

13:30 - 15:00 POSTER AWARDS KICK-OFF

VISUAL PRESENTATIONS 4AV.1

15:15 - 16:45 PV Module Design, Manufacture, Performance and Reliability (I)

Chairpersons:

Ralph Gottschalg
Fraunhofer CSP, Germany

Ulrike Jahn
TÜV Rheinland Energy, Germany

4AV.1.3 Corrosion Mechanism of Anodized PV Frame in the Accelerated Salt Spray Test

H.-H. Hsieh
ITRI, Hsinchu, Taiwan
W. Kai
National Taiwan Ocean University, Keelung, Taiwan
J.-F. Wen
United Renewable Energy, Hsinchu, Taiwan

4AV.1.4 Power Stabilization of Crystalline PV Modules

R. Ebner & G. Újvári
AIT, Vienna, Austria
W. Mühleisen & C. Hirschl
CTR, Villach, Austria

4AV.1.5 Measurement of Water Vapor Transmission Rate of PV Backsheet with Highly Accelerated Stress Test

Y.T. Li, C.F. Hsieh & S.-H. Chen
ITRI, Hsinchu, Taiwan
H.-L. Wu & P. Yu
National Chiao Tung University, Hsinchu, Taiwan

4AV.1.6 Experimental Benchmarking of Partial Shading Effect on Thin-Film and Crystalline-Silicon Solar Photovoltaic Modules

K.A.K. Niazi, Y. Yang, S.V. Spataru, M.U. Mutarraf & D. Sera
Aalborg University, Denmark

4AV.1.7 Optimization and Design Issues of Bifacial PV Modules and Systems

W. Mühleisen, L. Neumaier & C. Hirschl
CTR, Villach, Austria
B. Pletz & G. Safran
PVP Photovoltaik, Wies, Austria
G. Újvári, A. Mittal, M. Schwark & S. Zamini
AIT, Vienna, Austria

4AV.1.8 Accelerated TC Test in Comparison with Standard TC Test for PV Modules

C.H. Schiller, L.C. Rendler, S. Stecklum, D. Eberlein,
A. Kraft & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4AV.1.9 The Analysis of Electrical Characteristics of Separated Solar Cell by Laser Scribing for High Performance Shingled PV Module

Y.-J. Kim, Y.-K. Min, J.-W. Kang, J.-W. Baik, E.-J. Lee,
D.-S. Kim, C.-S. Park & K.-K. Hong
Shinsung E&G, Jeungpyeong-gun, Republic of Korea

4AV.1.10 Contributing to the Quality of PV Solar Modules in West Africa

N. Wyrsch
EPFL, Neuchâtel, Switzerland
M.L. Ndiaye, A. Ndiaye & C.M.F. Kebe
ESP, Dakar Fann, Senegal

4AV.1.12 Optimisation of Bifacial Photovoltaics Module with Reflective Layer in Outdoor Performance

E. Sng
REC Solar, Singapore, Singapore
S. Channabasappa Devihosur, R. Swaminathan, S. Roy &
I.L.H. Lim
University of Glasgow, United Kingdom
M. Kurinji
Ngee Ann Polytechnic, Singapore, Singapore

4AV.1.14 Investigating Partial Shadowing of PV Module at Solar Cell Level

L. Feng, S. Hempelmann, M. Grüneis, G. Behrens &
F.U. Hamelmann
University of Applied Sciences Bielefeld, Minden, Germany

4AV.1.15 Differential Scanning Calorimetry for Simulation and Optimization of PV Module Lamination

C. Herzog, T. Müller, M. Heinrich & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4AV.1.16 Additive Analysis in Encapsulant Materials and Correlation to Encapsulant Degradation Modes

C. Barretta & G. Oreski
PCCL, Leoben, Austria
K. Resch-Fauster
University of Leoben, Austria

4AV.1.17 Parallel Natural Weathering of Backsheets across Europe

L. Castillon & G. Oreski
PCCL, Leoben, Austria
J. Ascencio-Vásquez & M. Topič
University of Ljubljana, Slovenia
A. Panos & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany

4AV.1.18 Assessment and Evolution of Initial Mono-PERC Module Degradation Using Light Induced Degradation, Carrier Induced Degradation and Outdoor Exposure

J. Dupuis, G. El Hajje & P. Dupeyrat
EDF R&D, Moret-sur-Loing, France
E. Sandre & K. Radouane
EDF Renewables, Paris, France

4AV.1.19 Influence on the CASS Testing for Module Materials

C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, Y.-H. Chao,
L.-G. Wu & C.-Y. Yu
TSEC, Hsinchu, Taiwan
M.-A. Tsai & H.-H. Hsieh
ITRI, Hsinchu, Taiwan

4AV.1.20 Techno-Economic Analysis of Half-Cell Modules - The Impact of Half-Cells on Module Power and Costs

M. Mittag, A. Pfreundt, J. Shahid & H. Neuhaus
Fraunhofer ISE, Freiburg, Germany

4AV.1.22 Mechanical Stability of the Semi-Flexible HJT Solar Panels

S. Yakovlev, K. Emtsev, D. Andronikov, A. Abramov &
D. Orekhov
R&D Center TFTE, St. Petersburg, Russia
I. Shakhray
Avelar Solar Technology, Moscow, Russia

4AV.1.23 Determination of Depth-Dependent Variations in the Degree of Crosslinking of EVA due to Changing Lamination Parameters Using Raman Spectroscopy

K. Harms, L. Neumaier & C. Hirschl
CTR, Villach, Austria

- 4AV.1.24 Direct Measurement of Moisture Ingress in PV Laminates**
N. Kyranaki & T.R. Betts
CREST, Loughborough, United Kingdom
R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
- 4AV.1.25 Analysis of Drivers for PV-Material Yellowing Upon Artificial Aging**
Y. Voronko & G.C. Eder
OFI, Vienna, Austria
M. Edler
ISOVOLTAIC Solinex, Lebring, Austria
G. Oreski
PCCL, Leoben, Austria
W. Mühleisen
CTR, Villach, Austria
- 4AV.1.26 Pathways of Uncertainties in Service Lifetime Prediction (SLP) Models for PV Modules: How to Improve the Accuracy?**
I. Kaaya & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany
- 4AV.1.27 Characterisation of the Reverse DC Resistance due to Potential Induced Degradation (PID) in Crystalline PV Cells**
M. Florides, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
- 4AV.1.28 Qualification of Polyolefin Backsheet for PV Modules**
P. Gebhardt & D. Philipp
Fraunhofer ISE, Freiburg, Germany
P. Hülsmann
Bischof + Klein, Lengerich, Germany
- 4AV.1.29 Impact of Highly Breathable Polyolefin Backsheet on EVA Yellowing**
P. Gebhardt & D. Philipp
Fraunhofer ISE, Freiburg, Germany
F. Rummens
RENOLIT, Oudenaarde, Belgium
- 4AV.1.30 Performance and Reliability of Bifacial Modules Using a Transparent Backsheet**
W.J. Gambogi, M. Demko, T. Felder, S. MacMaster,
B.-L. Yu & K. Roy-Choudhury
DuPont, Wilmington, United States
A. Borne
DuPont, Geneva, Switzerland
H. Hu & Z. Pan
DuPont, Shanghai, China

- 4AV.1.31 H2020: Solar Train MSCA Fellowship Combined Effect of UV, Temperature and Humidity on Mono-Crystalline Mini-Modules Ageing Using UV LED Lamps at Specific Wavelengths**
A. Nairi, J. Bengoechea, M.J. Rodriguez & A.R. Lagunas
CENER, Sarriguren-Navarra, Spain
D.E. Mansour & L. Pitta Bauermann
Fraunhofer ISE, Freiburg, Germany
- 4AV.1.32 Artificial Soiling Testing and Performance Determination of Functional Coatings**
E. Klimm, C. Siess, T. Kaltenbach & K.-A. Weiß
Fraunhofer ISE, Freiburg, Germany
- 4AV.1.33 The Effect of Shadows from People and Cleaning Tools on the STC Power of CIGS Thin-Film PV Modules**
M. Kitze
Avancis, Torgau, Germany
S. Grünsteidl, P. Borowski, T. Dalibor & J. Palm
Avancis, Munich, Germany
- 4AV.1.34 Modelling the Generation and Diffusion of Acetic Acid in Aged Ethylene-Vinyl Acetate-Based Encapsulants Used in Solar Modules**
L. Gnocchi, A. Virtuani, E. Annigoni & C. Ballif
EPFL, Neuchâtel, Switzerland
H.-Y. Li
CSEM, Neuchâtel, Switzerland
- 4AV.1.36 Investigation of Stabilization Procedures for Power Determination of Thin-Film Modules**
T. Weber, L. Schmidt, M. Grieb, N. Pongthanacharoenkul,
L. Podlowski, P. Grunow & S. Xuereb
PI Berlin, Germany
- 4AV.1.37 Development of Ultra-Accelerated Ageing Tests for Improved Reliability and Durability of Bifacial Photovoltaic Modules in Harsh Desert Conditions**
J.-F. Lelièvre, B. Hladys, D. Muñoz & A. Derrier
CEA, Le Bourget du Lac, France
E. Cabrera
ISC Konstanz, Germany
V. Gutierrez
Fraunhofer Chile Research, Santiago, Chile
P. Ferrada
University of Antofagasta, Chile

- 4AV.1.38 Influence of Large Periods of DC Current Injection in c-Si Photovoltaic Panels**
A. Moreton-Fernandez, M.M. Jiménez-Martín, O. Martínez-Sacristan, M.A. González-Rebollo, J. Jiménez-López, S. Gallardo-Saavedra, V. Alonso-Gómez, L. Hernández-Callejo & J.I. Morales-Aragonés
University of Valladolid, Spain
- 4AV.1.39 Light Management Coatings for Solar Modules by Large-Area Nanoimprinting**
L.W. Veldhuizen & R.A.J.M. van Erven
Morphotonics, Veldhoven, The Netherlands
- 4AV.1.40 Optimising SHJ Solar Cell Bifaciality towards a Monolithic Module Architecture**
J. Eymard, V. Barth, L. Basset, E. Gerritsen & A. Danel
CEA, Le Bourget du Lac, France
M. Hebert & R. Clerc
University of Lyon, Saint-Etienne, France
- 4AV.1.41 Coupled Multi-Physics Model for Simulating Thermal Behavior, Electrical Yield and Structural Reliability of Monofacial and Bifacial Photovoltaic Modules under Desert Environment**
S. Ahzi, S.P. Aly & N. Barth
QEERI, Doha, Qatar
- 4AV.1.42 Numerical and Experimental Investigations on the Effect of Different Frame and Mounting Configurations of poly-c-Si PV Modules for Crack Propagation and Degradation**
L. Papargyri, M. Theristis, P. Papanastasiou & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
B. Kubicek
AIT, Vienna, Austria
- 4AV.1.45 One Step towards General Mathematical Formulation of Shading Tolerability for Photovoltaic Modules**
H. Ziar, O. Isabella & M. Zeman
Delft University of Technology, The Netherlands
- 4AV.1.46 Acceptable Volume of Investment for “Combined Stress Testing”**
T. Tanahashi & K. Sakurai
AIST, Tsukuba, Japan
M. Woodhouse & P. Hacke
NREL, Golden, United States

- 4AV.1.47 Superhydrophillic Self Cleaning SiO₂/TiO₂ Thin Film Coating for Solar Glass Cover Application**
A. Abhinav & S. Mallick
IIT Bombay, Mumbai, India
- 4AV.1.48 Cell Strength Test in Laminates – Findings and Practical Relevance**
M. Pander, U. Zeller, B. Jaeckel & M. Ebert
Fraunhofer CSP, Halle (Saale), Germany
- 4AV.1.49 Development of Conductive Back-Sheet for Manufacture of PV Modules with Back-Contact Cells**
G.J.W. Meijers & I.J. Bennett
DSM, Geleen, The Netherlands
- 4AV.1.50 Improvements in Energy Yield and Financial Benefits for Next-Generation DSM AR Coatings**
P. Pasmans, T. Besseling, G. Draaisma, X. Paquez, P. Tummers, N. Voicu, L. Zheng & I. Goudswaard
DSM, Geleen, The Netherlands
Y. Lei
DSM, Shanghai, China
F. Dross
DSM, Parsippany, United States
- 4AV.1.51 Laser-Assisted Bonding (LAB) and Hybrid Underfill Technology for Module Fabrication Based on Silicon Back Contact Solar Cell**
K.-S. Choi, J. Joo, S.H. Moon & Y.-S. Eom
ETRI, Daejeon, Republic of Korea
- 4AV.1.54 Reliability and Durability Influence of Different Backsheet for PV Modules in High Humidity Environment**
H. Gong, M. Gao & Y. Guo
Suntech Power, Wuxi, China
- 4AV.1.55 Experimental Validation of a Numerical Model of the Mechanical Behaviour of Photovoltaic Modules**
E. Boyère, A. Grousset, J.-C. Le Roux & D. Binesti
EDF R&D, Ecuelles, France
L. Flandi
EDF R&D, Palaiseau, France
J.-N. Jaubert
Canadian Solar, Suzhou, China
- 4AV.1.56 Performance Degradation of Solar Modules for Solar Roadways**
J.H. Kim
DGIST, Daegu, Republic of Korea
F. Khan
KFUPM, Dhahran, Saudi Arabia

4AV.1.58 From Degradation Kinetics in PV Modules to Residual Lifetime Prognostics
H. Hieber & H. Gropius
ICR, Weimar, Germany

4AV.1.59 Numerical Calculation for Internal Heat Flow through Applying a Heat Dissipation Structure to the Rear Side of PERC Solar Module
S.H. Jung, J. Kim, Y. Kim & S.M. Kim
GERI, Gumi, Republic of Korea
M.G. Kang & H.-E. Song
KIER, Daejeon, Republic of Korea

4AV.1.60 Failure Mechanisms in PID Resistant PV Modules Under Enhanced Environmental Humidity and Soiling Stress
V. Naumann, K. Ilse, M. Pander & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany

4AV.1.61 Study of PID Mechanism for n-Type Bifacial Solar Cells
I. Devoto & A. Halm
ISC Konstanz, Germany

VISUAL PRESENTATIONS 4AV.2

17:00 - 18:30 PV Module Design, Manufacture, Performance and Reliability/ Inverters and Balance of System Components/ Sustainability and Recycling

Chairpersons:

Werner Herrmann
TÜV Rheinland Energy, Germany

Nicola Pearsall
Northumbria University, United Kingdom

Mariska de Wild-Scholten
SmartGreenScans, The Netherlands

4AV.2.1 Correlation Analysis of Environmental Variables for Pb Free p-PERC Bifacial c-Si PV Module in Floating and Marine PVs
H.K. Ahn, J.-H. Choi, S.Y. Park, B.G. Bhang & W.B. Lee
Konkuk University, Seoul, Republic of Korea
G.-G. Kim
Chungbuk Technopark, Jincheon, Republic of Korea
C.-S. Won
Floating PV Team, Gyeonggi-Do, Republic of Korea
O. Kwon & H. Jo
K-water, Daejeon, Republic of Korea
H.J. Go
Koenergy, Gyeongsangnam-Do, Republic of Korea

4AV.2.2 The Development of Moisture Monitoring for Photovoltaic Module
H.-L. Wu & P. Yu
National Chiao Tung University, Hsinchu, Taiwan
Y.T. Li, C.F. Hsieh & S.-Y. Ting
ITRI, Hsinchu, Taiwan

4AV.2.3 Characterization and Optimization of an Inline PV Module Flash Tester in Terms of Realistic Bifacial Module Assessment in the Manufacturing Line
L. Neumaier, W. Mühleisen, A. Frank & C. Hirschl
CTR, Villach, Austria
G. Safran
PVP Photovoltaik, Wies, Austria

4AV.2.4 Power Performance of Bifacial c-Si PV Module at Low Irradiance Environments for Rooftop Applications
H.K. Ahn, B.G. Bhang, J.-H. Choi, S.Y. Park & W.B. Lee
Konkuk University, Seoul, Republic of Korea
C.-S. Won
Scotra, Pyeongtaek, Republic of Korea
Y.K. Kwon
Korea Testing Laboratory, Ansan, Republic of Korea
C.Y. Cho
Sun engineering, Daejeon, Republic of Korea
H. Jo & O. Kwon
K-water, Daejeon, Republic of Korea
H.J. Go
Koenergy, Jinju, Republic of Korea

4AV.2.5 LED-Based Differential Spectral Responsivity Measurements of PV Modules
H. Sträter, S. Riechelmann, F. Plag & S. Winter
PTB, Braunschweig, Germany

4AV.2.6 Quantitative Analysis of Electroluminescence Imaging of a PV Module with Different Mismatch Levels
J.D. Santos, A. Valverde & M.C. Alonso-García
CIEMAT, Madrid, Spain

4AV.2.8 The Electrochemical Reactions in Crystalline Silicon Solar Modules
H. Yyang & H. Wang
Xi'an Jiaotong University, China

4AV.2.9 Statistical EI-Image Evaluation for Describing the Degradation of PV-Modules after a Hailstorm
C. Buerhop-Lutz, T. Pickel & J. Hauch
HI ERN, Erlangen, Germany
T. Winkler & C.J. Brabec
FAU, Erlangen, Germany

- 4AV.2.10 In Situ Contactless Phosphor Thermometry of Encapsulated Photovoltaic Devices**
Y. Cao, G. Koutsourakis, G.J.M. Sutton, J.W.E. Kneller, S. Wood, J.C. Blakesley & F. Araujo de Castro
National Physical Laboratory, Teddington, United Kingdom
- 4AV.2.11 Characterizing the Angular Distribution of an LED-Based Solar Simulator for PV Modules**
S. Riechelmann
PTB, Braunschweig, Germany
- 4AV.2.12 Multiple Linear Regression Model for Evaluation of Indoor and Outdoor Measurements of Chalcopyrite Thin Film Modules**
G.A. Farías Basulto, P. Reyes-Figueroa, M. Aghaei, C. Ulbrich, R. Schlatmann & R. Klenk
HZB, Berlin, Germany
B. Szyszka
Berlin University of Technology, Germany
- 4AV.2.13 Development of Industrial Automation PLC Based Modeling for PV Module**
Y. Ouberrri, H. Yatimi & E. Aroudam
Abdelmalek Essaadi University, Tetouan, Morocco
- 4AV.2.14 Making the Most of Module Matrix Measurements - IEC 61853-1**
A. Driesse
PV Performance Labs, Freiburg, Germany
J.S. Stein
Sandia National Laboratories, Albuquerque, United States
- 4AV.2.15 First Results from a High Precision Indoor & Outdoor PV Module Monitoring Campaign**
C. Reise, U. Kräling, E. Schnabel & K. Kiefer
Fraunhofer ISE, Freiburg, Germany
U. Bohnert
Munich Re, Germany
- 4AV.2.16 Reducing Measurement Uncertainty of Temperature Coefficients**
T. Slikker, E. Garcia Goma & S. Roest
Eternal Sun, The Hague, The Netherlands
- 4AV.2.17 Highly Accurate Irradiation and Temperature Control for Next-Generation PV Module Characterisation**
A. van der Heide, J. Govaerts, J.A. Tsanakas, M. Aleman & E. Voroshazi
imec vzw, Genk, Belgium
N. Harder
Total, Paris la Defense, France

- 4AV.2.18 Degradation Analysis of PV Module Technologies in a Moderate Subtropical Climate**
J. Lopez-Garcia, E. Grau-Luque, R.S.R. Gali, R.P. Kenny, D. Pavanello & T. Sample
European Commission JRC, Ispra, Italy
- 4AV.2.19 Energy Yield Analysis of Bifacial PV Modules: Different Technologies and Configurations**
A.M. Gracia Amillo, J. Lopez-Garcia, R.P. Kenny & T. Sample
European Commission JRC, Ispra, Italy
- 4AV.2.20 Failure Diagnosis on Photovoltaic Modules Using Visual Inspection, Thermography, Electroluminescence and I-V Techniques**
S. Gallardo-Saavedra, V. Alonso-Gómez, L. Hernández-Callejo, J.I. Morales-Aragonés, A. Moreton-Fernandez, M.M. Jiménez-Martín, O. Martínez-Sacristan, M.A. González-Rebollo & J. Jiménez-López
University of Valladolid, Spain
- 4AV.2.21 Evaluation of Tilt Angle Effect on Soiling of PV Modules in Dubai, UAE**
A. Elnosh, A. Safieh, J.J. John & A. Alnuaimi
DEWA, Dubai, United Arab Emirates
- 4AV.2.22 Investigation on Shunt Severity in PV Modules by Electroluminescence Imaging and Lock-in Thermography**
S. Roy, S. Kumar, R. Meena & R. Gupta
IIT Bombay, Mumbai, India
- 4AV.2.23 Determination of Temperature Coefficient of Photovoltaic Modules**
O. Bazkir & S. Meric
TUBITAK-UME, Kocaeli, Turkey
- 4AV.2.24 Energy Yield Comparison between Bifacial and Monofacial PV Modules- Real World Measurements in Desert Climate (BWh)**
J. Saal, J. Bonilla Castro & M. Schweiger
TÜV Rheinland, Cologne, Germany
- 4AV.2.25 Real Condition Characterization of Five Photovoltaic Technologies: What Is the Impact of the Environment?**
A. Migan-Dubois
GeePs, Gif-sur-Yvette, France
J. Badosa
CNRS, Palaiseau, France
V. Bourdin
LIMSI, Orsay, France

4AV.2.26 Dozens of GWp with Structured Ribbons, Films, Multiwire and No Robust Method for Angular Response Characterization: New Hemispheric IAM (HIAM) Test for an IEC 61853-2 Amendment

M. Falsini
Florence, Italy

4AV.2.27 Angular Response Measurement of Thin-Film PV Modules with Solar Simulators

W. Herrmann, L. Rimmelspacher, J. Bonilla & M. Schweiger
TÜV Rheinland Energy, Cologne, Germany

4AV.2.28 Quantitative Electroluminescence Imaging of PV Modules: Low-Frequency Blur Removal

K.G. Bedrich, Y. Wang & Y. S. Khoo
SERIS, Singapore, Singapore

4AV.2.29 Temperature Reduction in Infinite Photovoltaic Solar Arrays

A. Glick, N. Ali, J. Bossuyt, G. Recktenwald & R.B. Cal
Portland State University, United States
M. Calaf
University of Utah, Salt Lake City, United States

4AV.2.30 In-Depth Degradation Analysis of Polyamide-Based Backsheets in Fielded Modules under Different Climates

Y. Lyu, A. Fairbrother, J.H. Kim & X. Gu
NIST, Gaithersburg, United States
M.D. Kempe
NREL, Golden, United States
S. Julien & K.-T. Wan
Northeastern University, Boston, United States
S. Napoli, A. Hauser & G. O'Brien
Arkema, King of Prussia, United States
Y. Wang, L. Bruckman & R.H. French
CWRU, Cleveland, United States
L. Ji & K. Boyce
Underwriters, Northbrook, United States

4AV.2.31 Effect of Curing Temperature on Properties of Ethylene Vinyl Acetate (EVA) Used for c-Si Solar Module Encapsulation

B. Adothu, A. Abhinav, S. Zele & S. Mallick
IIT Bombay, Mumbai, India
A.K. Singh
Renewsys, Bangalore, India

4AV.2.32 PV Module Design, Manufacture, Performance and Reliability

C. Beitel & C. Kedir
Renewable Energy Test Center, Fremont, United States

4AV.2.33 A Study on the Relationship Between Factors Affecting Peel Strength and Efficiency in Half Cell Multi-Wires Photovoltaics Module

S.H. Kim, H.J. Son & J.H. Kim
KETI, Seongnam, Republic of Korea

4AV.2.34 New PV System Concept - Wireless PV Module Prototype

F. Carigiet, R. Knecht, T. Baumann & F.P. Baumgartner
ZHAW, Winterthur, Switzerland
C.J. Brabec
FAU, Erlangen, Germany

4AV.2.35 A New Dual-Buck Five-Level Inverter with Coupled Inductors for PV System Application

H.-T. Yang, J.-T. Liao & M.-K. Chuang
National Cheng Kung University, Tainan, Taiwan

4AV.2.36 Validated Testing of Grid-Connected PV Inverters for LV Grids by Means of Controller-Hardware-in-the-Loop (CHIL) Setup

G. Lauss, Z. Miletic, C. Messner, F. Leimgruber & C. Seitz
AIT, Vienna, Austria

4AV.2.37 Operating Temperature Development of Overcommitted Inverters

U. Muntwyler, M. Lanz & T. Schott
BUAS, Burgdorf, Switzerland
M. Bolliger
BKW, Bern, Switzerland

4AV.2.38 Converter Based PV-Emulator Using Artificial Neural Network Control Strategy

M. Bolouky, J. Milimonfared & A. Eskandari
Amirkabir University of Technology, Tehran, Iran
M. Aghaei
Albert-Ludwigs-University of Freiburg, Germany

4AV.2.39 PV Connectors a Crucial Part of the Reliability of PV Installations – Computer-Tomography (CT) as a Promising Method to Detect Cross Connections of PV Connectors

U. Muntwyler & E. Schüpbach
BUAS, Burgdorf, Switzerland
S. Schielly
Stäubli Electrical Connectors, Allschwil, Switzerland

- 4AV.2.46 Technological and Ecological Assessment of Concepts for Sustainable Photovoltaics**
G. Oreski, A. Omazic & A. Wolfberger
PCCL, Leoben, Austria
G.C. Eder
OFI, Vienna, Austria
L. Neumaier & C. Hirschl
CTR, Villach, Austria
M. Wellacher & T. Dobra
University of Leoben, Austria
N. Lenck
VDE Renewables, Hanau, Germany
- 4AV.2.47 Ecological Footprint of PV Electricity: Influence of Waste Management, Degradation and Lifetime**
K.-A. Weiß, S. Herceg & S. Pinto
Fraunhofer ISE, Freiburg, Germany
- 4AV.2.48 Sustainability Performance of Industrial Scale Heterojunction Technology (HJT) for Solar Photovoltaics (PV): Using Life Cycle Assessment (LCA) Methods to Assess Environmental and Social Impacts and Benefits of the AMPERE Project**
D. Reid
ERM, Oxford, United Kingdom
B. Hartlin, C. Pouloupoulos & E. Bauguen
ERM, London, United Kingdom
- 4AV.2.49 A Parameterized Model for the Estimation of Life-Cycle Environmental Impacts of Crystalline PV Systems**
S. Tannous, R. Besseau, I. Blanc & P. Perez-Lopez
MINES ParisTech, Sophia-Antipolis, France
A. Prieur-Vernat & J. Clavreul
ENGIE, Paris, France
M. Payeur
ADEME, Valbonne, France
- 4AV.2.50 Update of the Projection of the Photovoltaic Waste in Spain until 2050**
J.D. Santos & M.C. Alonso-García
CIEMAT, Madrid, Spain
- 4AV.2.51 Recycling Silver from Decommissioned Silicon Photovoltaic Solar Cells**
R. Deng, J. Jiang, S. Wang, J. Ji & C.M. Chong
UNSW Australia, Sydney, Australia
- 4AV.2.52 An Universal Recycling Technology for Thin Film and Silicon Based Photovoltaic Modules as an Example for Circular Economy**
W. Palitzsch, A. Killenberg & I. Röver
Losser Chemie, Freiberg, Germany

- 4AV.2.53 Recycling Process of c-Si Photovoltaic Modules by Chemical and Thermal Operations**
S. Paneliya, S. Khanna, V. Pandya, V. Bhavsar, M. Lad, A. Ray & I. Mukhopadhyay
PDP University, Gujarat, India
- 4AV.2.54 Electrochemical Method for Silicon Photovoltaic Module Recycling**
J.W. Ko, S.J. Park, H. Park, S.H. Bae, Y. Kang, H.-S. Lee & D.H. Kim
Korea University, Seoul, Republic of Korea
- 4AV.2.55 Innovative Recycling of End of Life Silicon PV Panels: Materials Recovering and Glass Re-Use**
C. Audoin & J.P. Rakotoniaina
CEA, Grenoble, France
P. Cerchier, K. Brunelli, L. Pezzato & M. Dabala
University of Padua, Padova, Italy
M. Tammaro
ENEA, Portici, Italy
G. Sabia
ENEA, Bolongna, Italy
A. Attanasio
CETMA, Brindisi, Italy
A. Nisi
I.T.O., Galatone, Italy
T. Sessa
Relight, Rho, Italy
H. Suitner
PROKO, Salzburg, Austria
- 4AV.2.56 Environmental and Social Impact Assessment of High-Efficient Double Side Contacted Cells with Innovative Carrier Selective Contacts**
C. Pouloupoulos, B. Hartlin & E. Bauguen
ERM, London, United Kingdom
D. Reid
ERM, Oxford, United Kingdom
S. Galley
ERM, Manchester, United Kingdom
- 4AV.2.57 Measuring the Incidence Angle Modifier of Optically Uncoupled Glass for PV Application**
K. Meisenzahl, N. Schneble, M. Volk, U. Blieske, L. Clasing & J. Müller-Ost
Cologne University of Applied Sciences, Germany
J. Münzberg & P. Hakenberg
paXos Consulting & Engineering, Cologne, Germany

NOTES

Tuesday, 10 September 2019

VISUAL PRESENTATIONS 3BV.1

08:30 - 10:00 CI(G)S, CdTe and Related Thin Film Solar Cells / III-V and Related Compound Semiconductor Based Devices

Chairpersons:

Volker Sittinger
Fraunhofer IST, Germany

Gianluca Timò
RSE, Italy

3BV.1.3 Comparison of Accelerated Ageing and Metastabilities between CIGS Based Solar Cells and Thin-Film Modules

R. Vidal Lorbada, T. Lavrenko, D. Mücke & T. Walter
Ulm University of Applied Sciences, Germany

3BV.1.4 Novel Two-Stage Processing Technique towards Wide Spreading of CIGS Solar Cell Industry with Materially Efficient Fabrication

Y. Cho, S. Song, S. Lee, A. Cho, S.K. Ahn, K. Kim, J.H. Yun, I.Y. Jeong, J.S. Yoo, J.S. Cho, S.J. Ahn, J.H. Park, D.H. Shin, Y.J. Eo & J. Gwak
KIER, Daejeon, Republic of Korea

3BV.1.6 A European Thin Film Tandem Device Proficiency Test - Practical Outcomes and Preliminary Results

I. Lauermann
HZB, Berlin, Germany
E. Salis, D. Pavanello & H. Müllejans
European Commission JRC, Ispra, Italy
A. Gerber
Forschungszentrum Jülich, Germany
J. Wenzel Andreasen & S.A. Gevorgyan
Technical University of Denmark, Roskilde, Denmark
T.R. Betts, M. Blagovest & R. Gottschalg
Loughborough University, United Kingdom
A.O. Kodolbas & O. Yilmaz
TUBITAK, Gebze, Turkey
R. Leidl, M. Rennhofer & S. Zamini
AIT, Vienna, Austria
M. Acciarri & S. Binetti
UNIMIB, Milan, Italy
E. Lotter
ZSW, Stuttgart, Germany
K. Bakker, J.M. Kroon & W.J. Soppe
ECN part of TNO, Petten, The Netherlands

G. Razongles
CEA, Le Bourget du Lac, France
L.V. Mercaldo, F. Roca & A. Romano
ENEA, Portici, Italy
J. Hohl-Ebinger & W. Warta
Fraunhofer ISE, Freiburg, Germany
J.L. Balenzategui & J.F. Trigo
CIEMAT, Madrid, Spain
S. Neubert
PVcomB, Berlin, Germany

3BV.1.7 Increased PID Immunity of Cu(In,Ga)Se₂ Solar Cells

O. Salomon, W. Hempel, O. Kiowski, E. Lotter & W. Witte
ZSW, Stuttgart, Germany
A. Ferati, A. Schneikart, G. Kaune & R. Schäffler
NICE Solar Energy, Schwäbisch Hall, Germany
D. Mücke & T. Walter
HSU, Ulm, Germany
R. Vidal Lorbada
UPM, Madrid, Germany

3BV.1.9 Light Management in Ultra-Thin Cu(In, Ga)Se₂ Photovoltaic Devices

M. Kovacic, J. Krc, B. Lipovsek & M. Topič
University of Ljubljana, Slovenia
W.-C. Chen & M. Edoff
Uppsala University, Sweden
P.J. Bolt & J. van Deelen
TNO, Eindhoven, The Netherlands
M. Zhukova, J. Lontchi & D. Flandre
UCLouvain, Louvain-la-Neuve, Belgium

3BV.1.10 CIGS Device Processing on Insulated (Stainless) Steel Foils

F. Kessler, S. Spiering & R. Würz
ZSW, Stuttgart, Germany

3BV.1.11 Effects of Selenium Partial Pressure on Cu(In,Ga)Se₂ Solar Cells

L.-H. Tu, W.-C. Huang & C.-H. Lai
NTHU, Hsinchu, Taiwan

3BV.1.12 The “Absolute” Quantification of Solar Absorber via a Cross-Characterization Method: The Example of Cu(In,Ga)Se₂

M. Bouttemy, J. Vigneron, D. Aureau, M. Frégnaux,
F. Jomard & A. Etcheberry
UVSQ, Versailles, France
S. Béchu, A. Loubat & D. Messou
IPVF, Palaiseau, France
B. Theys
CNRS-IPVF, Palaiseau, France
S. Gaiaschi, J. Marciano & P. Chapon
HORIBA, Palaiseau, France

3BV.1.13 Air Reactivity of CIGS and CdTe Solar Absorbers Characterized by XPS Measurements

S. Béchu
IPVF, Palaiseau, France
M. Bouttemy, J. Vigneron, D. Aureau, M. Frégnaux & A. Etcheberry
UVSQ, Versailles, France
D. Lincot & J.-F. Guillemoles
CNRS, Palaiseau, France

3BV.1.14 Tailoring the Properties of Indium Sulfide by Doping

M. Mathew
St. Joseph's College, Kozhikode, India

3BV.1.15 Improving Light Absorption in Cu₂ZnSn(S,Se)₄ Solar Cells by Down-Shifting Quantum Dot Layer

W.-L. Jeong, K.-P. Kim & D.-S. Lee
GIST, Gwangju, Republic of Korea

3BV.1.16 Optimization of Sodium and Zinc Composition of a Flexible CZTSSe on Molybdenum Foil for High Photoconversion Efficiency

K. Kim, W.-L. Jeong & D.-S. Lee
GIST, Gwangju, Republic of Korea

3BV.1.17 Experimental Study on Band Gap Discrepancies of Sputtered Cu₂ZnSn(S,Se)₄ Thin Films: Using Different Characterization Techniques

G. Siddharth, B.S. Sengar, V. Garg & S. Mukherjee
IIT, Indore, India

3BV.1.18 Bias Dependent Reversibility of Degradation of CIGS Solar Cells under Damp Heat and Illumination

M. Theelen, F. Hakka, F. Lanfranchi, H. Steijvers & K. Bakker
TNO/Solliance, Eindhoven, The Netherlands
E. Haverkamp
ReRa Solutions, Nijmegen, The Netherlands
N. Barreau
IMN-UMR, Nantes, France

3BV.1.19 Investigations of Accelerated In-Line CIGS Co-Evaporation

R. Hünig, W. Hempel, T. Magorian-Friedlmeier & S. Paetel
ZSW, Stuttgart, Germany

3BV.1.20 Materials Design of Cu(In,Ga)(S,Se)₂ Absorber in CIGSSe Solar Cells by Using 3D Mapping of Electronic Structures

T. Wada, M. Yanagita & T. Maeda
Ryukoku University, Otsu, Japan

3BV.1.21 The Influence of Copper Thickness on the Defects Formation in CdTe Solar Cells

E. Artegiani, V. Kumar & A. Romeo
University of Verona, Italy

3BV.1.22 Influence of Doping Density on the Back Contact of Cu(In,Ga)Se₂ Solar Cells

D. Mücke, R. Vidal Lorbada & T. Walter
Ulm University of Applied Sciences, Germany

3BV.1.23 The Investigation of the Effect of Copper Content on the Kinetics of Microwave Photoconductivity in CIGS Solid Solution

G.F. Novikov, E.V. Rabenok & M.V. Gapanovich
RAS, Chernogolovka, Russia
I.N. Odin
Lomonosov Moscow State University, Russia
V.F. Gremenok
NASB, Minsk, Belarus

3BV.1.24 Improved Photovoltaic Parameters in CdTe Solar Cells by Insertion of a i-CdO Layer

A.Q. Amjad, L. Gagara & T. Potlog
Moldova State University, Chisinau, Moldova
V. Fedorov & V. Suman
Institute of Electronic Engineering and Nanotechnologies,
Chisinau, Moldova

3BV.1.25 Investigating and Improving Performance Ratio of Cu(In,Ga)(S,Se)₂ Photovoltaic Devices

A. Weber, R. Lechner, S. Grünsteidl, P. Borowski,
C. Schubbert & T. Dalibor
Avancis, Munich, Germany
S.J. Heise, J. Ohland, I. Savchenko, H. Ahmed,
H. Hirwa & J. Parisi
University of Oldenburg, Germany
R. Klenk, P. Reyes-Figueroa, G. Farias, M. Aghaei,
C. Ulbrich & E. Waack
HZB, Berlin, Germany
R. Hock, J. Dallmann, U. Künecke,
M. Schuster & P. Wellmann
FAU, Erlangen, Germany

3BV.1.26 Thinner Front and Reflective Rear Contact for Increased Light Conversion of CIGS Solar Cells on Flexible Substrates

R. Hertwig, S. Nishiwaki, R. Carron, J. Löckinger, T. Feurer,
S. Buecheler & A.N. Tiwari
EMPA, Dubendorf, Switzerland

3BV.1.27 Tunable Iron-Based Kesterite Thin Films for Tandem Solar Cells

V. Trifiletti, A. Spinardi & S. Binetti
University of Milan, Italy
V. Mikli, M. Danilson & M. Grossberg
Tallinn University of Technology, Estonia

3BV.1.28 Copper Electroplating on Aluminum Zinc Oxide

A. Lachowicz, C. Ballif & M. Despeisse
CSEM, Neuchâtel, Switzerland

3BV.1.30 Improved Performance of Sputtered Cu₂ZnSnSe₄ Solar Cell by Ge Doping Strategy

M. He, C. Yan, J. Huang & X. Hao
UNSW Australia, Sydney, Australia

3BV.1.31 Synthesis and Study of Loss Kinetics of Photogenerated Current Carriers in Cu₂ZnSn(S_xSe_{1-x})₄ Solid Solutions

E.V. Rabenok, V.V. Rakitin, B.I. Golovanov & G.F. Novikov
RAS, Chernogolovka, Russia
V.F. Gremenok
NASB, Minsk, Belarus
V.V. Khoroshko
BSUIR, Minsk, Belarus

3BV.1.32 Effect of Ag Alloying on Band Offsets, Grading, and Alkali Incorporation in CIGS Solar Cells

K. Sopiha, J. Keller, M. Edoff & J.J.S. Scragg
Uppsala University, Sweden
C. Persson
University of Oslo, Norway

3BV.1.33 Back End Monolithic Interconnection of CIGS Using Shunt-Free Laser Scribing and Inkjet Printing of Dielectric and Conductive Inks

V.S. Gevaerts, A.F.K.V. Biezemans, H. Het Mannetje,
H. Linden & J. Bosman
TNO, Eindhoven, The Netherlands

3BV.1.34 Spatial Atomic Layer Deposition (SALD) Studies for Buffer and Window Layers in CIGS Solar Cells towards in-Line Manufacturing Technologies

M. Balestrieri & D. Lincot
CNRS, Palaiseau, France
S. Lakhdar Chaouche, V. Huong Nguyen, J. Resende,
A. Sekkat, C. Jimenez, D. Bellet & D. Munoz-Rojas
Grenoble INP, France

3BV.1.35 Optical and Electrical Design of ZnO Nanorod-Based CdTe Solar Cells with CdS and Mg_xZn_{1-x}O Buffer Layers

C. Özcan, D. Türkay & S. Yerci
METU, Ankara, Turkey

3BV.1.36 Wide Band Gap CuGaSe₂ Solar Cells for Tandem Application

K. Bouras
IPVF, Palaiseau, France
M. Sood, A. Lomuscio, F. Babbe & S. Siebentritt
University of Luxembourg, Belvaux, Luxembourg
D. Lincot
CNRS, Palaiseau, France

3BV.1.37 Cu₂SnS₃ Thin Films Using Chelating Effect of Hybrid Ink

A. Cho, S.J. Ahn, J.H. Yun, J. Gwak, S.K. Ahn, Y.J. Eo,
J.S. Cho, J.H. Park, J.S. Yoo, K. Kim, D.H. Shin & I. Jeong
KIER, Daejeon, Republic of Korea

3BV.1.38 Investigations and Performance Optimisation of Windowless CdTe:Se/CdTe Solar Cells

B. Späth, V. Krishnakumar, G. Papageorgiou, C. Drost,
D. Menossi, R. Magiera, S. Böhnisch, G. Fu & B. Siepen
CTF Solar, Dresden, Germany
O. Zywitzki, T. Modes, D. Hirsch, T. Kopte & C. Metzner
Fraunhofer FEP, Dresden, Germany
S. Peng
CTIEC, Shanghai, China

3BV.1.39 Analysis of Growth Mechanism in Ga-Rich Cu(In,Ga)Se₂ Thin Films

K. Nakada, T. Kobayashi, T. Shimoyama & A. Yamada
Tokyo Institute of Technology, Japan

3BV.1.40 Atomic Layer Deposition of Highly Stoichiometric Cu₂SnS₃ Films as Absorber Materials for Photovoltaic Applications

T.-M. Chung, R.E. Agbenyeke, B.K. Park, Y.K. Lee,
C.G. Kim, J.H. Han
KRICT, Daejeon, Republic of Korea

3BV.1.42 Comparison of Light Induced Metastabilities on Different Thin Film Technologies

A. Mittal & M. Renhofer
AIT, Vienna, Austria
V. Schlosser
University of Vienna, Austria

3BV.1.44 Aluminum-Based Back Reflectors for Ultrathin Cu(In,Ga)Se₂ Solar Cells with ITO Diffusion Barrier

T. Schneider & R. Scheer
Martin Luther University, Halle (Saale), Germany

3BV.1.46 High Speed MOVPE for InGaP/GaAs Multijunction Solar Cells

H. Sodabanlu, K. Watanabe, Y. Nakano & M. Sugiyama
University of Tokyo, Japan
A. Ubukata
TNSC, Ibaraki, Japan
T. Sugaya
AIST, Ibaraki, Japan

3BV.1.48 Analysis of Spatial Inhomogeneity in Multi-Junction Solar Cells Using Transport Efficiency Mapping

H. Xu, K. Watanabe, Y. Nakano & M. Sugiyama
University of Tokyo, Japan
A. Delamarre & J.-F. Guillemoles
CNRS, Palaiseau, France

3BV.1.49 Roll-Based Transfer Process of Flexible Multi-Junction Solar Cells for Mobile Applications

K.-S. Kim, B.-I. Choi, B. Jang, S.-M. Kim & J.-H. Kim
KIMM, Daejeon, Republic of Korea
S.H. Jung & H.K. Kang
KANC, Suwon, Republic of Korea

3BV.1.50 Optimization of Ion Beam Sputtered Ta₂O₅ Anti-Reflective Coatings for III-V Multi-Junction Solar Cells

J. Reuna, V. Polojärvi, M. Raappana, T. Aho, R. Isoaho,
A. Aho, A. Tukiainen, E. Anttola, S. Mäkelä & M. Guina
TUT, Tampere, Finland

3BV.1.51 Development of Inverted-Growth 3-Junction Solar Cells with 1.0 eV Bulk GaAsBi Bottom Cell

T. Paulauskas, V. Pacebutas, R. Butkutė,
A. Geizutis & A. Krotkus
Center for Physical Sciences and Technology, Vilnius,
Lithuania
R. Jakiela
Institute of Physics PAS, Warsaw, Poland

3BV.1.52 Optical in situ Quantification of the As versus P Content during GaAsP Graded Layer Growth for III-V-on-Si Tandems

O. Supplie, A. Heinisch, A. Paszuk, A. Tummaliéh &
T. Hannappel
Ilmenau University of Technology, Germany
M. Sugiyama
University of Tokyo, Japan

3BV.1.53 Characterization and Pseudo-3D Modeling of GaSb Solar Cells for High Concentration Photovoltaics

J. Kret, S. Parola, A. Vauthelin, F. Martinez, J. Tournet,
J. El Hussein, R. Vaillon, Y. Rouillard,
E. Tournié & Y. Cuminal
University of Montpellier II, France

3BV.1.54 MOCVD Grown InGaAsP-Based Single Junction Solar Cells with Bandgap-Voltage Offsets Approaching Radiative-Recombination-Only Limit

L. Li
State Key Lab of Space Powersources, Shanghai, China

3BV.1.55 Multijunction Solar Cell Electroluminescence: Method for Subcells IV-Curve Obtaining

M.A. Mintairov, V.V. Evstropov, S.A. Mintairov,
M.Z. Shvarts & N.A. Kalyuzhnyy
RAS / Ioffe, St. Petersburg, Russia

3BV.1.56 Ultrafast Carrier Dynamics of Coupling Effects in InGaP/InGaAs/Ge Multi-Junction Solar Cells

V. Paraskeva, M. Hadjipanayi, A. Othonos & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

3BV.1.57 New Results on SiGeSn MOVPE Grown for Multi-Junction Solar Cells

G. Timò, G. Abagnale, M. Calicchio, M. Cornelli, N. Armani,
F. Trespidi, E. Malvisi & E. Achilli
RSE, Piacenza, Italy
F. Annoni
IMEM-CNR, Parma, Italy
B. Schineller
AIXTRON, Herzogenrath, Germany
R. Couderc
CEA-INES, Le Bourget du Lac, France
G. Siefert
Fraunhofer ISE, Freiburg, Germany
E. Achilli
University of Pavia, Italy

3BV.1.60 Influence of Temperature on Evolution of Properties of Ammonia-Free Chemical Bath Deposited CdS Thin Films

I. Gupta & B.C. Mohanty
Thapar University, Patiala, India

3BV.1.61 A Facile Route for Synthesis of Copper Iron Tin Sulfide Thin Films

A. El Kissani, D. Ait Elhaj, F. Welatta, H. Ait Dads, L. Nkhaili,
K. El Assali & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

3BV.1.62 High Fill Factor CIGS Solar Modules by Evaporated Metal Grid: Numerical Simulation and Module Analysis

S. Lin & H. Shan
NICE, Beijing, China
D. Zhuang
Tsinghua University, Beijing, China
R. Wächter, T. Repmann, T. Freund & N. Zancan
NICE Solar Energy, Schwäbisch Hall, Germany

3BV.1.63 Bifacial and Flexible CIGS Solar Cell by Mechanical Lift-Off Process

T. Masuda & N. Hamada
Toyota, Susono, Japan
M. Inoue, J. Chantana, T. Nishimura & T. Minemoto
Ritsumeikan University, Shiga, Japan

3BV.1.64 Alternative Buffer Layer for Reducing Optical Losses in Cu(In,Ga)(Se,S)₂ Solar Cells

R. Kamada, Y. Yasaki, Y. Hirai, S. Imanishi, T. Kato &
H. Sugimoto
Showa Shell Sekiyu, Atsugi, Japan

VISUAL PRESENTATIONS 3BV.2

13:30 - 15:00 Perovskites Based Photovoltaics / Organic and Dye-Sensitised Devices / Tandems

Chairpersons:

Giorgio Bardizza
European Commission JRC, Italy

Wolfgang Tress
EPFL, Switzerland

Alessandro Virtuani (i)
EPFL, Switzerland

3BV.2.1 Time Dependent Electroluminescence in Planar and Mesoporous Methylammonium Lead Iodide Solar Cells

M.A. Córdoba, A. Koffman-Frischknecht & K. Taretto
National University of Comahue, Neuquén, Argentina
W. Herrera & M.D. Perez
CNEA, San Martín, Buenos Aires, Argentina

3BV.2.3 Interfaces and Stability in Halide Perovskite Solar Cells

P. Schulz
CNRS, Palaiseau, France

3BV.2.6 Reduced Dimensional Perovskites: In-Situ Investigation of Film Formation and Morphological Studies Affecting the Device Performance

R. Munir, A. Merdasa, K. Hirslandt, O. Shargaieva,
J. Dagar & E. Unger
HZB, Berlin, Germany

3BV.2.8 Fabrication of Smooth, Mirror-Like and Pbl2-Free Thin Film Perovskite Layers in Ambient Conditions

C. Montes, L. Ocaña, L. De Sousa-Vieira, J.S. Moreno-Ramírez, M. Friend & M. Cendagorta
ITER, Granadilla de Abona, Spain
S. González-Pérez, B. González-Díaz & C. Hernandez-Rodriguez
ULL, La Laguna, Spain

3BV.2.9 Layer Structure and Pseudo-Halide Perovskite Solar Cells

Y.-A. Chen, M.-H. Li, Y.-Y. Chiu, P.-T. Hsieh, I.-G. Chen & P.-C.-Y. Chen
National Cheng Kung University, Tainan, Taiwan

3BV.2.10 On the Stability of Planar CH₃NH₃PbI₃ Perovskite Solar Cells Produced on under Ambient Conditions by Using Polymer Encapsulates

L. Ocaña, C. Montes, L. De Sousa-Vieira, M. Friend & M. Cendagorta
ITER, Granadilla de Abona, Spain
B. González-Díaz, R. Guerrero-Lemus & C. Hernandez-Rodriguez
ULL, La Laguna, Spain

3BV.2.11 Synthesis and Thermal Stability Analysis of Lead-Free Cs₂AgBiBr₆ Double Perovskites

T. Burwig, K. Heinze & R. Scheer
Martin Luther University, Halle (Saale), Germany
V. Izquierdo-Roca, M. Guc & P. Pistor
IREC, Sant Adrià de Besòs, Spain

3BV.2.12 2D Modeling of MAPbI₃-Based Perovskite Solar Cell with Textured Surface

J.-Y. Huang, E.-W. Chang & Y.-R. Wu
NTU, Taipei, Taiwan

3BV.2.13 Inorganic-Organic Hybrid Perovskite Solar Cells Using Spinel Cobaltites Based Hole Transport Layers

J. Ge, R. Scheer & Y. Zhang
Martin Luther University, Halle (Saale), Germany

3BV.2.15 Low Temperature Wet Processing of SnO₂: High Efficiency Device, Thermal Stability and Scalability Considerations

R. Couderc, C. Roux, M. Manceau & S. Berson
CEA, Le Bourget du Lac, France

3BV.2.16 Comparison Study of Optical, Structural and Morphological Properties of CsPbBr₃ Thin Films Grown Using Different Vacuum Based Routes

G. Gordillo, C.A. Otálora, E.A. Ramírez Pérez & O.G. Torres
National University of Colombia, Bogotá, Colombia

3BV.2.17 Studying the Use of Mixed Binders Made with Epoxy Resin and Collodion for Producing Conductive Inks for the Metallization of Perovskite Solar Cells via Screen Printing Techniques

C. Montes, L. Ocaña, L. De Sousa-Vieira, M. Friend & M. Cendagorta
ITER, Granadilla de Abona, Spain
S. González-Pérez & B. González-Díaz
ULL, La Laguna, Spain

3BV.2.19 Wet (CBD, Spin-Coating) and Dry (ALD, CVD) Deposition of Tunable Metal Hybrid Perovskites MAS_nxPb_{1-x}(IxB_{1-x})₃ and Oxides for Tandem Application

M. Kozolinsky, T. Hildebrandt & F. Donsanti
EDF R&D, Palaiseau, France
F. Rousseau
ParisTech, France

3BV.2.20 Efficient and Stable Fully Slot Die Coated Perovskite Solar Cell

A. Verma, J. Heier, R. Schneider & F. Nüesch
EMPA, Dübendorf, Switzerland
D. Martineau & T. Meyer
Solaronix, Aubonne, Switzerland

3BV.2.22 Tailoring the 2D/3D Structure of Perovskite Film for Its Integration on Highly Textured c-Si Bottom Cell

F. Hilt & E. Drahi
TOTAL, Paris la Défense, France
C. Aider
IPVF, Palaiseau, France
J. Rousset
EDF R&D, Palaiseau, France

3BV.2.23 Optical Perovskite Test for Optimisation of Perovskite Solar Module Encapsulation Procedures

E.P. Booker, M. Majorel, M. Matheron, N. Nguyen, S. Cros & S. Berson
CEA, Le Bourget du Lac, France
J.B. Boutin
Arkema, Pierre-Benite, France

3BV.2.24 PZN-4.5pt Perovskites Nanoparticles Thin Films for High Light Absorption and Ferrophotovoltaics Application

R. Ndioukane, N.C.Y. Fall, M. Touré & D. Kobor
Assane Seck University, Ziguinchor, Senegal
L. Lebrun
INSA, Lyon, France

3BV.2.25 Photovoltaic Properties of PZN-4.5PT Perovskite Nanoparticles Thin Film Deposited on Silicon Nanowires Substrate

R. Ndioukane & D. Kobor
UASZ, Ziguinchor, Senegal
L. Motte & J. Solard
University of Paris 13, France

3BV.2.26 Investigation of the Reliability of the Perovskite Photovoltaic Module

Z. Tang, H. Zhang, Y. Wang, W. Guo, C. Jian, Y. Li & X. Xu
Hanergy Thin Film Power, Chengdu, China
X. Hao & J. Zhang
Sichuan University, Chengdu, China

3BV.2.27 Structural Properties of Solution Processed FAPbI₃ Perovskites Combined with DFT Calculations

K. Sekar, J.J. Ríos - Ramírez & V. Subramaniam
CINVESTAV, Ciudad de Mexico, Mexico
J. Bouclé
University of Limoges, France

3BV.2.28 The Effects of Thickness and Interface of CuSCN on the Performance of Perovskite Solar Cells

H. Gao
Beijing University of Technology, China

3BV.2.29 Device Design Rules and Operation Principle of Perovskite Solar Cells for High-Power Indoor Applications

M.H. Ann, N.Y. Ha & J. Kim
Ajou University, Suwon, Republic of Korea
J. Kim
KETI, Seongnam-si, Republic of Korea
M. Kim, J. Seidel & J.S. Yun
UNSW, Sydney, Australia
N. Park
KETI, Gyeonggi-do, Republic of Korea

3BV.2.30 Effect of ZnO Seed Layer in Perovskite Solar Cell

D.K. Jarwal, A. Kumar, A. Mishra, D.C. Upadhaya,
C.K.S. Jit & M.R. Tripathy
IIT(BHU) Varanasi, India

3BV.2.35 Air-Stable Semi-Transparent Organic Solar Cells Based on Innovative Donor Polymer and Graphene Electrode

G. Bianchi, C. Carbonera, A. Cominetti, F. Ferrazza & R. Po eni, Novara, Italy
M.M. Tavakoli & J. Kong
MIT, Cambridge, United States

3BV.2.36 Lifetime of Inkjet Printing OPV Modules for Indoor Applications

H. Alkhatib, M. Pasquinelli, L. Escoubas & J.J. Simon
Aix Marseille University, France
P. Pierron & S.B. Dkhil
Dracula Technologies, Valence, France

3BV.2.39 Co-Sensitization of Ruthenizer with MOF for Increasing Power Conversion Efficiency in DSSCs

M. Younas, A. Helal, A. Al-Ahmed & F.A. Al-Sulaiman
KFUPM, Dhahran, Saudi Arabia
M. Afzaal
Higher Colleges of Technology, Sharjah, United Arab Emirates

3BV.2.41 Highly Efficient Halogen-Free Solvent Processed Large Area Polymer Solar Cell Module Enabled via Molecular Engineering of Copolymers

S. Rasool, C.E. Song, H.K. Lee, S. K. Lee, J.-C. Lee,
S.-J. Moon & W. S. Shin
KRICT, Daejeon, Republic of Korea

3BV.2.45 CuGaSe₂ / c-Si Tandem Solar Cells with an Optimized CuGaSe₂ Co-Evaporation Process

A. Rivalland, L. Arzel & N. Barreau
IMN, Nantes, France
P. Bellanger & S. Dubois
CEA, Le Bourget du Lac, France

3BV.2.46 Polymer-Based Rear Side Light Trapping Structures for Silicon-Based Tandem Solar Cells

H. Hauser, O. Höhn, R. Müller, N. Tucher, K. Mühlbach,
R.M. da Silva Freitas, J. Benick, M. Hermle & B. Bläsi
Fraunhofer ISE, Freiburg, Germany

3BV.2.47 Atomic Structure of As-Modified Si(100) Surfaces Prepared in CVD Ambience for III-V/Si Tandems

A. Paszuk, O. Supplie, M. Nandy, P. Kleinschmidt &
T. Hannappel
Ilmenau University of Technology, Germany
O. Romanyuk
ASCR, Prague, Czech Republic

3BV.2.49 Building Blocks Development for Defect-Free Growth of GaAs on Silicon for Tandem Solar Cells

D. Mencaraglia, A. Jaffré, J. Alvarez, J.-P. Kleider &
J.P. Connolly
CNRS, Gif sur Yvette, France
C. Renard, G. Hallais, L. Vincent & D. Bouchier
C2N, Palaiseau, France
N. Cherkashin
CEMES, Toulouse, France

3BV.2.50 Towards a GaAs/AlGaAs Nanowires-on-Silicon Tandem Solar Cell

M. Vettori, P. Regreny & M. Gendry
Ecole Centrale de Lyon, Ecully, France
X. Li, C. Chevalier, M. Lemiti & A. Fave
INSA Lyon, Villeurbanne, France
V. Piazza, A. Cattoni, A. Scaccabarozzi, G. Patriarcho & M. Tcherynecheva
CNRS, Palaiseau, France

3BV.2.51 Composite-Cell Current Matching for Higher Efficiency Tandem Solar Cells

R. Garrison & R.N. Kleiman
McMaster University, Hamilton, Canada

3BV.2.52 Rational Design of Recombination Junction for Efficient Monolithic Tandem Integration of Perovskite and Standard Si Solar Cells

Y.H. Jang, H.S. Seo, H.S. Yun, I. Kim & D.-K. Lee
KIST, Seoul, Republic of Korea

3BV.2.53 Optical Characterizations and Modelling of Semitransparent Perovskite Solar Cells for Tandem Applications

E. Raoult, R. Bodeux, S. Jutteau, S. Rives, A. Yaiche & J. Rousset
EDF R&D, Palaiseau, France
D. Coutancier & S. Collin
CNRS, Palaiseau, France

3BV.2.54 Monolithic Perovskite/Silicon Tandem Solar Cells with Nanocrystalline Silicon Oxide Recombination Junction

E. Lamanna, E. Calabrò, F. Matteocci & A. Di Carlo
University of Rome II, Italy
M.L. Addonizio, E. Bobeico, M. Della Noce, V. La Ferrara, A. De Maria, G. Rametta, L. Lancellotti, L.V. Mercaldo, I. Usatii & P. Delli Veneri
ENEA, Portici, Italy

3BV.2.55 Low Temperature Activation of B Implantation for Si Subcell Fabrication in III-V/Si Tandem Solar Cells

Y.-T. Sun, M.C. Chen, G. Omanakuttan, A. Strömberg & S. Lourdudoss
KTH Royal Institute of Technology, Kista, Sweden
R. Hansson & M. Rinio
Karlstad University, Sweden

3BV.2.56 Fabrication Procedure of c-Si Tunnel Junction for Tandem Photovoltaic Cells

X. Li, A. Fave & M. Lemiti
INSA Lyon, Villeurbanne, France

3BV.2.57 CIGS Growth on a III-V/Si(001) Platform: Towards CIGS/Si Tandem Solar Cells

O. Durand, A. Létoublon, C. Cornet & A. Zhou
INSA-Rennes, France
N. Barreau & E. Gautron
University of Nantes, France
M. Balestrieri, D. Coutancier & D. Lincot
CNRS, Palaiseau, France
A. Ben Slimane & S. Béchu
IPVF, Palaiseau, France
T. Bidaud & S. Collin
CNRS, Orsay, France
M. Feifel & F. Dimroth
Fraunhofer ISE, Freiburg, Germany
M. Bouttemy, A. Etcheberry, M.A. Pinault-Thaury & F. Jomard
UVSQ, Versailles, France

3BV.2.58 Time-Response Analysis of Perovskite/Silicon Tandem Solar Cells

V. Paraskeva, M. Hadjipanayi & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus
A.W.Y. Ho-Baillie, N.J. Ekins-Daukes & J. Zheng
UNSW Australia, Sydney, Australia

3BV.2.59 Optimization of the Transparent Conductive Adhesive Layer for Two Terminal Multijunction Solar Cells

C. Li, P. Zhang, Z. Liu, X. Hao & M.A. Green
UNSW Australia, Sydney, Australia

3BV.2.60 Designing Carrier Selective Perovskite on Silicon 3T Tandems

J.P. Connolly, J.P. Kleider, M.E. Gueunier-Farret, Z. Djebbour, J. Alvarez & D. Mencaraglia
CNRS, Gif sur Yvette, France
M.K. Nazeeruddin
EPFL, Lausanne, Switzerland
V.D. Mihailetschi
ISC Konstanz, Germany
P. Baranek
EDF R&D - IPVF, Palaiseau, France
P. Schulz
CNRS, Palaiseau, France

3BV.2.61 Monolithic CZTS/Si Tandem Cells with MoS₂/TCOs Intermediate Contact

C. Malerba, M. Valentini, M. Izzi, L. Serenelli, E. Salza, M. Tucci & A. Mittiga
ENEA, Rome, Italy

VISUAL PRESENTATIONS 1BV.3

15:15 - 16:45 Fundamental Studies / New Materials and Concepts for Cells and Modules

Chairpersons:

Antonio Martí Vega
UPM, Spain

Jean-Francois Guillemoles
CNRS, France

1BV.3.1 Analysis for Efficiency Potential of Perovskite Solar Cells and Perovskite/Si Tandem Solar Cells

M. Yamaguchi, K.-H. Lee, Y.-C. Wang, K. Araki & N. Kojima
Toyota Technological Institute, Nagoya, Japan

1BV.3.2 Hot Carrier Approach to the Efficiency of a Solar Cell

S. Ašmontas, J. Gradauskas, A. Sužiedelis, A. Šilenas,
E. Širmulis, V. Vaicikauskas, V. Švedas & O. Žalys
CPST, Vilnius, Lithuania

1BV.3.4 Comparison among Models for Lambertian Light Trapping in Textured Si Solar Cells

L. Abenante
ENEA, Rome, Italy

1BV.3.5 Internal Rear Reflectance at Lambertian Light Trapping in Textured Si Solar Cells

L. Abenante
ENEA, Rome, Italy

1BV.3.7 Improved Efficiency of Organic Solar Cells by Embedded Colloidal Crystals and Nano-Texturing Surfaces

F.C Díaz-Granados, F.E. Rojas Tarazona, H. Méndez,
J.C. Salcedo, H. Rodríguez, A. Mejía & G. Yamhure
Pontifical Xavierian University, Bogotá, Colombia

1BV.3.8 Absorption of Light by a Particulate Monolayer: Effect of Ordering, Concentration, and Size of c-Si Particles

V.A. Loiko, A.A. Miskevich & N.A. Loiko
NASB, Minsk, Belarus

1BV.3.9 Synthesis of CuO Nanowires with Controlled Density

L. Nkhaili, A. Narjis, A. El Kissani, A. Agdad & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

1BV.3.10 Towards a Low-Cost High-Power LED Array for Solar Cells Characterization

M.M. Hassan, S.O. Abdellatif & H.A. Ghali
The British University in Egypt, Cairo, Egypt

1BV.3.11 Study of an Acquisition Chain for the Thermal Characterisation of Thin Film – An Inverse Method to Estimate Material Parameters

S. Peillon, C. Rodiet & Y. Cuminal
IES / EPF, Montpellier, France

1BV.3.12 Analytical Framework for the Assessment and Modelling of Single- and Multi-Junction Solar Cells

C.S. Schuster
University of York, United Kingdom

1BV.3.13 Functionalized Graphene Quantum Dots Embedded Polymer: Photon Downshifter for CIGS Photovoltaics

F. Khan & A. Al-Ahmed
KFUPM, Dhahran, Saudi Arabia
J.H. Kim
DGIST, Daegu, Republic of Korea

1BV.3.14 Research on Flexible GaInP/GaInAs/Ge/Bi₂Te₃/Sb₂Te₃ PV-TE Integrated Systems

P. Gao, H. Wang, Q.-M. Zhang, C. Xue & Q. Sun
Tianjin Institute of Power Sources, China
C.-Y. Hou
Donghua University, Shanghai, China

1BV.3.20 Photocurrent Measurements and Deep Level Transient Spectroscopy on In₂S₃:V Intermediate Band Solar Cells

T. Jawinski, R. Pickenhain, M. Grundmann &
H. von Wenckstern
University of Leipzig, Germany
L.A. Wägele & R. Scheer
Martin Luther University, Halle (Saale), Germany

1BV.3.22 Strained Quantum Well Superlattice Solar Cells

S.M. Hubbard, M. Kacharia & S.J. Polly
Rochester Institute of Technology, United States
R. Welser & A. K. Sood
Magnolia Optical Technologies, Woburn, United States

1BV.3.23 Oxide Solar Cell Devices Based Cu₂O/ZnO Deposited via Open Air Spatial Atomic Layer Deposition towards Building Integrated Photovoltaic Application

A. Sekkat, V.H. Nguyen, C. Masse de la Huerta, D. Bellet,
A. Kaminski-Cachopo, G. Chichignoud & D. Munoz-Rojas
Grenoble INP, France

1BV.3.25 Increasing Photovoltaic Module Sustainability through UV-Curable Self-Healing Polymer Layers

D. Ehrhardt, B. Van Mele & N. Van den Brande
VUB, Brussels, Belgium
K. Van Durme & J. Jansen
DSM, Geleen, The Netherlands

- 1BV.3.28 Copper Doped TiO₂ Nano Crystallites for Dye-Sensitized Solar Cell (DSSC) Applications**
S. Chahid, R. Alcántara & D.M. de los Santos
UCA, Puerto Real, Spain
- 1BV.3.30 Pseudo-Phase Transition Behavior in CuSbS₂ Thin Films by S Flux**
A. Cho, S. Banu, Y. Cho, S.J. Ahn, J.H. Yun, J. Gwak, S.K. Ahn, Y.J. Eo, J.S. Cho, J.H. Park, J.S. Yoo, K. Kim, D.H. Shin & I. Jeong
KIER, Daejeon, Republic of Korea
- 1BV.3.32 SnS Thin Films Grown by Successive Layer Adsorption and Reaction Method at Room Temperature**
M. Mathew
St. Joseph's College, Kozhikode, India
- 1BV.3.33 Light Trapping in Commercial Silicon Solar Cell Structures Using Silver Nano Particles**
M. Mathew
St. Joseph's College, Kozhikode, India
- 1BV.3.35 Reaching Entire Solar Spectrum Absorption through Micro-Textured Metal Thin Film Induced Strong Localized Surface Plasmon Resonance**
H.-J. Syu, H.-C. Chuang, M.-J. Lin & C.-F. Lin
NTU, Taipei, Taiwan
- 1BV.3.36 Antimony Selenide Based Solar Cells by Vacuum Evaporation**
V. Kumar, E. Artegiani & A. Romeo
University of Verona, Italy
- 1BV.3.37 Fabrication of Uniform Silicon Nanowires Array via Chemical Controlled Silica Template for Enhancing Light Trapping Properties**
S. Khanna, S. Paneliya, V. Bhavsar, P. Marathey, R. Banerjee & I. Mukhopadhyay
PDP University, Gandhinagar, India
D. Roy
DRDO, Kanpur, India
- 1BV.3.38 Investigation of Al₂O₃ –SiO₂ Antireflection Coatings for Silicon Solar Cells**
V.F. Gremenok
NASB, Minsk, Belarus
V.V. Khoroshko
BSUIR, Minsk, Belarus
S.X. Suleymanov, V.G. Dyskin, M.U. Djanklich, N.A. Kulagina & O.A. Dudko
Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan
A.N. Pyatlitski, V.A. Saladukha & T.V. Piatlitskaya
JSC "INTEGRAL", Minsk, Belarus

- 1BV.3.39 Upconversion Nanophosphors (Er:Yb:Y₈V₂O₁₇ and Y₂Te₄O₁₁) for Solar Cell**
A.K. Dikshit, A. Singh & P. Chakrabarti
IIT, Varanasi, India
Y. Dwivedi
Kurukshetra University, India
N. Mukherjee
IEST Shibpur, Howrah, India
- 1BV.3.41 Electrodeposited Cuprous Oxide Based Thin Film Heterojunction Solar Cells**
P. Marathey, B. Patel, S. Khanna, I. Mukhopadhyay & A. Ray
PDP University, Gandhinagar, India
- 1BV.3.42 Nanocomposite Solar Cells Based on Organic/Inorganic Heterojunction Clonidine/Si**
S.V. Mamykin, A.V. Korovin, N.V. Kotova, T.R. Barlas, O.S. Kondratenko, I.B. Mamontova, V.R. Romanyuk, P.S. Smertenko & N.M. Roshchina
NAS ISP, Kyiv, Ukraine
- 1BV.3.44 Texture and Bandgap Tuning of Phase Pure Cu₂O Thin Films Grown by a Simple Potentiostatic Electrodeposition Technique**
S.F.U. Farhad, M.M. Hossain & N.I. Tanvir
BCSIR Labs, Dhaka, Bangladesh
- 1BV.3.45 Structural Study of Nickel Silicide Formation Using Ni/a-Si/c-Si and a-Si/Ni/a-Si/c-Si Multilayers Prepared by RF Sputtering for Photovoltaic Application**
A. Agdad, A.-I. El Khalfi, A. Tchenka, M. Azizan, E.M. Ech-Chamikh & Y. Ijdiyaou
Cadi Ayyad University, Marrakech, Morocco
- 1BV.3.46 Synthesis and Characterization of Cu₂NiSn₄ Thin Films Solar Cells via Sol-Gel Method**
D. Ait El Haj, A. El Kissani, H. Chaib & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco
- 1BV.3.47 Front Interface Modification for Efficient Sb₂Se₃ Thin-Film Solar Cells**
K. Shen, C. Ou & Y. Mai
Jinan University, Guangzhou, China
Z. Li
Hebei University, Baoding, China
- 1BV.3.48 Modelling Acceptor Composition Dependent Voc in Ternary Organic Solar Cells**
A. Singareddy & P.R. Nair
IIT Bombay, Mumbai, India

1BV.3.49 Designing a Wet Solar Cell Composed of Titanium Dioxide Anode and Copper Oxides Cathode
H. Nay Wunn, S. Motoda & M. Morita
Kaiyodai, Tokyo, Japan

1BV.3.50 Experimental Results of Testing Different PV Receivers for Laser Wireless Energy Transfer System for UAV
V. Kapranov, D. Ovchinnikov, V. Tugaenko & A. Razuvaev
powerin.space, Moscow, Russia

1BV.3.51 Multifunctional Coated Composite Material for Encapsulation of Photovoltaic Devices
N. Yurrita, J. Aizpurua, J.M. Vega de Seoane,
G. Imbuluzketa, I. Arrizabalaga, W. Cambarau & F.J. Cano
Tecnalia, San Sebastián, Spain

VISUAL PRESENTATIONS 6BV.4

17:00 - 18:30 PV on/in Buildings, Infrastructure, Landscape, Water and Nature / Professional Applications of PV

Chairpersons:

Alessandra Scognamiglio
ENEA, Italy

Urs Muntwyler
BUAS, Switzerland

6BV.4.2 CONIPHER: Performance Analysis of an Innovative Facade Solution for Renovation Market Photovoltaic Integration Enhancement
Y.B. Assoa, P. Thony & P. Messaoudi
CEA, Le Bourget du Lac, France
E. Schmitt
Vicat, L'Isle-d'Abeau, France
O. Bizzini
ARaymond, Saint-Egrève, France

6BV.4.3 Transformative Techniques for Photovoltaic Integration in Building Roofs and Facades
G. Cattaneo, K. Söderström, L. Hengyu, J. Escarre Palou,
U. Fuerholz, P. Heinsteinst, S. Pittet, P. Duvoisin,
L.-E. Perret-Aebi, M. Despeisse & C. Ballif
CSEM, Neuchâtel, Switzerland

6BV.4.4 The Key to a Sustainable Building Façade: Demonstration and Results
Q. van Nieuwenhoven & S. Scheerlinck
Laborelec, Linkebeek, Belgium
S.C. Veenstra
ECN part of TNO, Eindhoven, The Netherlands
T. Aernouts
imec, Leuven, Belgium

6BV.4.5 Classification of Building Parts in Real City Point Clouds
S. Schiffel, G. Behrens & F. Fehring
University of Applied Sciences Bielefeld, Minden, Germany

6BV.4.6 Performance Assessment of BIPV Systems: From Current Normative Framework to Next Developments
P. Bonomo, F. Parolini, F. Frontini, E. Saretta,
M. Caccivio & G. Bellenda
SUPSI, Canobbio, Switzerland
M. Machado
Tecnalia, San Sebastián, Spain
S. Boddaert
CSTB, Sophia-Antipolis, France

6BV.4.7 BIPV Round Robin Action of IEA PVPS Task 15
P. Illich
UAS Technikum Wien, Vienna, Austria
P. Gaisberger
FH-OÖE, Wels, Austria
G.C. Eder
OFI, Vienna, Austria
K.A. Berger & G. Újvári
AIT, Vienna, Austria
D. Moor
Erte Solar, Amstetten, Austria
S. Boddaert
CSTB, Sophia-Antipolis, France
R.M.E. Valckenborg & J. van den Brand
SEAC, Eindhoven, The Netherlands
P. Bonomo & C.S. Polo López
SUPSI, Canobbio, Switzerland
M. del Buono
Eurac Research, Bolzano, Italy
A.G. Imenes
University of Agder, Grimstad, Norway
N. Martín Chivelet & H. Gonzáles
CIEMAT, Madrid, Spain
A. Sanz Martínez & M. Machado
Tecnalia, San Sebastián, Spain
J.T. Kim
Kongju National University, Cheonan, Republic of Korea
A. Masolin & M. Ritzen
ZUYD, Heerlen, The Netherlands

6BV.4.8 The Relation between Partial Shadings and Irradiation Losses in BIPV Systems in Different Locations Around the World

C.D. Zomer & R. Rüther
UFSC, Florianópolis, Brazil

6BV.4.9 Design Applications of Bifacial c-Si PV Module for BIPV Environments

H.K. Ahn, S.Y. Park, J.-H. Choi, B.G. Bhang & W.B. Lee
Konkuk University, Seoul, Republic of Korea
C.-S. Won
Scotra, Pyeongtaek, Republic of Korea
S.C. Woo
Woodo Energy, Busan, Republic of Korea
S.H. Lee
KETEP, Seoul, Republic of Korea
H.J. Go
Koenergy, Jinju, Republic of Korea
H. Jo & O. Kwon
K-water, Daejeon, Republic of Korea

6BV.4.10 Comparison of Crystalline Silicon and CIGS BIPV in Desert Environment of Dubai, UAE

O.M. Albadwawi, J.J. John & A. Alnuaimi
DEWA, Dubai, United Arab Emirates

6BV.4.11 Energy Yield Analysis of a Heat Pipe Based Photovoltaic Thermal Solar Collector for Building Integrated Applications

M.P. Bellmann
SINTEF, Trondheim, Norway
S.P. Lester
Flint Engineering, Mayfield, United Kingdom
H. Jouhara
Brunel University, London, United Kingdom
R. Einhaus
Apollon Solar, Lyon, France

6BV.4.12 Numerical Study for the PV Potential and Integration in Urban Areas

B. Raybaud & P. Thony
CEA, Grenoble, France
E. Vergnault, L. Merlier & J.J Roux
INSA-Lyon, Villeurbanne, France

6BV.4.13 EnergyMatching Project – Adaptable and Adaptive RES Envelope Solutions to Maximize Energy Harvesting and Optimize EU Building and District Load Matching

L. Maturi, S. Giona, D. Moser, R. Lollini & M. Lovati
Eurac Research, Bolzano, Italy
P. Alonso & I. Weiss
WIP Renewable Energies, Munich, Germany
C. Bales
Dalarna University, Borlänge, Sweden
J.M. Vega de Seoane
Tecnalia, San Sebastián, Spain
A. Becker
Ferroamp Elektronik, Spånga, Sweden
S. Hallbeck
NIBE, Markaryd, Sweden
E. Widlak
Tulipps, Waalwijk, The Netherlands
D.-J. Bles
Plastica Plaat, Waalwijk, The Netherlands
V. Zanon
Eurofinestra, Governolo, Italy
E. Rico
Onyx Solar Energy, Avila, Spain
L. Papaiz
Pellini, Codogno, Italy
A. Perez Carballo
Solarwall, Madrid, Spain
C. de Nacquard
Bouygues, Paris, France
O. Caboni
R2M Solution, Pavia, Italy
V. Esposito
Casa, Florence, Italy
J. Hedberg
LudvikaHem, Sweden
S. Metayer
Habitat76, Rouen, France

6BV.4.14 On the Feasibility of Solar Fuelled Electric Ferries

M. Jomåa
SINTEF, Oslo, Norway

6BV.4.16 Design and Optimization for Seawater Desalination Plant by Reverse Osmosis, Using Photovoltaic Solar Energy

L. Luciano de la Cruz
National University of Engineering, Lima, Peru

6BV.4.17 Evaluation of Thermal Properties for BIPV in Façade - Experimental Results of G Value for Crystal Silicon BIPV Module According to ISO 19467

H. Ishii
LIXIL, Tokyo, Japan

- 6BV.4.18 Comparison of the Outdoor Performance of Cylindrical and Rectangular-Parallelepiped PV Modules**
H. Noge & M. Konagai
Tokyo City University, Japan
T. Masuda & A. Satou
Toyota, Shizuoka, Japan
- 6BV.4.20 Operational Power Performance Analysis of Various BIPV Systems in Republic of Korea**
H. Lee, J. Yoon, M. Choi & D. Shin
Hanbat National University, Daejeon, Republic of Korea
- 6BV.4.21 Steps Towards an Optimized Building-Integrated Photovoltaics Value Chain in The Netherlands**
E. van der Poel, Y. Aartsma & E. Teunissen
Berenschot, Utrecht, The Netherlands
A. De Vries
Celstar, Brussels, Belgium
W.G.J.H.M. van Sark
Utrecht University, The Netherlands
- 6BV.4.22 Design Evaluation of Customized Building Integration Photovoltaic Prototypes in Hot Climates**
D. Efurosibina Attoye, K.A. Tabet Aoul & A. Hassan
UAEU, Al Ain, United Arab Emirates
- 6BV.4.23 A Solar Cell with Switchable Colour**
N. Neugebohm, M. Götz, K. Gehrke, M. Vehse & C. Agert
DLR, Oldenburg, Germany
- 6BV.4.24 Output Characteristic of Thin-Film Solar Cell Assuming Various Greenhouse Installation Forms**
Y. Hirata & Y. Watanabe
Suwa University of Science, Nagano, Japan
- 6BV.4.25 An Easy-to-Mount BIPV Roof System**
J. Oscarsson, P. Neretnieks, M. Ljunggren, A. Eriksson, K. Theelen, J. Endrell & L. Stolt
Solibro Research, Uppsala, Sweden
- 6BV.4.26 Direct Determination of Total Hemispherical Emittance of Perovskite and Silicon Solar Cells**
L. Granados, J. Bing, S. Huang, H. Mehrvarz & A.W.Y. Ho-Baillie
UNSW, Sydney, Australia
N. Takamure & D.R. McKenzie
University of Sydney, Australia
- 6BV.4.27 Experimental Study on the Performance Evaluation of Building Integrated Photovoltaic (BIPV) Generated Curtain-Wall for Reliability Verification**
E. Ryu, S. Lee, D. Kim, K.-J. Kim & J. Park
KCL Korea Conformity Laboratories, Chungbuk, Republic of Korea

- 6BV.4.28 Increasing Coverage of Heating Demand by PVs Electricity Generation through Geometrical Modification in a Medium Sized Building**
A. Rahmani & R. Wagner
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany
- 6BV.4.31 Design and Technoeconomic Optimization of Grid-Connected Hybrid PV-System for the Agricultural Sector**
J. Fagerstrøm, I.H. Lereng & J.H. Selj
Institute for Energy Technology, Kjeller, Norway
A.-G. Hjelkrem & A.K. Bakken
NIBIO, Ås, Norway
- 6BV.4.32 An Innovative PVT Hybrid Module for Positive Energy Buildings - An Example of Implementation in France**
L. Brottier & J.-M. Drap
DualSun, Marseille, France
R. Bennacer
LMT/ENS, Cachan, France
- 6BV.4.34 Solar Streetlights Using Vertical Bifacial Solar Modules: A Case Study for India**
E. Gerritsen
CEA, Le Bourget du Lac, France
- 6BV.4.35 Wind-Solar Hybrid Systems May Raise Project IRR by up to 10%**
S. Dayal
Sunil Dayal, Delhi, India
- 6BV.4.36 Extended Battery Life in Wearable Device Using Quantum Dot Embedded Flexible Photovoltaic Harvester and Low Power Conversion System**
C. Lee, Y. Park, Y. Ryu & S. Yeo
Samsung Electronics, Seoul, Republic of Korea

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Wednesday, 11 September 2019

VISUAL PRESENTATIONS 6CV.1

08:30 - 10:00 PV Driven Energy Management and System

Chairpersons:

Franz Baumgartner
ZHAW, Switzerland

Ingrid Weiss
WIP Renewable Energies, Germany

6CV.1.1 Power Flow Monitoring at Substations of Low Voltage Distribution Grids with High Penetration of PV Installation

H. Behrends, R. Völker & S. Geißendörfer
DLR, Oldenburg, Germany
T. Kumm
EWE, Oldenburg, Germany

6CV.1.2 Development of Advanced Control Using Forecast Data for PV-Diesel Hybrid Systems on a Simulation Platform

A. Wantier & T.-P. Do
CEA, Le Bourget du Lac, France
C. Grellier & J. Colas
CVE, Marseille, France

6CV.1.4 Energy Management for Energy Community Sharing Based on Particle Swarm Optimization and Alternating Direct Method of Multiplier (ADMM)

M.A. Albachrony, D.L. Ha, Q.T. Tran & A. Brun
CEA, Le Bourget du Lac, France
M. Petit
Supelec, Gif-sur-Yvette, France

6CV.1.5 Incentive-Based Solutions for High Photovoltaic Penetration in Distribution Grid

L. Bloch, J. Holweger, C. Ballif & N. Wyrsh
EPFL, Neuchâtel, Switzerland

6CV.1.6 Photovoltaic Energy Yield Prediction Using an Irradiance Forecast Model Based on Machine Learning

S. Wendlandt
PI Berlin, Germany
F. Popescu
Fraunhofer FOKUS, Berlin, Germany

6CV.1.7 Day-Ahead Scheduling of Household Electricity Consumption Based on a Genetic Algorithm

C. Lucas, M. Guemri & Q.T. Tran
CEA, Le Bourget du Lac, France

6CV.1.8 Spatio-Temporal Forecasting of PV Power Generation for High Integration in the Grid

M. Malvoni & N. Hatzigiorgiou
ICCS/NTUA, Zografou, Greece

6CV.1.9 A Systematic Approach to Development of a Sustainable Monitoring and Evaluation Framework for PV Hybrid Mini-Grids

B. Ravanbach, M. Kühnel, B. Hanke, K. von Maydell & C. Agert
DLR, Oldenburg, Germany
O. Weigel & S. Maebe
GIZ, Hamburg, Germany
A. McMaster
DEDEAT, East London, South Africa

6CV.1.11 A Solar PV/T Living Laboratory as a Cyber-Physical System

A. Rachid
UPJV, Amiens, France

6CV.1.12 Fuel Consumption Decrease in Hybrid-Power Systems Using PV Power Monitoring and Forecast Solution

L.-E. Boudreault, E. Buessler, O. Liandrat & S. Cros
Reuniwatt, Sainte-Clotilde, France

6CV.1.13 Simulation of Multi-Agent Systems Coordination for Load Management in MicroGrid

M. Ait Benali & A. Outzourhit
Cadi Ayyad University, Marrakech, Morocco

6CV.1.14 Complementarity of Renewable Energy for Rural Zones, Study Case Cundinamarca-Colombia

A. Aldana-Urrea, D.J. Rodriguez & J.A. Hernández
District University of Bogotá, Colombia

6CV.1.15 Prototype of Electric Car for Physically Disabled People Integrated with Residential Solar Power System in Sao Paulo, Brazil

S. Shimura & D. Deotti
IFSP, São Paulo, Brazil
R. de Paula Diver
UNICAMP, Campinas, Brazil
J.O. Motta Pompeu e Silva
UFRJ, Rio de Janeiro, Brazil

6CV.1.16 A Framework on Spatiotemporal Shifting of Solar Energy Based on EV Aggregator

K. Kato, D. Watari, I. Taniguchi & T. Onoye
University of Osaka, Suita, Japan

6CV.1.17 Load Management Strategies for Weak Grids with High Penetration of Electric Vehicles
P. Klement, J. Helms, B. Hanke & K. von Maydell
DLR, Oldenburg, Germany

6CV.1.18 Modelling the PV Opportunities to Power E-Mobility
H. Ossenbrink
Band Gap, Bad Feilnbach, Germany

6CV.1.19 Preparing the Massive Introduction of Intermittent Energies and Electric Vehicles in Insular Territories: First Steps in Martinique and in Malta
A. Guerin de Montgareuil
CEA, St-Paul-lez-Durance, France
B. Azzopardi
MCAST Energy, Paola, Malta
L. Bellemare
AME, Ducos, Martinique

6CV.1.20 Preliminary Weather Forecast Tracking and Modelling of Electromobility
J. Ascencio-Vásquez & M. Topič
University of Ljubljana, Slovenia

6CV.1.21 Artificial Neural Network Based Decision Support System for the Present Power Grid Accounting for the Successful Integration of Renewable Energy Sources such as PV Systems
M. Linke, T. Meßmer, G. Micard, A. Wenzel & G. Schubert
University of Applied Sciences, Constance, Germany
M. Kindl
Smart Infrastructure, Stuttgart, Germany
A. Minde
ISC Konstanz, Constance, Germany

NOTES

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VISUAL PRESENTATIONS 2CV.2

12:45 - 15:00 Feedstock, Crystallisation, Wafering, Defect Engineering / Thin Film and Foil-Based Si Solar Cells / Characterisation & Simulation of Si Cells

Chairpersons:

Stephan Riepe
Fraunhofer ISE, Germany

Marco Topič
University of Ljubljana, Slovenia

Stefan Peters
Hanwha Q CELLS, Germany

Francesca Ferrazza
eni, Italy

Timothy Bruton
Progress in Photovoltaics, United Kingdom

2CV.2.2 Key Structures in Silicon Heterojunction Solar Cells for the Complete Regeneration of BO-Related Defects in n-Type Upgraded Metallurgical-Grade Czochralski Silicon

C. Sun, R. Basnet, S.P. Phang & D. Macdonald
ANU, Canberra, Australia
W. Weigand, Z. Yu & Z.C. Holman
Arizona State University, Tempe, United States
D. Chen & B. Hallam
UNSW Australia, Sydney, Australia

2CV.2.3 Bulk Degradation of n-Type Czochralski-Grown Upgraded Metallurgical-Grade Silicon Wafers during the Processing of Phosphorus-Doped Poly-Silicon Cells

R. Basnet, S.P. Phang, C. Samundsett, D. Yan, C. Sun, H.T. Nguyen & D. Macdonald
ANU, Canberra, Australia
F.E. Rougieux
UNSW Australia, Sydney, Australia

2CV.2.4 Degradation and Regeneration of n+-Poly-Si on Oxide Surface Passivation under Illumination and Dark Annealing on p-Type Cz-Si

M. Winter, S. Bordihn, R. Peibst & J. Schmidt
ISFH, Emmerthal, Germany

2CV.2.5 Light and Elevated Temperature Induced Degradation in p- and n-Type Mono-Like Silicon and Float Zone Silicon Materials and Their Correlation with Silicon Nitride Film Properties

D. Kang, H.C. Sio & D. Macdonald
ANU, Canberra, Australia
X. Zhang, T. Zhang & H. Jin
Jinko Solar, Haining, China

2CV.2.6 LeTID Studied by Hyperspectral Photoluminescence Imaging

T. Mehl, J.-F.-B. Cappelen, I. Burud & E. Olsen
NMBU, Ås, Norway
R. Søndena
Institute for Energy Technology, Kjeller, Norway

2CV.2.7 Trapping in Multi-Crystalline Silicon Wafers: Capture Cross Section and Impact of Laser Treatment and Firing

S. Jafari, Y. Zhu, F. Rougieux & Z. Hameiri
UNSW Australia, Sydney, Australia

2CV.2.8 Influence of Deep Level Defects on Photoelectrical Processes in p-n Junction Solar Cells with Porous Silicon Antireflection Coating

V. Tregulov, V. Litvinov, A. Ermachikhin & A. Maslov
RSREU, Ryazan, Russia

2CV.2.9 Investigations of Grain Boundary Defects and Precipitates in Multi-Crystalline Silicon Wafers with EBSD, TEM, and Hyperspectral Photoluminescence Imaging

A. Thøgersen & I.T. Jensen
SINTEF, Oslo, Norway
T. Mehl, I. Burud & E. Olsen
NMBU, Ås, Norway
J. Zhu, S.E. Foss & R. Søndena
IFE, Kjeller, Norway

2CV.2.11 Investigation of the Influence of Solar Cell Processing on Structural Defects in HPMC-Si Wafers by Photoluminescence Image Analysis

H. Haug, M. Syre Wiig & C.R. Søndena
Institute for Energy Technology, Kjeller, Norway

2CV.2.12 Investigation of Spectral Dependence of Efficiency and Deep-Level Defects in Active Layers of Multicrystalline Silicon Solar Cells

S.M. Karabanov, V.G. Litvinov, N.V. Vishnyakov,
A.V. Ermachikhin, A.S. Karabanov & S.P. Vikhrov
RSREU, Ryazan, Russia

2CV.2.13 Control of Oxygen Concentration at the Top- and End-Position of Ingot to Improve Efficiency of Commercial p-Type PERC

W. Nam, J.C. Park & B. Lee
Woongjin Energy, Daejeon, Republic of Korea

2CV.2.14 Mathematical Modeling of Electromagnetic Stirring of Silicon Melt under the Conditions of a Travelling Magnetic Field

S.M. Karabanov, D.V. Suvorov, D.Y. Tarabrin & E.V. Slivkin
RSREU, Ryazan, Russia
A.S. Karabanov & O.A. Belyakov
Helios-Resource, Saransk, Russia

2CV.2.15 Generation and Propagation of Dislocation Clusters Originated from Multicrystallization by S.3n Rotation and in Quasi-Monocrystalline Silicon

T. Kojima, K. Tajima, T. Matsumoto, H. Kudo & N. Usami
Nagoya University, Japan
P. Krenckel & S. Riepe
Fraunhofer ISE, Freiburg, Germany

2CV.2.16 Further Tests of Methods to Reduce the Red Zone in the Top Region of MC - Silicon Ingots

T. Bähr & M. Ghosh
Access, Aachen, Germany
C. Kranert
Fraunhofer THM, Freiberg, Germany
C. Reimann
Fraunhofer IISB, Erlangen, Germany
C. Morche
ALD Vacuum Technologies, Hanau, Germany

2CV.2.17 Evaluation of Improvement Strategies of Grain Structure Properties in High Performance Multi-Crystalline Silicon Ingots

M. Trempa, C. Reimann & J. Friedrich
Fraunhofer IISB, Erlangen, Germany
C. Kranert & I. Kupka
Fraunhofer THM, Freiberg, Germany

2CV.2.18 The Development of 3D Visualization of Ingot Structure Based on Digital Processing of Photoluminescent Wafer Images of Multicrystalline Silicon

S.M. Karabanov, A.E. Serebryakov & D.V. Suvorov
RSREU, Ryazan, Russia
O.A. Belyakov & A.S. Karabanov
Helios-Resource, Saransk, Russia

2CV.2.19 Reduced Oxygen Contamination in Directionally Solidified Multi-Crystalline Silicon Ingots by Adjusted Silicon Nitride Coating

S. Schwanke, M. Trempa, C. Reimann & J. Friedrich
Fraunhofer IISB, Erlangen, Germany
M. Kuczynski, G. Schroll & J. Sans
AlzChem, Trostberg, Germany

2CV.2.20 Cost Effective Growth of Silicon Mono Ingots by the Application of Active Crystal Cooling in Combination with Large Melt Volumes in Cz-Puller

F. Mosel, A.V. Denisov, B. Klipp & N. Sennova
PVA Crystal Growing Systems, Wettengel, Germany
R. Kunert & P. Dold
Fraunhofer CSP, Halle (Saale), Germany

2CV.2.21 Mono-Like Silicon Ingot Casting Based on Simulation Result in Electron-Beam Melting System

J.-K. Lee, J.S. Lee, Y.S. Ahn & G.-H. Kang
KIER, Daejeon, Republic of Korea

2CV.2.22 An Approach for Implementing Machine Learning in the Solar Industry

A. Schlezinger
Applied Materials, Santa Clara, United States

2CV.2.23 On the Mechanical Strength of Diamond-Sawn Monocrystalline, Multicrystalline and Quasi-Monocrystalline Silicon Wafers: Influence of Thickness and Saw Mark Orientation

L. Carton, R. Riva, F. Coustier & A. Chabli
CEA-LITEN, Le Bourget du Lac, France
D. Nelias & M. Fourmeau
INSA Lyon, Villeurbanne, France

2CV.2.24 Variation of Silicon Wafer Strength and Edge Chipping Induced by Residual Stresses at the Brick Bonding Interface

R. Koepge, F. Kaule, F. Herbst, A. Langhans & S. Meyer
Fraunhofer CSP, Halle (Saale), Germany
E. Velispahic
Jowat, Detmold, Germany

2CV.2.31 Adoption of Wide-Bandgap Microcrystalline Silicon Oxide and Dual Buffers for Semitransparent Solar Cells in Building-Integrated Photovoltaic Window System

J. Yang & J.-D. Kwon
KIMS, Changwon, Republic of Korea
D.-W. Kang
Chung-Ang University, Seoul, Republic of Korea
M. Shin
Korea Aerospace University, Goyang, Republic of Korea

2CV.2.32 Power Increase of Transparent a-Si:H Solar Cells Using Albedo Effects

J.W. Lim, M.A. Park & K. Kim
ETRI, Daejeon, Republic of Korea

2CV.2.33 Analysis of the Bowing Phenomenon Using 100um Scale Partially Processed c-Si Solar Cells

J.-R. Lim, W.G. Shin, S.H. Ko, H. Hwang, Y.-C. Ju & G.-H. Kang
KIER, Daejeon, Republic of Korea

2CV.2.38 Performance Characterization for Bifacial Photovoltaic Modules

G.H. Wang, L. Zhao, C.L. Zhou, H.W. Diao & W.J. Wang
CAS, Beijing, China

2CV.2.42 Investigation of the Accelerated Light Soaking Testing for p-Type PERC Cell with and without Laser LIR Technology

C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, Y.-H. Chao, L.-G. Wu & C.-Y. Yu
TSEC, Hsinchu, Taiwan
Y.-C. Lee, M.-A. Tsai & H.-H. Hsieh
ITRI, Hsinchu, Taiwan

2CV.2.43 Analysis of Degradation in Metallization Process with E-Beam Evaporation in High-Efficiency n-Type Silicon Solar Cells

D. Choi, S.J. Park, C. Lee, S. Bae, Y. Kang, H.-S. Lee & D.H. Kim
Korea University, Seoul, Republic of Korea

2CV.2.44 Non-Destructive Approach for Measuring Base Resistivity of Emitter Diffused Wafers

V. Kuruganti, J. Haunschild, A. Brand, S. Al-Hajjawi & S. Rein
Fraunhofer ISE, Freiburg, Germany

2CV.2.45 Evidence of Solute PEDOT:PSS as an Efficient Passivation Material

V.H. Nguyen, K. Gotoh, Y. Kurokawa & N. Usami
Nagoya University, Japan
S. Kato
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2CV.2.46 A Simulation Approach for Device Structure and Thickness Optimization of Silicon Heterojunction Solar Cells Featuring TiO₂ as Carrier-Selective Contact

D.K. Gorle & N. Chander
IIT, Bhubaneswar, India

2CV.2.47 Investigation of Deep Energy Level Spectra in Active Layer of Si Heterostructure (HIT) Solar Cell

A. Maslov, V. Litvinov, N. Vishnyakov, V. Gudzev, A. Ermachikhin & S.P. Vikhrov
RSREU, Ryazan, Russia

2CV.2.49 Improving the Analysis of Contact Recombination by Photoluminescence Imaging

P. Manshanden
ECN part of TNO, Petten, The Netherlands

2CV.2.50 Sublayer-Resolved Structure Analysis of Passivation Layers for PERC Cells Deposited by a High-Throughput Inline PECVD Process

S. Großer, S. Richter, A. Hähnel & C. Hagendorf
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G. Köhler, H.-P. Sperlich, T. Große & H. Mehlich
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2CV.2.51 Point-by-Point Parameter Mapping of a mc-Si Solar Cell

N. Kwarikunda & W. Okullo
Makerere University, Kampala, Uganda
E.E. van Dyk & F.J. Vorster
Nelson Mandela University, Port Elizabeth, South Africa

2CV.2.52 A New Measurement of Voc Temperature Coefficients at Very Large Temperature Range

M. Amara, B. Guillo Lohan & M. Lemiti
INSA Lyon, Villeurbanne, France
A. Kaminski-Cachopo
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2CV.2.53 Effects of Si Bulk Defects Generated by SiNx:H PECVD on Light Induced Degradation

Y. Ohshita, K. Watanabe, R. Wakita, H. Lee & K. Nakamura
Toyota Technological Institute, Nagoya, Japan
T. Kamioka & A. Ogura
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2CV.2.54 FDTD Simulations of Structures Created by the Black-SiN Method to Optimize the Reflection Reduction of Solar Cells

M. John & N. Bernhard
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2CV.2.55 Powerful Topographic Analysis Method Using Fast Fourier Transform for c-Si Solar Cells and Emerging Technologies

K. Saliou & G. Fischer
IPVF, Palaiseau, France
F. Hilt & E. Drahi
TOTAL, Paris La Défense, France
T. Hildebrandt & P.P. Grand
EDF R&D, Palaiseau, France

2CV.2.56 Life(Time) at the Limits – Very High Lifetimes in Crystalline Silicon Measured by Photoconductance and Photoluminescence

B. Steinhauser, T. Niewelt, A. Richter, J. Polzin,
F. Feldmann, M.C. Schubert & M. Hermle
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2CV.2.57 Opto-Electronic Properties of Dislocations in Cast-Mono Silicon for Solar Cells

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2CV.2.58 Porous Silicon Low Dielectric Constant Thin Films and Its Application in Solar Cell

K. Rahmoun
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2CV.2.59 Accurate Performance Measurement of c-Si Solar Cells Adopting Advanced Metallization Technologies

S.K. Ahn, K. Kim, J.H. Yun, A. Cho, Y.J. Eo, J.S. Cho,
S.J. Ahn, J.H. Park, J.S. Yoo, D.H. Shin, I. Jung, S. Lee,
S. Song, A. Lee & J. Gwak
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2CV.2.60 Comparing Near-Field Calculations and Effective Medium Models for Light Reflection and Absorption of Black Silicon Nano-Textures

T.P.N. Veeken & A. Polman
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T.H. Fung & M. Abbott
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2CV.2.61 Impact of AlO and SiN Thickness on Field-Effect Passivation of AlO/SiN Dielectric Stacks on Crystalline Silicon

T. Mochizuki, K. Tanahashi, K. Shirasawa & H. Takato
AIST, Koriyama, Japan
A. Ito & H. Nakanishi
SCREEN, Kyoto, Japan
I. Kawayama & M. Tonouchi
Osaka University, Japan

2CV.2.62 The Development of the Probe Bar for the Newest c-Si PV Cell with the Unique Electrode Design Such as Busbar-Less, Multi Busbar and Complicated Busbar

Y. Nakamichi, H. Kojima, T. Morishima, Y. Takeda,
R. Tomioka, T. Murata & K. Iwamoto
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2CV.2.63 Analysis of Laser Boron Doping and Laser Damage

N. Yang, S. Li, C. Liu, X. Yuan, X. Ye & H. Li
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2CV.2.64 Investigation of the Temperature Dependence of the Optical Properties of Silicon Nitride Anti-Reflection Coating on Silicon Photovoltaic Modules

S. Zhang, R. Bhoopathy & Z. Hameiri
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A. Gentle
University of Technology Sydney, Ultimo, Australia

2CV.2.65 Light Trapping with Free-Floating Arrays of Subwavelength Trumpet Non-Imaging Light Concentrators

A. Prajapati, A. Chauhan, D. Keizman & G. Shalev
BGU, Beer-Sheva, Israel

2CV.2.72 Key Aspects for Industrial Efficiency above 22% PERC Solar Cells Based on Double-Side AlOx Passivation

Y. Cui, S. Yuan, Y. Wang, Y. Hu, W. Zhang, X.W. Zhang, Z. Niu, S. Peng, Y. Ke, Y. Wan & Q. Huang
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2CV.2.73 Simplify Printed-ALOX PERC Cell Process: A PDA-Free Process

T.-C. Chen, C.-C. Lin, C.-H. Ku, J. Yu, S.-L. Lee, T.-W. Kuo & C.-C. Wen
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New E Materials, Kaohsiung, Taiwan
Z.-P. Yang
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2CV.2.74 The AMPERE Project Key Exploitable Result: A Bifacial Heterojunction Cell and Module Industrial Automated Manufacturing Plant in Europe

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2CV.2.75 23% Efficient Industrial Bifacial n-Type Crystalline Silicon Solar Cells with Electron-Selective Polysilicon Passivating Contacts

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2CV.2.76 Inverted Pyramid Texturing of Monocrystalline Silicon Wafer

A. Sutejo, H.P. Hsu & C.-W. Lan
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2CV.2.77 Influence of the Acidic Texturing Structure on the Different Surface Roughness for Solar Cell

Y. Jung, S.H. Bae, Y. Kang, H.-S. Lee & D.H. Kim
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2CV.2.78 Simultaneous Front-Side Texturing and Rear-Side Polishing of Monocrystalline Silicon Wafer by Spray-Etching with HF-HCl-Cl₂ Mixtures

K. Halbfäß, B. Neubert, A. Stapf & E. Kroke
Freiberg University of Technology, Germany

2CV.2.79 Industrially MCCE Textured Cells on Monolike Substrates

Z. Xu, H. Wang, Y. Wang, F. Li, J. Shi & D. Song
Yingli Green Energy, Baoding, China

2CV.2.81 Metal Assisted Texturing on Micro Pyramids for Enhanced Anti Reflective Properties

O. Aydin, M.Z. Borra, E. Semiz & F. Es
METU, Ankara, Turkey

2CV.2.82 Uniformity of Black Silicon Texture and Its Impact on Cell Performance

M.U. Khan, T.H. Fung, G. Scardera, S. Wang, U. Varshney, D. Payne & M. Abbott
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S. Zou, X.-S. Wang & G. Xing
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2CV.2.83 Process Optimization for Inline Black Silicon Based Solar Cell Production Line

M.C. Raval, I. Melnyk, A. Teppe, S. Madugula, W. Jooss & P. Fath
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S. Gok, T. Eren, M. Comak & M. Ender
BereketEnerji, Pamukkale, Turkey
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2CV.2.85 Investigation of Laser Damage for Selective Emitter Silicon Solar Cells

J. Dong, W. Wang, Z. Zhang, Z. Ma, Q. Ye, J. Sheng & C. Zhang
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2CV.2.86 Hydrosilane-Free Low-Cost APCVD of SiO₂ Films for Crystalline Si Solar Cell Applications

H. Nagel, E. Issa, M. Glatthaar & S.W. Glunz
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2CV.2.87 Plasma Oxidation for the Front Side Passivation of PERC Solar Cells

A. Mohamed Okasha Mohamed Okasha, B. Kafle, B. Torda, C. Teßmann, A. Moldovan & M. Hofmann
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2CV.2.88 Multivariate Statistical Modelling to Correlate PECVD Layer Properties with Plasma Chemistry during Silicon Nitride Deposition

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2CV.2.89 LPCVD In-Situ Doped Phosphorus Polysilicon Layers for Passivated Contact Solar Cells

B. Martel, T. Blevin, H. Lignier, S. Benguesmia & M. Hayes
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2CV.2.90 Highly Transparent and Highly Conductive Magnetron Sputtered TCO-Layers for Industrial Production of Heterojunction Silicon Solar Cells

S. Hübner, R. Korn, M. Huber & P. Wohlfart
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2CV.2.91 Development of Nanostructured FTO Films as Transparent and Diffuse Electrodes and Their Integration in Silicon Solar Cells

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2CV.2.92 Low-Energy Plasma-Assisted Deposition of ITO Thin Films for Si Cells by Sublimation in an Anodic Vacuum Arc Discharge

B. Scheffel, T. Preußner, O. Zywitzki, T. Modes & T. Kopte
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2CV.2.93 FoIMet-Connect: Progress of Al-Foil Based Metallization Technology for PERC Cells

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2CV.2.94 Plated Front Side Metallization on Transparent Conducting Oxide Utilizing Low-Cost APCVD SiO₂ Insulating Layer

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2CV.2.95 A Solution for In-Situ Spatially-Resolved Intensity Measurements in Belt Furnaces

A. Herguth, C. Derricks & G. Hahn
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2CV.2.96 Photoluminescence Imaging for Inline Detection of Organic Residues on Silicon Wafers

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P.-T. Miclea, S. Wahl & C. Hagendorf
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2CV.2.97 Contacting New Solar Cell Metallization Layouts and Contact Quality Surveillance in Production

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2CV.2.98 Sorting Criteria for Bifacial PERC Cells for Improved Module Classification

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2CV.2.99 Industry 4.0 PV Factory of the Future: Installing a Test-Bed in a Solar Research Facility

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2CV.2.100 New Approach for a Combined Process of an Ultrafast Boron-Oxygen Defect Regeneration and Thermal Contact Treatment on Ni-Cu-Ag Plated Cells

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2CV.2.101 Comparing Cz-Si PERC Solar Cells from Various Manufacturers Regarding BO-Related Light-Induced Degradation and Regeneration

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2CV.2.102 Micro- and Macrot textured Foils for Solar Cells Application

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R. Warmers, G. Jenke & R. Schlegel
SAUERESSIG, Vreden, Germany
S. Brüning
Schepers, Vreden, Germany
P. Veldhuizen & R. van Erven
Morphotonics, Veldhoven, The Netherlands

VISUAL PRESENTATIONS 5CV.3

15:15 - 16:45 Solar Resource and Forecasting / Design and Installation of PV Systems / Storage / Concentrators and PV for Space Applications

Chairpersons:

Carsten Baur
European Space Agency, The Netherlands

Francesco Dolci
European Commission JRC, The Netherlands

Kari Lappalainen
Tampere University, Finland

Christos Protogeropoulos
EEPS, Greece

5CV.3.1 A Comparison of Two Models for the Separation of Direct and Diffuse Irradiance in Plane of Array

D.E. Guzman Razo, S. Halilovic, S. Killinger, B. Müller &
C. Wittwer
Fraunhofer ISE, Freiburg, Germany

5CV.3.3 Spectroradiometer Comparison under Outdoor DNI and Indoor High-Power AM0-Like Conditions

R. Galleano, D. Pavanello & W. Zaaïman
European Commission JRC, Ispra, Italy
G. Jüngst
INTA, Torrejón de Ardoz, Spain
M. Halwachs & M. Rennohofer
AIT, Vienna, Austria
A.A. Santamaria Lancia
Technical University of Denmark, Roskilde, Denmark
E.J. Haverkamp & D. Van der Woude
Radboud University, Nijmegen, The Netherlands
A. Minuto & E. Celi
RSE, Piacenza, Italy
M. Theristis
University of Cyprus, Nicosia, Cyprus
R. Couderc & P. Voarino
CEA, Le Bourget du Lac, France

5CV.3.6 Improving Solar Irradiance Forecast Using Ensemble Method in French Guiana

M. Salloum, M. Diallo, A. Primerose & L. Linguet
University of French Guiana, Cayenne, French Guiana

5CV.3.7 BQC: A Website to Quality Control Solar Radiation Measurements with Satellite-Based and Reanalysis Databases

R. Urraca Valle, A. Sanz & F.J. Martinez-de-Pison
University of La Rioja, Logrono, Spain
A.M. Gracia Amillo
European Commission JRC, Ispra, Italy

5CV.3.8 Best Practices for Solar Resource Assessment: A Reliable Maintenance, Calibration and Traceability Procedures

A. Amar & M.H. Bouhamidi
MASEN, Rabat, Morocco

5CV.3.9 Insight from a Detailed Comparison between the Solar Irradiance Measured in the North of France, and Its Satellite-Based and Simulation-Based Estimates

N. Ferlay, G. Chesnoiu, P. Dubuisson, F. Auriol,
G. Brogniez & F. Parol
University of Lille, Villeneuve d'Ascq, France
T. Elias, M. Compiègne & D. Ramon
HYGEOS, Lille, France

5CV.3.10 Field Evaluation of Mars™ Optical Soiling Sensor

M. Gostein & W. Stueve
Atonometrics, Austin, United States
F. Farina & B. Bourne
SunPower, Richmond, United States

5CV.3.11 Intra-Day Solar Irradiance Forecasting for PV Power Generation Utilising Machine Learning Models

S. Theocharides, G. Makrides, M. Theristis &
G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

5CV.3.12 Uncertainty Estimation of Deterministic Solar Irradiance Forecasts for Microgrid Energy Management Using the Analogs Ensemble Method

F. Calderon-Obaldia & A. Migan-Dubois
GeePs, Gif-sur-Yvette, France
J. Badosa
LMD, Palaiseau, France
V. Bourdin
LIMSI, Orsay, France

5CV.3.13 Influence of Cloud Cover on Power Fluctuations of Photovoltaic Systems

L. Visser, T. AlSkaif & W.G.J.H.M. van Sark
Utrecht University, The Netherlands

5CV.3.14 Photovoltaic Power Forecasting with Ensemble of Learners: Large Test Case from PV Plants in Italy, Zambia and Australia

M. Tucci
University of Pisa, Italy
A. Betti, L. Gigoni, F. Ruffini, A. Piazzini & C. Lanzetta
I-EM, Livorno, Italy

5CV.3.15 Supporting the Global Growth of PV: An International Collaborative to Improve Data Quality and Minimize Measurement Uncertainty

L. Burnham
Sandia National Laboratories, Albuquerque, United States
S. Dittmann
Anhalt University of Applied Sciences, Köthen, Germany
S.-Y. Oh
Yeungnam University, Gyeongsan, Republic of Korea
A. Benlarabi
IRESEN, Rabat, Morocco
J.-H. Choi
KTL, Seoul, Republic of Korea
M. Ebert & R. Gottschal
Fraunhofer CSP, Halle (Saale), Germany
B.W. Figgis
QEERI, Doha, Qatar
K.S. Kim
KIER, Yuseong-gu, Republic of Korea
T. Reindl
SERIS, Singapore, Singapore
R. Rütter
UFSC, Florianópolis, Brazil

5CV.3.16 Physical and Statistical Solar Power Forecasting for an Arbitrary Oriented Panel

N. Boyouk & N. Munzke
Karlsruhe Institute of Technology,
Eggenstein-Leopoldshafen, Germany

5CV.3.17 Evaluation of Mars™ Optical Soiling Sensor at a Commercial-Scale PV Power Plant

M. Gostein & B. Stueve
Atonometrics, Austin, United States
S. Kagan, F. Zureick, E. Giosa & R. Flottesmesch
Constellation Energy, Baltimore, United States

5CV.3.18 Fast Physical Radiative Transfer Code to Compute Solar Radiation Effectively Collected by a Photovoltaic Panel

E. Thierry, D. Ramon & M. Compiègne
HYGEOS, Lille, France
N. Ferlay
LOA, Villeneuve d'Ascq, France

5CV.3.19 Comparative Study of the Photovoltaic Productivity of the Three Silicon Technologies in Ouarzazate City
Y. Darmane
University Ibn Zohr, Ouarzazate, Morocco

5CV.3.30 Practical Comparison between View Factor Method and Ray-Tracing Method for Bifacial PV System Yield Prediction
J. Kang & C. Reise
Fraunhofer ISE, Freiburg, Germany
J. Jang & K. Lee
Korea Polytechnic University, Siheung, Republic of Korea

5CV.3.31 A Comparison of Ray Tracing and View Factor Simulations of Locally Resolved Rear Irradiance with the Experimental Values
D. Berrian & J. Libal
ISC Konstanz, Germany

5CV.3.32 Bifacial Performance Optimization Studies Using Bifacial Radiance and High Performance Computing
J.S. Stein
Sandia National Laboratories, Albuquerque, United States
C. Deline & S. Ayala Pelaez
NREL, Golden, United States

5CV.3.33 Analysis of Bifacial PV System Energy Performance and Module Mismatch Depending on Atmospheric Environment and System Installation Condition
J. Jang & K. Lee
Korea Polytechnic University, Siheung, Republic of Korea

5CV.3.34 An Empirical Model for Assessing the Bifacial Energy Gain (BEG) of PV Modules
J. Leloux
UPM, Madrid, Spain
J. Robledo
LuciSun, Sart-Dames-Avelines, Belgium
C. Tjendgdrawira & D. Vaduda
Tractebel Engineering, Brussels, Belgium
C.A. Gueymard
Solar Consulting, Colebrook, United States

5CV.3.35 A Ray-Tracing Based 3D Tool for Accurate Prediction of PV Plants Yield
M. Chiodetti, E. Boyère & O. Lgheit Rhazi
EDF R&D, Moret-sur-Loing, France
M. Bila & G. Terrom
EDF Renewables, Paris La Defense, France

5CV.3.36 Explicit Model Based on Approximated I-V Curves for Partial Shading Modelling of Photovoltaic Systems
M. Dallapiccola, P. Ingenhoven, M. Lovati & D. Moser
Eurac Research, Bolzano, Italy

5CV.3.38 Study of PV Systems for Self-Consumption at the UPC
S. Silvestre & D. Fontanilles
UPC, Barcelona, Spain

5CV.3.40 A Comparative Study between Classical and Linear PV Power Plant Architectures
T. Le, T. Tran & H. Colin
CEA, Le Bourget du Lac, France

5CV.3.41 Designing PV Systems below 50 cents/Wp
G.J. Schaeffer
Dutch Solar Energy, Tilburg, The Netherlands

5CV.3.43 Benefits of Adapted PV Module Interconnection Layouts for Mobile Applications - Simulation Results and Outdoor Solar Yield Measurements
H. Hanifi, D. Hahn, D. Götz & S. Schindler
Fraunhofer CSP, Halle (Saale), Germany

5CV.3.44 DC- Versus AC-Based Power Systems for Cost-Effective Electrification of Rural Sub-Saharan Africa
N. Opiyo
Ulster University, Londonderry, United Kingdom

5CV.3.45 Solar Cogeneration a Innovative Technology of CSP and PV a Developing in Morocco Country
S.E. Lachhab, E.A. Ibrahmi & L. Dlimi
Ibn Tofail University, Kenitra, Morocco

5CV.3.51 Fight Global Warming with Solar Energy + Multi-Storage Resilient Island Nano-Grid Smart Home/Building
J. Borland
J.O.B. Technologies, Aiea, United States

5CV.3.52 Legal, Technical and Operational Feedback from a PV System with Storage for Self-Consumption Installed in France
N. Lebert & B. Gaiddon
HESPUL, Lyon, France
J. Buffiere & F. Lagut
ALEC, Grenoble, France
S. Fraisse
Epices Energie, Lyon, France

5CV.3.53 Techno-Economic Analysis and Battery Storage Placement in Grid-Connected Photovoltaic (PV) System
J.Z. Tee, L.H.I. Lim, E.Z.D. Chia & K.H. Tan
University of Glasgow, Singapore, Singapore

- 5CV.3.54 Diagnosis and Prognosis of Li-Ion Battery State-Of-Health Based On Electrode Potential Shifts**
J.-L. Koné & M. Montaru
CEA, Le Bourget du Lac, France
Y. Bultel
LEPMI, Grenoble, France
S. Fiette
CEA, Grenoble, France
- 5CV.3.55 Simulation of Grid-Tied PV Systems with Battery Storage in PVsyst**
B. Wittmer & A. Mermoud
PVsyst, Satigny, Switzerland
- 5CV.3.56 Grid Flexible Solar: Unlocking Solar's Full Potential**
M. Morjaria
First Solar, Scottsdale, United States
- 5CV.3.57 Parallel Operation of Battery-Based Storage Systems in Applications to Low-Voltage Nanogrids**
Y.-C. Chen & Y.-Y. Tzou
NCTU, Hsinchu, Taiwan
- 5CV.3.58 CO₂ UPHEs (Underground Pumped-Hydro Energy Storage) in LRC (Lined Rock Cavern) as Short/Medium-Duration Storage, as Efficient Heat Pump, Alternatively as Long-Duration Storage When Used as Hybrid PTES (Pumped Thermal Electricity Storage)**
P. Lalanne
HydroClapeyron, Dinard, France
P. Byrne
University of Rennes, France
- 5CV.3.62 Electron and Proton Irradiation of GaAs Solar Cells**
N. Gruginskie, G.J. Bauhuis, P. Mulder, E. Vlieg & J.J. Schermer
Radboud University, Nijmegen, The Netherlands
F. Cappelluti
Polytechnic University, Turin, Italy
- 5CV.3.64 MicroFlex: Optical Modeling and Characterization of PseudoMorphic Glass (PMG)**
A. Bermudez Garcia, V. Maneval, R. Cariou, P. Voarino, O. Raccurt & Y. Roujol
CEA, Grenoble, France
- 5CV.3.65 Modelling the Efficiency of Solar Cells for Concentrating Photovoltaic and Thermal Systems**
R.R. Vardanyan, D.G. Arstamyán & H.S. Petrosyan
National Polytechnic University of Armenia, Yerevan, Armenia

- 5CV.3.66 CPV-T Receiver Concepts with Spectral Splitting**
A. Resch & R. Höller
University of Applied Sciences Upper Austria, Wels, Austria
- 5CV.3.67 "Current Pinching" Effect in Multijunction Solar Cells**
S.V. Pushko & N.T. Vagapova
JSC Kvant, Moscow, Russia
M.Z. Shvarts, M.A. Mintairov & M.V. Nakhimovich
RAS / Ioffe, St. Petersburg, Russia
- 5CV.3.68 High-Efficiency Planar Micro-Tracking Photovoltaic Modules with Hybrid Direct/Diffuse Light Collection for Rooftop Installations**
G. Nardin, A.F. Aguilar, L. Anglade, F. Gerlich, M. Ackermann & L. Coulot
Insolight, Ecublens, Switzerland
D. Petri, J. Levrat, J. Champiaud, A. Faes & M. Despeisse
CSEM, Neuchâtel, Switzerland
S. Askins, N. Jost, C. Domínguez & I. Antón Hernández
UPM, Madrid, Spain

VISUAL PRESENTATIONS 5CV.4

17:00 - 18:30 **Operation, Performance and Maintenance of PV Systems**

Chairpersons:

Gerhard Mütter
Alteso, Austria

Joshua Stein
Sandia National Laboratories, United States

5CV.4.1 Power Curtailment and PV Panel Operating Voltage

M. Järvelä & S. Valkealahti
Tampere University, Finland

5CV.4.2 How Many Performance Parameters Do You Need to Know if a Module Is Failing?

J.C. Jimeno, E. Ortega, G. Aranguren & J.R. Gutiérrez
UPV/EHU, Bilbao, Spain
O. Kunz
UNSW Australia, Sydney, Australia

5CV.4.3 The VAR Method: A Less Environment-Sensitive and Data-Based Approach to Evaluate the Performance Loss Rate of PV Power Plants

M. Meftah
EDF R&D, Chatou, France
E. Lajoie-Mazenc & M. Van Iseghem
EDF R&D, Écuellles, France
R. Perrin
EDF Renouvelables, Colombiers, France
D. Boublil & K. Radouane
EDF Renouvelables, Paris, France

5CV.4.4 Advanced Fault Detection for PV Plants: An Enhanced Adimensional Approach

V. Barone, D. Bertani, S. Guastella & G. Maugeri
RSE, Milan, Italy

5CV.4.5 Defect Recognition and Power Loss Estimation of PV Systems Using Infrared Thermography

B.L. Aarseth
University of Oslo, Kjeller, Norway
E.S. Marstein
Institute for Energy Technology, Kjeller, Norway

5CV.4.6 Student Award Finalist Presentation: Fault Inspection of CIGS PV Plant Using Aerial Infrared Thermography

D. Amstad & A. Häberle
University of Applied Sciences, Rapperswil, Switzerland
A.K. Vidal de Oliveira & R. Rüther
UFSC, Florianópolis, Brazil

5CV.4.7 Field Tests of Soiling Detection System for PV Modules

M. Korevaar, T. Bergmans, J. Mes & X. van Mechelen
Kipp & Zonen, Delft, The Netherlands
A. Alami Merrouni
IRESEN, Rabat, Morocco
F. Wolfertstetter & S. Wilbert
German Aerospace Center, Tabernas, Spain

5CV.4.8 Operation of PV Arrays at the Largest MPP Voltage Instead of the Global MPP Voltage during Irradiance Transitions Caused by Clouds

K. Lappalainen & S. Valkealahti
Tampere University, Finland

5CV.4.9 PVs under Harsh Dust Soiling: Modeling and Prediction of the Performance for a Broad Range of Soiling State

N. Barth, B.W. Figgis, S.P. Aly & S. Ahzi
QEERI, Doha, Qatar

5CV.4.10 PV Module Diagnosis with Automatic Online IV Curve Measurement

A. Plissonnier, S. Lespinats, M. Amhal & H. Colin
CEA, Le Bourget du Lac, France

5CV.4.11 Remote Monitoring of PV Station for Rain Stimulation System

D.V. Aghabekyan, L.M. Lakhoyan & A.A. Vardanyan
NPUA, Yerevan, Armenia

5CV.4.12 Identification of Series Resistance from the Measured PV Panel Electrical Characteristics

H. Kalliojärvi-Viljakainen & S. Valkealahti
Tampere University, Finland
G. Spagnuolo
University of Salerno, Fisciano, Italy

5CV.4.13 Development of a Big Data Bank for PV Monitoring Data, Analysis and Simulation in COST Action 'PEARL PV'

A.H.M.E. Reinders & F. van Slooten
University of Twente, Enschede, The Netherlands
D. Moser
Eurac Research, Bolzano, Italy
W.G.J.H.M. van Sark
Utrecht University, The Netherlands
G. Oreski
PCCL, Leoben, Austria
N.M. Pearsall
Northumbria University, Newcastle upon Tyne, United Kingdom
M. Devetakovicc
University of Belgrade, Serbia
J. Leloux
UPM, Madrid, Spain
D. Capeska Bogatinoska
UIST, Ohrid, Macedonia
A. Driesse
PV Performance Labs, Freiburg, Germany

5CV.4.14 PV|Harvester – A Tool for PV Power Plant Performance Evaluation and Economical Optimization

R. Höller, A. Högl, M. Birajdar & A. Royes Moreno
FH OOE, Wels, Austria
D. Gudopp
deea solutions, Frankfurt am Main, Germany

5CV.4.15 Performance, Faults and Energy Losses of Photovoltaic Power Plants in France: Methodology and Feedback

J. Sayritupac, M. Amhal & H. Colin
CEA, Le Bourget du Lac, France

5CV.4.16 Application of an Efficiency-Degradation Model to a 34-Year Field-Exposed Si-Module Array

L. Abenante, F. De Lia, R. Schioppo & S. Castello
ENEA, Rome, Italy

5CV.4.18 Effective False Detection Methods for Safety Predictable Power Performance of PV Power Station

H.K. Ahn, N. Park, G.-G. Kim, B.G. Bhang, S.Y. Park,
W.B. Lee, H.J. Choi & J.-H. Choi
Konkuk University, Seoul, Republic of Korea

5CV.4.19 Optimization of the Cost Priority Number (CPN) Methodology to the Needs of a Large O&M Operator

G. Oviedo Hernández & P. Chiantore
BayWa, Rome, Italy
S. Lindig & D. Moser
Eurac Research, Bolzano, Italy

5CV.4.20 A Machine Learning-Based Predictive Maintenance System for Solar Inverters

G. Guerra & P. Mercade Ruiz
GreenPowerMonitor, Barcelona, Spain
L. Landberg
DNV GL, Hellerup, Denmark

5CV.4.21 Characterization and Modelling of the Soiling Effect on the PV Generation under Urban Mediterranean Conditions

N. Martín Chivelet, J. Polo, M. Alonso-Abella, C. Sanz & N. Vela
CIEMAT, Madrid, Spain
F.J. Batlles, J. Alonso-Montesinos, J.L. Bosch & J. Barbero
UAL, Almeria, Spain
G. López
UHU, Huelva, Spain

5CV.4.22 Results and Lessons Learned from the Field Deployment of DUSST, a Low-Maintenance PV Soiling Sensor

L. Micheli, F. Almonacid & E.F. Fernández
University of Jaén, Spain
J. Morse & M. Muller
NREL, Golden, United States

5CV.4.23 Experimental Comparison of the Soiling Effect on Different PV Technologies

J.G. Bessa, L. Micheli, E.F. Fernández & F. Almonacid
University of Jaén, Spain

5CV.4.24 Opportunities to Improve Photovoltaic Plant Maintenance Informed by Data Analytics of Commercially-Operating Large-Scale Plants

M.L. Bolen & S. Hackett
EPRI, Charlotte, United States
T. Gunda
Sandia National Laboratories, Albuquerque, United States

5CV.4.25 Detailed Loss Analysis for Wall Mounted Photovoltaic Systems at High Latitude; A Comparison of Multicrystalline Si- to CIGS- Modules

G. Otnes, M.B. Øgaard, L.T. Milde, S.E. Foss & J.H. Selj
Institute for Energy Technology, Kjeller, Norway

5CV.4.26 Failure Modeling for Detection and Diagnostic Studies of Large-Scale Grid-Connected Photovoltaic System

M. Malvoni
NTUA, Zografou, Greece
Y. Chaibi
ENSAM, Fes, Morocco

5CV.4.27 Comparative Analysis of a Very Large CIS and Small c-Si PV Systems under Tropical Climate

K. Kunaifi & A.H.M.E. Reinders
University of Twente, Enschede, The Netherlands
D. Kaharudin, A. Harmanto & K. Mudiarto
PT PJB, Surabaya, Indonesia

5CV.4.28 Solar Power Forecasting with LSTM Network Ensemble

M. Emamian, J. Milimonfared, A. Eskandari & R. Hosseini Abardeh
Amirkabir University of Technology, Tehran, Iran
M. Aghaei
Albert-Ludwigs-University of Freiburg, Germany

5CV.4.29 Performance and Electroluminescence Analysis on Reliability and Lifetime of Thin-Film Photovoltaics (PEARL TF-PV)

E. Sovetkin & V. Huhn
Forschungszentrum Jülich, Germany
A.W. Weeber
Delft University of Technology, The Netherlands
A. Martin
Crystalsol, Vienna, Austria
B. Rau
HZB, Berlin, Germany
E.J. Achterberg
Solar Tester, Schinnen, The Netherlands
M. Rennhofer
AIT, Vienna, Austria
M. Theelen
TNO, Eindhoven, The Netherlands
T. Weber
PI Berlin, Germany

5CV.4.30 Performance Evaluation of Monitoring Algorithms for Photovoltaic Systems

M.B. Øgaard, A. Skomedal & J.H. Selj
Institute for Energy Technology, Kjeller, Norway

5CV.4.31 Mapping Annual and Seasonal Soiling in Western Europe

L. Micheli, J.G. Bessa, F. Almonacid & E.F. Fernández
University of Jaén, Spain
J. Leloux
UPM, Madrid, Spain

5CV.4.32 Identifying Order of ARIMA Model Using Different Criteria Selection for Forecasting of Degradation Rates

A. Kyprianou, G. Makrides & G.E. Georghiou
University of Cyprus, Nicosia, Cyprus

5CV.4.33 GOVP: A Global Approach to Reduce PV Electricity Cost

S. Guillerez & B. Commault
CEA, Le Bourget du Lac, France
A. Apraiz
Mondragon Assembly, Aretxabaleta, Spain
A. Virtuani
EPFL, Neuchâtel, Switzerland
A. Canino
ENEL Green Power, Rome, Italy
G. Demofonti
Convert, Rome, Italy
R. Alonso
Tecnalia, San Sebastián, Spain
G. Maugeri
RSE, Milan, Italy
X. Rodriguez
LEITAT, Terrassa, Spain
I. Savych
GXC Coatings, Goslar, Germany

5CV.4.34 A Comparative Study of the Performance Features of Heterojunction and Diffusion Si Modules in Humid Continental and Subarctic Climates

A. Titov, K. Emtsev, D. Andronikov, A. Abramov & D. Orekhov
R&D Center TFTE, St. Petersburg, Russia
B. Bulygin, A. Dubrovskiy & I. Shakhray
Hevel Solar, Novocheboksarsk, Russia

5CV.4.35 Quantifying Long Term PV Performance and Degradation under Real Outdoor and IEC 61853 Test Conditions Using High Quality Module IV Measurements

S. Ransome
Steve Ransome Consulting, Kingston upon Thames, United Kingdom
J. Sutterlueti
Gantner Instruments, Schruns, Austria

5CV.4.36 The Influence of Module Tilt on Snow Shadowing of Frameless Bifacial Modules

A.M. Petersson, J. Narvesjö, P. Toth & J. Petersson
RISE, Piteå, Sweden

5CV.4.37 Sunlight Variation Study for Drone-Based Daylight Electroluminescence Imaging of PV Modules

G.A. dos Reis Benatto, C. Mantel, A.A. Santamaria Lancia, N. Riedel, S. Thorsteinsson, P.B. Poulsen & S. Forchhammer
Technical University of Denmark, Roskilde, Denmark
H.R. Parikh, S.V. Spataru & D. Sera
Aalborg University, Denmark

5CV.4.38 Monitoring of a PV-Hybrid and Two Grid Connected Systems in Three Countries

A. Jiménez Franco, A. Thönnnes, C.A. Mayorga Sánchez, C. Jürißen, L. Clasing, R. Gecke & U. Blieske
Cologne University of Applied Sciences, Germany

5CV.4.39 Effect of Dust on Solar Photovoltaic Modules in Shiraz

S.A. Bahreini & M. Yaghoubi
Shiraz University, Iran

5CV.4.40 Software Correction of Angular Misalignments of Tilted Reference Solar Cells Using Clear-Sky Satellite Open Data

T. Barbier
Optimum Tracker, Meyreuil, France
P. Blanc & Y.-M. Saint-Drenan
MINES ParisTech, Sophia-Antipolis, France

5CV.4.41 A Probabilistic Approach to Predict the Degradation of a PV System

M. Malvoni
ICCS/NTUA, Zografou, Greece
N.M. Kumar
City University of Hong Kong, China

5CV.4.42 Impact of Defective Modules on the Characteristics of a Large-Scale Grid-Connected PV Power Plant

T. Finsterle, L. Cerná, P. Hrzina & V. Benda
CTU, Prague, Czech Republic

5CV.4.43 Soiling Ratios and Management Strategies in Utility Scale PV Plants in the Atacama Desert

P. Darez & C. Darr
350renewables, Las Condes, Chile

5CV.4.44 A New Optical Device for PV Soiling Monitoring

A. Azouzoute & A. Ghennioui
IRESEN, Rabat, Morocco
M. Chouitar
Lycée Technique Mohammeda, Morocco
M. Garoum
University Mohammed V in Rabat, Morocco

5CV.4.45 Design of an Application for the Estimation of the PV Power Plant Production in Real Time

J. Alonso-Montesinos, J. Barbero & F.J. Batlles
UAL, Almeria, Spain
G. López
UHU, Huelva, Spain
J. Polo, N. Martín Chivelet, M. Alonso-Abella & N. Vela
CIEMAT, Madrid, Spain

5CV.4.46 Hyperspectral Photoluminescence Imaging as a Tool to Studying Degradation of Outdoor Silicon Solar Panels

M. Vukovic, A.S. Flø, E. Olsen, T. Mehl & I. Burud
NMBU, Ås, Norway

Thursday, 12 September 2019

VISUAL PRESENTATIONS 2DV.1

12:45 - 15:00 Homojunction Solar Cells / Heterojunction Solar Cells

Chairpersons:

Arthur Weeber
ECN part of TNO, The Netherlands

Matthieu Despeisse
CSEM, Switzerland

Delfina Muñoz
CEA, France

Joachim John
imec, Belgium

2DV.1.1 Surface Passivation of Atmospheric Pressure Dry Etched Multicrystalline Silicon Surfaces

A.I. Ridoy, B. Kafle, M. Klitzke, N.W. Khan & M. Hofmann
Fraunhofer ISE, Freiburg, Germany
L. Clochard & E. Duffy
Nines Photovoltaics, Dublin, Ireland

2DV.1.2 Functionalized Oxides for Bifacial Solar Cells with Passivated Contacts: First Results of the OXYGEN Project

T. Desrues, A. Morisset, E. Bruhat, A. Veau, M. Hayes,
P. Bellanger, R. Cabal & S. Dubois
CEA, Le Bourget du Lac, France
A. Kaminski-Cachopo, Q. Rathay, N. Ait-Abdelkader &
Y. Kalboussi
IMEP-LAHC, Grenoble, France
J.P. Kleider, J. Alvarez & M.E. Gueunier-Farret
CNRS, Gif-sur-Yvette, France
C. Marchat
IPVF, Palaiseau, France
D. Blanc-Pélissier, P. Schutz, C. Chevalier & M. Lemiti
INSA Lyon, Villeurbanne, France
D. Munoz-Rojas & V.H. Nguyen
LMGP, Grenoble, France
G. Borvon & F. Torregrosa
Ion Beam Services, Peypnier, France

- 2DV.1.3 Simultaneous Contacting of Boron and Phosphorus Doped Surfaces with a Single Screen Printing Paste**
J.D. Huyeng, A. Spribille, M.G. Prince, L.C. Rendler & U. Eitner
Fraunhofer ISE, Freiburg, Germany
C. Ebert
SCHMID Group, Freudenstadt, Germany
- 2DV.1.4 Optimization of Boron Doping Paste for Simplified Fabrication of Interdigitated Back Contact Solar Cells**
A. Aliefendioglu, E.H. Çiftçinar & R. Turan
METU, Ankara, Turkey
- 2DV.1.5 A Comparison Study of Front and Rear Surface Passivation Techniques of Nitric Acid Oxidation of Silicon on Phosphorus-Diffused and Non-Diffused Texture Surfaces for p-Type Bifacial PERC**
S. Joonwichien, Y. Kida, M. Moriya, S. Utsunomiya, K. Shirasawa & H. Takato
AIST, Koriyama, Japan
- 2DV.1.6 532 nm Laser Treated Selective Emitter Profiles Study with SIMS and ECV Technics**
A. Moussi, S. Meziani, L. Benharrat & S. Chaouchi
CRTSE, Algiers, Algeria
M. Slimane
CDTA, Algiers, Algeria
- 2DV.1.7 Development of an Industrially-Relevant Process for Passivating Contacts on p-Type Silicon Wafers**
A. Desthieux, J. Posada & P.P. Grand
EDF R&D, Palaiseau, France
C. Broussillou, B. Bazer-Bachi & G. Goer
EDF ENR PWT, Bourgoin Jallieu, France
E. Drahi
TOTAL, Palaiseau, France
P. Roca i Cabarrocas
CNRS, Palaiseau, France
- 2DV.1.8 Investigation on the Surface Texturing of the Casting Quasi-Single Crystal Silicon**
D. Hu, W. Lian, Q. Wei & Z. Ni
Talesun Solar, Changshu, China
- 2DV.1.9 Stability of the Regenerated p-Type Multi-Crystalline PERC Solar Cells after Light and Evaluated Temperature Induced Degradation**
J. Zhu, R. Søndena & S.E. Foss
Institute for Energy Technology, Kjeller, Norway
B. He
Donghua University, Shanghai, China
Q. Wei, H. Qian & Z. Ni
Talesun Solar, Suzhou, China

- 2DV.1.10 High Voltage Solar Cells Based on Nanostructured Ultra-Thin Silicon**
N. Moulin, M. Amara, F. Mandorlo & M. Lemiti
INSA Lyon, Villeurbanne, France
- 2DV.1.11 Characteristics of Reaction Kinetics on Light-Induced Degradation and Regeneration Process with Passivation Properties in p-Type PERC Solar Cell**
S.M. Kim, S.H. Jung, J. Kim, G. Choi & Y.B. Kim
GERI, Gumi, Republic of Korea
M.G. Kang & H.-E. Song
KIER, Daejeon, Republic of Korea
- 2DV.1.13 A Novel Method of Rear-Side Alkaline Polishing for Low-Cost and High-Efficiency PERC Solar Cells**
J. Yu, C.-H. Ku, S.-L. Lee, T.-W. Kuo, T.-C. Chen, C.-C. Lin & C.-C. Wen
E-TON Solar Tech, Tainan, Taiwan
- 2DV.1.14 Effects of Particle Size of Aluminum Powder in Silver/Aluminum Paste on n-Type Solar Cells**
T. Aoyama
Noritake, Miyoshi, Japan
M. Aoki & I. Sumita
Asada Mesh, Matsubara, Japan
A. Ogura
Meiji University, Kawasaki, Japan
- 2DV.1.15 Si Surface Passivation by GaOx Films Deposited Using a Mist Chemical Vapor Deposition Process**
Y. Adachi, T. Harada, Y. Hotta, H. Yoshida, K. Maeda & K. Arafune
University of Hyogo, Himeji, Japan
- 2DV.1.16 Comparative Study on Temperature Coefficients of Different Kinds of Industrial Silicon Solar Cells**
H. Wang, X. Cheng & H. Yyang
Xi'an Jiaotong University, China
- 2DV.1.17 Enhanced TiO₂ Surface Passivation and Thermal Stability with Al Doping**
W. Liang, K.C. Fong & J. Tong
ANU, Canberra, Australia
K.R. McIntosh
PV Lighthouse, Coledale, Australia
- 2DV.1.18 Optimization of Triple-Layer Antireflection Coating with SiO_x on Black Silicon PERC Solar Cell**
S. Zhang, Y. Yao, H. Qian, Y. Li, Q. Wei, Z. Ni & W. Lian
Talesun Solar, Changshu, China
J. Jie & X. Zhang
Soochow University, Suzhou, China

2DV.1.19 A Study on Aluminum Pastes for Rear Emitter in n-Type Silicon Solar Cells

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Asada Mesh, Matsubara, Japan
T. Aoyama
Noritake, Miyoshi, Japan

2DV.1.20 Investigating the Performance of Molybdenum Oxide-Silicon Nanowires Solar Cells

C. Lu, A.B. Prakoso & R. Rusli
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2DV.1.21 Low Temperature p-n Junction Fabrication by PECVD for n-PERT Solar Cells: An Alternative to Boron Diffusion

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K.-H. Kim
Cheongju University, Republic of Korea
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CNRS, Palaiseau, France

2DV.1.22 PECVD Grown SiO_x/Poly-Si for TOPCon Solar Cell Application

L. Zhang, Z. Shu, C.H. Shin, C.-P. Ouyang, Y. Chae & S.H. Cho
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2DV.1.23 Understanding of UV-ps Laser Ablation Mechanisms on Bifacial n-PERT Silicon Solar Cells and Impact on Ni/Cu Plating

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J. Nekkarda & V. Arya
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2DV.1.24 Ultra-Fine Contact Finger Achieved by Pattern Transfer Printing (PTP) Technology for Silicon Solar Cells – Recent Development

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M. Matusovsky & A. Noy
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2DV.1.25 Efficient Sprayed Al₂O₃ Surface Passivation for Multicrystalline Silicon Solar Cells

L. Zougar, S. Sali, S. Kermadi & M. Boumaour
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2DV.1.26 Excellent Silicon Surface Passivation with Atomic Layer Deposited SiO₂ Thin Films

S. Li, J. Xu, N. Yang, X. Yuan, C. Liu & H. Li
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2DV.1.27 Laser Enhanced Contact Optimization as a Multi-Faceted Approach to Improved LCOE via Increased Efficiency and Increased Yield

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A. Henning
Heraeus, Hanau, Germany
H. Zhao & E. Hofmüller
Cell Engineering, Kabelsketal, Germany

2DV.1.35 Recent Results for the Deployment of Silicon Heterojunction Production Lines at ENEL Green Power: Effect of the Number of Busbars

W. Favre, L. Sicot, V. Barth, A. Bettinelli, A. Danel, J.-F. Lerat & P.-J. Ribeyron
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M. Sciuto, G. Condorelli, A. Ragonesi, A. Canino, M. Foti & C. Gerardi
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2DV.1.36 Identification of the Source of Degradation of Silicon Heterojunction Solar Cells from the Shape of the I-V Characteristics Linked to Its Dependence on the Doping Level in a-Si:H: Theory and Experimental Case Study

Y. Abdulraheem & M.Y. Ghannam
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H. Sivaramakrishnan Radhakrishna & I. Gordon
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2DV.1.37 Power Loss Mechanisms of Ultra-Thin a-Si:H/c-Si Heterojunction Solar Cells with over 20% Efficiencies

Y. Imai, M. Kozawa & H. Fujiwara
Gifu University, Japan
H. Sai, M. Tanabe & T. Matsui
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2DV.1.38 Si-Based Heterojunction Solar Cells Passivated by a-SiO_x:H Thin Film

K. Saito
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T. Takamura, Y. Ichikawa & M. Konagai
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2DV.1.39 Silicon Heterojunction Solar Cells with Electroplated Copper Grid Electrodes

X. Shu, L. Xu, C. Liu, B. Liu, L. Liu, H. Wang, W. Long,
S. Yin, H. Wu, C. Yu, Y.M. Li & X. Xu
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2DV.1.40 Development of Transparent Conductive Oxide for Silicon Heterojunction Solar Cell

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2DV.1.41 Effect of Argon-Hydrogen Gas Mixture on Properties of ITO Layers and Performance of Silicon Heterojunction Solar Cells

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2DV.1.42 Progress in In₂O₃-Based Transparent Conductive Oxide Films for Solar Cells

T. Koida, Y. Ueno & H. Shibata
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2DV.1.43 Overview of Deposition Methods for Heterojunction Solar Cells with High Deposition Rates

S. Leszczynski, C. Strobel, B. Leszczynska, M. Albert &
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2DV.1.44 DC Sputtering of TCO Layers in Neon Atmosphere and Its Application to Silicon Heterojunction Solar Cells

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2DV.1.45 17.25%-Efficient, All Room-Temperature Silicon Solar Cells

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2DV.1.46 Room Temperature Dopant Free Carrier Selective Contact Solar Cells on Industrially Viable Cz Wafers

M. Nayak, K. Singh, S. Mudgal, S. Mandal, S. Singh & V.K.
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2DV.1.47 Study of the Influence of Defects in Doped Thin-Film Layers in Heterojunction Silicon Solar Cells Employing Opto-Electrical Simulations

J. Balent, J. Krc, F. Smole & M. Topič
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2DV.1.48 Transport Losses at the TCO/a-Si:H/c-Si Heterojunction: Influence of Different Layers and Annealing

C. Luderer, M. Bivour & M. Hermle
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2DV.1.49 Impact of Interfacial SiO_x on Carrier Selectivity and Thermal Stability of Transition Metal Oxide

J. Tong, W. Liang, M. Ernst, D. Walter, M. Stocks,
A. Blakers & K.C. Fong
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2DV.1.50 Hydrogen-Doped In₂O₃ as High Mobility TCO for Silicon Heterojunction Solar Cell Application

M.L. Addonizio, A. Spadoni & A. Antonaia
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2DV.1.51 Approach to Clarify the Cause of Handling Defects in SHJ Cell Production through the Interplay of Different Imaging Techniques

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2DV.1.52 The Economic Case for IBC Silicon Heterojunction Solar Cells

R. Vasudevan, S. Harrison, P. Guillaume, P.J. Ribeyron,
D. Muñoz & C. Roux
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2DV.1.53 Improved Front Contact for Silicon Heterojunction Solar Cells with n-Type Nanocrystalline Silicon Oxide Window Layer

W. Duan, D. Qiu, A. Lambertz, M. Pomaska & K. Ding
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2DV.1.54 Graphene Application as Non Conventional Transparent Conductive Electrode in c-Si Based Heterojunction Solar Cells

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2DV.1.55 Optimization Studies on the Material Properties of ITO as Window Layer for Silicon Heterojunction Solar Cells

S. Güler, E. Donercark, A.E. Aytaç, A.C. Erçelebi & R. Turan
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2DV.1.56 Development of Phosphorus Thin Doped Layers by Plasma Immersion for Homo- Hetero Junction Solar Cells Application

J. Jourdan, T. Desrues, A. Lanterne, D. Muñoz, R. Varache, A. Danel, P. Carroy, C. Roux & S. Dubois
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2DV.1.57 Application of Different Gas Mixtures Types in p-Doped Layers of Silicon Heterojunction Solar Cells in the Rear Emitter Configuration

A. Abramov, D. Andronikov, K. Emtsev, G. Ivanov, A.V. Semenov & E.I. Terukov
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2DV.1.59 Influence of Surface Defectivity on the Performances of Silicon Heterojunction Solar Cells

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2DV.1.60 Optoelectronic Properties of Sputtered TCOs and Their Application in Silicon Heterojunction Solar Cells

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2DV.1.61 Plating Processes for Silicon Heterojunction Cells: An Overview

A. Lachowicz, C. Ballif & M. Despeisse
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2DV.1.62 Thermally Stable MoOx Hole Selective Contact with a Tunneling Interlayer for Industrial Size Silicon Solar Cells

M.T.S.K. Ah Sen, P.C.P. Bronsveld, E.G. Hoek, B.W.J. Kikkert & A.W. Weeber
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2DV.1.63 TCO Layers with High Charge Carrier Mobility as Transparent Conductive Contacts for Silicon Heterojunction Solar Cells

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I. Nyapshaev, S. Abolmasov, D. Andronikov, A. Abramov, E.I. Terukov & D. Orekhov
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M. Dimer, U. Graupner, M. Thumsch & E. Schneiderlöchner
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2DV.1.64 A Proposed Flexible p-Si/n-ZnO Heterojunction Based All Solid-State Solar Cell

A.K. Dikshit, A. Singh & P. Chakrabarti
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K. Kamal
MNNIT, Prayagraj, India
Y. Dwivedi & N. Mukherjee
NIT, Kurukshetra, India

2DV.1.65 Investigation of Silicon Films for Heterojunction Solar Cells Deposited by Hot-Wire CVD

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F. Schoerg
RENA, Gütenbach, Germany
M. Dimer
VON ARDENNE, Dresden, Germany
O. Astakhov
Forschungszentrum Jülich, Germany

2DV.1.66 Integrating Nanopyramid Gratings into Crystalline Silicon Solar Cells: Augmenting the Absorption of Infrared Photons

A. Razaq, V. Depauw, H. Sivaramakrishnan Radhakrishna, I. Gordon, J. Szlufcik & J. Poortmans
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2DV.1.67 Limits of the Open-Circuit Voltage and Fill Factor in Thin Silicon Heterojunction Solar Cells

O. Astakhov, T. Merdzhanova, D. Weigand, V. Buga, A. Gad, K. Ding & U. Rau
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2DV.1.68 Interplay of Intrinsic and Doped Amorphous Silicon Layer and ITO Properties and Process Conditions on Contact Passivation in Silicon Heterojunction Cells

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2DV.1.69 Poly-Si Passivated Solar Cells Fabricated by Firing Contact Metallization with the Shallow Silver Penetration

H.-C. Chang, C.-C. Lo, S.-T. Liao, B.-C. Kung, C.-J. Huang & M.-T. Kuo
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TeraSolar Energy Materials, Hsinchu, Taiwan

2DV.1.71 Development and Characterization of Silicon-Rich Nitride Layers for Silicon Solar Cell Passivating Contacts

R. Sharma, M. Recamán Payo,
H. Sivaramakrishnan Radhakrishna & J. Poortmans
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2DV.1.72 Plasma Oxidation for Polycrystalline Silicon-Based Passivated Contact

C.-Y. Lee, S. Deng, T. Zhang, K. Khoo, U. Romer & B. Hoex
UNSW Australia, Sydney, Australia

2DV.1.73 Effect of a-Si: H Layer Thickness on the Passivation of the c-Si Wafers in the Heterojunction Solar Cells

A. Trad-Khodja, F. Kezzoula, S. Nouali & H. Menari
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VISUAL PRESENTATIONS 7DV.2

15:15 - 16:45 Costs, Economics, Finance and Markets / Policies and Scenarios for Renewables, Societal and Global Challenges

Chairpersons:

Gaetan Masson
Becquerel Institute, Belgium

Maria Getsiou
European Commission DG RTD, Belgium

7DV.2.1 Super PV Project – Innovative and High-Quality PV Systems to Regain Leadership of European PV Businesses on the World Market

J. Ulbikas & V. Ulbikaite
PROTECH, Vilnius, Lithuania
J. Denafas
SOLITEK R&D, Vilnius, Lithuania
R. Witteck & M. Köntges
ISFH, Emmerthal, Germany
M. Topič
University of Ljubljana, Slovenia
F. Frontini, P. Bonomo & E. Saretta
SUPSI, Canobbio, Switzerland
P. Macé
Becquerel Institute, Brussels, Belgium
P.J. Bolt
TNO, Eindhoven, The Netherlands
A.G. Ulyashin
SINTEF, Oslo, Norway
T. Haarberg
BNW-Energy, Trondheim, Norway
W. Palitzsch
Loser Chemie, Freiberg, Germany
B. Terheiden
University of Konstanz, Constance, Germany
I. Weiss & A. Fuentes Cano
WIP Renewable Energies, Munich, Germany
J.L. Domínguez-García
IREC, Barcelona, Spain

7DV.2.5 CitizEE Project - Scaling Up Public Sustainable Investments via Citizen Financing Schemes

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J.-F. Marchand, L. Vanstraelen & M. Casas
ENERGINVEST, Brussels, Belgium
F. Pause & M. Wimmer
Stiftung Umweltenergierecht, Würzburg, Germany
N. Brito-Jorge
GoParity, Lisbon, Portugal
E. Steyaert & H. Ruttens
VEB, Brussels, Belgium
V. Segon
REGEA, Zagreb, Croatia
R. Adomaviciene, K. Vaskelien & G. Zakevicius
Public Investment Development Agency, Brussels, Belgium
L. Della-Sala
European Crowdfunding Network, Brussels, Belgium

7DV.2.6 Residential PV Prosumers: Analysis of the Reality in Chile

J.C. Osorio-Aravena
Universidad Austral de Chile, Coyhaique, Chile
E. Muñoz-Cerón
University of Jaén, Spain

7DV.2.7 An Overview of Patent Application Data in the Field of Photovoltaics

N. Persat & M.-A. Le Meur
European Patent Office, Berlin, Germany
M. Boero & C. Königstein
European Patent Office, Rijswijk, The Netherlands

7DV.2.8 Web Tool for Early Stages of Techno-Economical Analysis of Shared Solar Cooperatives in the Brazilian Context

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UFSC, Florianópolis, Brazil
M.O.M. de Oliveira
OCB, Brasília, Brazil

7DV.2.9 Financial Investment in off Grid Solar PV for Rural Households

E.L. Meyer & S. Zuma
University of Fort Hare, Alice, South Africa

7DV.2.10 Technical-Economic Analysis of Photovoltaic Based Distributed Generation Systems for the Mexican Industrial Sector

N.R. Leon Rodriguez
UNAM, Temixco, Mexico

7DV.2.11 Brazilian Business Models in Distributed Photovoltaic Generation: International Experiences and New Opportunities

J.P. Correa da Costa e Silva, M. Mortari Carrilho,
F. Luiz Cyrino Oliveira & R. Flora Calili
PUC-Rio, Rio de Janeiro, Brazil

7DV.2.12 Most Recent Bottom-Up Costs Analysis from NREL for the PV Module Supply Chain and Systems Coupled with Storage

M. Woodhouse
NREL, Golden, United States

7DV.2.13 System Contribution of Residential Photovoltaic (PV) Self-Consumption

H.J.J. Yu
CEA, Gif sur Yvette, France

7DV.2.14 Challenges for Financing Utility Scale Solar PV Projects Using Bifacial Technologies

D. Barandalla, X. Puerta & M. Clemente
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7DV.2.15 Solar PV on the Distribution Grid: Smart Integrated Solutions of Distributed Generation Based on Solar PV, Energy Storage Devices and Active Demand Management

H. Bartoszewicz-Burczy
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7DV.2.16 Energy, Cost And CO2 Savings from Replacing Residential Airconditioners by Impressive Photovoltaic Windows

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F. Sauvage
University of Picardie, Amiens, France
M. Grätzel & S. Zakeeruddin
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C. Barolo
University of Turin, Italy
A. Di Carlo
University of Rome, Italy
Y. Cao
HGLASS, Lausanne, Switzerland
Y. Lafon & E. Gay
Euroquality, Paris, France

7DV.2.17 Community Solar as an Innovative Business Model for Building-Integrated Photovoltaics

A. Stauch & P. Vuichard
University of St.Gallen, Switzerland

- 7DV.2.22 Management of about 50% PV Electricity for Switzerland**
U. Muntwyler & E. Schüpbach
BUAS, Burgdorf, Switzerland
- 7DV.2.23 PV Tender Program in Japan: Its Design and Impacts on Cost Reduction**
K. Sugibuchi, I. Kaizuka, H. Yamaya, T. Ohigashi & O. Ikki
RTS Corporation, Tokyo, Japan
- 7DV.2.24 Policy and Statement of Certified PV Module Registration in Taiwan**
C.-C. Chou
ITRI, Hsinchu, Taiwan
- 7DV.2.25 Renewable Energy Financing, Markets and Policies: Issues and Perceptive in West Africa, Special Case of Niger**
M.I. Rabiou
CODDAE, Niamey, Niger
- 7DV.2.26 Energy for Sustainable Development in Niger: Successes, Challenges and Possible Way Forward**
I. Ali Soumana
ANETIC, Niger, Niger
- 7DV.2.27 Solar Energy and Sustainable Development in Morocco**
M. Boussetta & R. El Bachtiri
USMBA, Fez, Morocco
Y. Chaibi
ENSAM, Meknes, Morocco
- 7DV.2.28 Neighbourhood Influence and Social Acceptance of PV Systems in Rural Developing Communities**
N. Opiyo
Ulster University, Londonderry, United Kingdom
- 7DV.2.29 How Mobile Money Platforms and Other Innovative Technologies Have Stimulated Energy Revolution in Rural Sub-Saharan Africa**
N. Opiyo
Ulster University, Londonderry, United Kingdom
- 7DV.2.31 Binomial Rate for Low Voltage Consumers in Brazil: Conditions for Successful Implementation**
R. Teixeira, R. Flora Calili & D. Louzada
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- 7DV.2.33 SocialRES Project - Fostering Socially Innovative and Inclusive Strategies for Empowering Citizens in the Renewable Energy Market of the Future**
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ESTIA Institute of Technology, Côte Basque, France
V. Kromrey
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S. Saludes
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R. Ruiz
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N. Brito-Jorge
GoParity, Lisbon, Portugal
K. Harder
Abundance, London, United Kingdom
V. Segon
REGEA, Zagreb, Croatia
F. Ciausiu
Tractebel, Bucharest, Romania
- 7DV.2.34 Newcoming Citizen Photovoltaic Projects in Ile-de-France**
C. Blondel, T. Le Roux, N. Harada, B. Blanc, A. Le Huérou, F.-M. Blondel, G. Hervé & G. Macchi
Sud Paris Soleil, Cachan, France
D. Lincot
IPVF, Palaiseau, France
- 7DV.2.35 Multi-Criteria Decision Analysis for Renewable Energy Applications**
A. Boumaiza, A. Sanfilippo & N. Mohandes
QEERI, Doha, Qatar

7DV.2.36 BIPVBOOST Project – Bringing Down Costs of Building-Integrated Photovoltaic (BIPV) Solutions and Processes Along the Value Chain, Enabling Widespread Implementation in Near Zero Energy Buildings (nZEBs) Implementation

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A. Apraiz
Mondragon Assembly, Aretxabaleta, Spain
S. Pierret
Optimal Computing, Mons, Belgium
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CSTB, Sophia-Antipolis, France
J. Adami
Eurac Research, Bolzano, Italy
J. Payet
Cycleco, Ambérieu-en-Bugey, France
R. Baetens
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P. Stassen
Tulipps, Waalwijk, The Netherlands
U. Rühle
Flisom, Dubendorf, Switzerland
K. Viriden
Viriden + Partner, Zurich, Switzerland
M. Martínez
ISFOC, Puertollano, Spain
C. Pirotta
PIZ, Cosio Valtellino, Italy
M. Polo
COMSA, Munich, Germany
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7DV.2.38 EU-Comparison of the Economic Viability of Prosumer PV Systems

V. Fluri, K. Niedermeier, H. Steffens, B. Wille-Hausmann,
C. Kost, T. Schlegl & S. Shammugam
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7DV.2.39 MOST Project – Advanced Master’s Education Based on Smart Grid Technology

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G. Heilscher & S. Hofbauer
Ulm University of Applied Sciences, Germany
A. Michiorri
MINES ParisTech, France
E. Loucaidou
Deloitte, Lemassol, Cyprus

17:00 - 18:30 POSTER AWARDS WINNERS SESSION

Chairperson:

Julio Cárabe
CIEMAT, Spain

Aiming to increase the visibility of poster awards winners and as a recognition to the quality of their presentation, the winners will have the opportunity to perform a 5 minutes presentation to the poster area audience during the closing visual session on Thursday from 17:00 to 18:30. Winning posters will be moved to the “Winners Wall” in the poster area and presentations will take place there.

The Poster Awards ceremony, when awards will be delivered, is scheduled for Friday morning on the occasion of the Conference Closing.

For more information on the Poster Area please refer to the Poster Guide or visit www.photovoltaic-conference.com

AUTHORS INDEX**A**

- Aarseth, B.L., 5CV.4.5
Aartsma, Y., 6BV.4.21
Abagnale, G., 3BV.1.57
Abbott, M., 2DO.6.1, 2AO.4.3, 2DO.6.5, 2CV.2.82, 2CV.2.60
Abdellatif, S.O., 1BV.3.10
Abdullah, M., 4CO.2.1
Abdulraheem, Y., 2DV.1.36
Abenante, L., 5CV.4.16, 1BV.3.4, 1BV.3.5
Abhinav, A., 4AV.1.47, 4AV.2.31
Ablinger, R., 4DO.4.3
Abolmasov, S., 2DV.1.41, 2DV.1.44, 2DV.1.63
Abou-Ras, D., 3AO.9.4
Abramov, A., 2DV.1.41, 2DV.1.44, 4AV.1.22, 2DV.1.57, 5CV.4.34, 2DV.1.63
Acciarri, M., 3BV.1.6
Achard, V., 3AO.7.4
Achilli, E., 3BV.1.57
Achilli, E., 3BV.1.57
Achterberg, E.J., 5CV.4.29
Ackermann, M., 7DO.7.6, 5CV.3.68
Adachi, Y., 2DV.1.15
Adami, J., 7DV.2.36, 6CO.15.4
Addonizio, M.L., 2DV.1.50, 3BV.2.54
Adinolfi, G., 4DO.4.1
Adomaviciene, R., 7DV.2.5
Adothu, B., 4AV.2.31
Adrian, A., 2DV.1.24
Aeby, C., 2BO.4.5, 2EO.1.3
Aernouts, T., 3CO.7.3, 3CO.6.6, 6BV.4.4, 3CO.8.5
Afentaki, E., 7DO.7.3
Afzaal, M., 3BV.2.39
Agbenyeke, R.E., 3BV.1.40
Agdad, A., 1BV.3.45, 1BV.3.9
Agert, C., 6CV.1.9, 6BV.4.23, 6CO.16.1, 6DO.9.6
Aghabekyan, D.V., 5CV.4.11
Aghaei, M., 4AV.2.38, 5BO.6.4, 5CV.4.28
Aghaei, M., 4AV.2.12, 3BV.1.25
Aguilar, A.F., 5CV.3.68
Ah Sen, M.T.S.K., 2DO.6.3, 2DV.1.62
Ahmed, H., 3BV.1.25
Ahn, H.K., 4AV.2.1, 6BV.4.9, 4AV.2.4, 5CV.4.18
Ahn, S.J., 3BV.1.4, 2CV.2.59, 1BV.3.30, 3BV.1.37, 3AO.7.5
Ahn, Y.S., 2CV.2.21
Ahn, S.K., 2CV.2.59, 3AO.7.5
Ahn, S.K., 3BV.1.4, 1BV.3.30, 3BV.1.37
Aho, A., 3BV.1.50
Aho, T., 3BV.1.50
Ahrens, B., 2CV.2.96
Ahzi, S., 5CV.4.9, 4AV.1.41
Aider, C., 3BV.2.22
Aihara, T., 1AP.1.1
Aillaud, P., 5DO.2.6
Ait Benali, M., 6CV.1.13
Ait Dads, H., 3BV.1.61
Ait El Haj, D., 1BV.3.46
Ait Elhaj, D., 3BV.1.61
Ait-Abdelkader, N., 2DV.1.2
Aizpurua, J., 1BV.3.51
Akmal, K.M., 3CO.5.4
Aktaa, J., 4BO.11.1
Al Habshi, E., 4CO.2.1
Al Saggaf, A., 4CO.2.1
Al-Ahmed, A., 3BV.2.39, 1BV.3.13
Al-Ahoury, A., 3CP.1.2
Alami Merrouni, A., 5CV.4.7

- Alamy, P., 7DV.2.36, 6DO.8.6
 Alaoui, S.M., 5BO.7.2
 Alapont Sabater, A., 2CV.2.98
 Albachrony, M.A., 6CV.1.4
 Albadwawi, O.M., 6BV.4.10
 Albaric, M., 2AO.5.6
 Albe, K., 3AO.9.4
 Albert, M., 2DV.1.43
 Albrecht, S., 3CP.1.2
 Alcántara, R., 1BV.3.28
 Aldalali, B., 5DP.2.2
 Aldana-Urrea, A., 6CV.1.14
 Aleman, M., 4AV.2.17
 Alet, P.-J., 3CO.7.5, 4DO.4.1
 Algasinger, M., 3AO.7.1
 Al-Hajjawi, S., 2CV.2.44
 Ali, N., 4AV.2.29
 Ali Soumana, I., 7DV.2.26
 Aliefendioğlu, A., 2DV.1.4
 Alkhatib, H., 3BV.2.36
 Allebé, C., 2BO.4.6, 4CO.3.2, 2BP.1.2, 2CO.10.2, 2BO.2.4
 Allen, T.G., 2CO.12.4
 Almonacid, F., 5CV.4.22, 5CV.4.23, 5BO.7.3, 5CV.4.31
 Alnuaimi, A., 6BV.4.10, 4AV.2.21
 Alonso, R., 7DV.2.36, 5CV.4.33
 Alonso, P., 7DV.2.5, 7DV.2.36, 6BV.4.13, 6DO.8.4, 6DO.8.6, 7DV.2.33
 Alonso-Abella, M., 5CV.4.21, 5CV.4.45
 Alonso-García, M.C., 4AV.2.50, 4AV.2.6
 Alonso-Gómez, V., 4AV.1.38, 4AV.2.20
 Alonso-Montesinos, J., 5CV.4.21, 5DO.1.1, 5CV.4.45
 Al-Shakarchi, F., 6CO.16.3
 AlSkaif, T., 5CV.3.13
 Al-Sulaiman, F.A., 3BV.2.39
 Alt, M., 2CV.2.97
 Altermatt, P.P., 2EO.1.2
 Alvarez, J., 2DV.1.2, 1AO.2.6, 2DV.1.21, 3BV.2.49, 3BV.2.60
 Alves, M., 3AO.9.3
 Alvino, K., 7EO.3.3
 Aly, S.P., 5CV.4.9, 4AV.1.41
 Amar, A., 5CV.3.8
 Amara, M., 2DV.1.10, 2CV.2.52
 Amhal, M., 5CV.4.10, 5CV.4.15
 Amjad, A.Q., 3BV.1.24
 Amstad, D., 5CV.4.6
 An, X., 2DO.5.2
 Anacleto, P., 3AO.9.3, 3AO.8.1
 Anderson, K.F., 3CO.6.1
 Andreetta, L., 2BO.4.5, 2EO.1.3
 Andresen, G.B., 7EP.2.1
 Andriessen, R.A.J.M., 3CO.6.6, 3CO.8.5
 Andronikov, D., 2DV.1.41, 2DV.1.44, 4AV.1.22, 2DV.1.57, 5CV.4.34, 2DV.1.63
 Anglade, L., 5CV.3.68
 Ann, M.H., 3BV.2.29
 Annigoni, E., 4BO.12.4, 4AV.1.34
 Annoni, F., 3BV.1.57
 Antognini, L., 2CO.11.1
 Antón Hernández, I., 5CV.3.68
 Antonaia, A., 2DV.1.50
 Anttola, E., 3BV.1.50
 Aoki, M., 2DV.1.14, 2DV.1.19
 Aoyama, T., 2DV.1.14, 2DV.1.19
 Apablaza-Arancibia, E., 4DO.4.3
 Apraiz, A., 7DV.2.36, 5CV.4.33
 Arafune, K., 2DV.1.15
 Araki, K., 3BO.8.5, 1BV.3.1, 6EO.2.3
 Arancón, S., 7DV.2.39
 Aranguren, G., 5CV.4.2
 Araujo de Castro, F., 3CO.6.3, 4AV.2.10
 Ardiaca, F., 3CO.6.4, 3CO.5.5
 Armani, N., 3BV.1.57
 Aroudam, E., 4AV.2.13
 Arrizabalaga, I., 1BV.3.51
 Arstamyán, D.G., 5CV.3.65
 Artegiani, E., 3BV.1.21, 1BV.3.36
 Arya, V., 2BO.2.3, 2CV.2.100, 2DV.1.23
 Arzel, L., 3BV.2.45
 Ascencio-Vásquez, J., 4AV.1.17, 6CV.1.20
 Askins, S., 5CV.3.68
 Ašmontas, S., 1BV.3.2
 Assoa, Y.B., 6DO.8.4, 6BV.4.2
 Astakhov, O., 2DV.1.65, 2DV.1.67
 Attanasio, A., 4AV.2.55
 Atwater, H.A., 3BO.8.6
 Audoin, C., 4AV.2.55
 Augusto, A., 2CO.10.4
 Aulich, H.A., 6EP.1.1
 Aureau, D., 3BV.1.12, 3BV.1.13
 Auriol, F., 5CV.3.9
 Avancini, E., 3AO.7.3
 Ayala Pelaez, S., 5CV.3.32, 5DO.3.4
 Aydin, O., 2CV.2.81
 Aytaç, A.E., 2DV.1.55
 Azizan, M., 1BV.3.45
 Azouzoute, A., 5CV.4.44
 Azzopardi, B., 6CV.1.19
- B**
- Babbe, F.-S., 3BV.1.36
 Babcock, S.J., 1AO.2.3
 Badel, N., 2CO.10.1, 3CO.8.6, 4CO.3.2, 2BP.1.2, 2CO.10.2, 2BO.2.4
 Badosa, J., 5CV.3.12, 4AV.2.25
 Bae, S.H., 2CV.2.43, 2CV.2.77, 4AV.2.54, 2BO.3.6
 Baetens, R., 7DV.2.36
 Bagnall, D.M., 2DO.6.5
 Bähr, T., 2CV.2.16
 Bahreini, S.A., 5CV.4.39
 Baik, J.-W., 4AV.1.9
 Bain, P., 7DO.7.3
 Bakken, A.K., 6BV.4.31
 Bakker, K., 3BV.1.6, 3BV.1.18
 Bakowskie, R., 2BP.1.4
 Balaji, P., 2CO.10.4
 Balent, J., 2DV.1.47
 Balenzategui, J.L., 3BV.1.6
 Bales, C., 6BV.4.13
 Balestrieri, M., 3BV.2.57, 3BV.1.34
 Baliozian, P., 2DO.6.2
 Ballif, C., 2CO.10.1, 2CV.2.74, 4BO.12.4, 6DO.8.2, 2BO.4.6, 3CO.8.6, 4CO.3.2, 2BP.1.2, 2CO.12.6, 2CO.10.2, 2BO.2.4, 3CO.7.5, 2CO.11.1, 4AV.1.34, 3CO.8.1, 3CO.5.3, 6CV.1.5, 6BV.4.3, 3BV.1.28, 2DV.1.61
 Balucani, M., 2CV.2.74
 Bandara, I.R.M., 3CO.6.3
 Banerjee, R., 1BV.3.37
 Banu, S., 1BV.3.30
 Bao, J., 2BP.1.5
 Barakel, D., 3CO.7.1
 Barandalla, D., 7DV.2.14
 Baranek, P., 3BV.2.60
 Barbero, J., 5CV.4.21, 5DO.1.1, 5CV.4.45
 Barbier, T., 5CV.4.40
 Barchi, G., 4DO.4.1
 Bardizza, G., 3CP.1.4
 Bardou, N., 1AO.3.2
 Barhdadi, A., 5BO.7.2

- Barlas, T.R., 1BV.3.42
 Barolo, C., 7DV.2.16
 Barone, V., 5CV.4.4
 Barreau, N., 3BV.2.45, 3BV.1.18, 3AO.8.5, 3BV.2.57
 Barretta, C., 4CO.4.2, 4AV.1.16
 Barth, N., 5CV.4.9, 4AV.1.41
 Barth, V., 2DV.1.35, 2CO.9.5, 4AV.1.40
 Bartha, J.W., 2DV.1.43
 Barthe, B., 2DO.5.3
 Bartoszewicz-Burczy, H., 7DV.2.15
 Bartsch, J., 2CO.10.1, 2DO.5.5
 Basaheeh, A., 4CO.2.1
 Basnet, R., 2CV.2.2, 2CV.2.3
 Basset, L., 2CO.10.6, 4AV.1.40
 Batlles, F.J., 5CV.4.21, 5DO.1.1, 5CV.4.45
 Bätzner, D.L., 2BO.4.5, 2EO.1.3
 Bauer, J., 2CO.12.2
 Bauguen, E., 4AV.2.48, 4AV.2.56
 Bauhuis, G.J., 5CV.3.62
 Baumann, T., 4AV.2.34
 Baumgartner, F.P., 4AV.2.34, 4DO.4.3
 Bay, N., 2CV.2.100
 Bazer-Bachi, B., 2DV.1.7
 Bazkir, O., 4AV.2.23
 Bechmann, S., 2DO.5.5, 2DO.5.1
 Béchu, S., 3BV.1.12, 3BV.1.13, 3BV.2.57, 2DV.1.23
 Beck, A., 1AO.3.2
 Becker, C., 3CO.7.6
 Becker, G., 7EO.3.5
 Becker, A., 6BV.4.13
 Bedrich, K.G., 4AV.2.28
 Behrends, H., 6CV.1.1
 Behrens, G., 4AV.1.14, 6BV.4.5
 Beinert, A.J., 4BO.11.1, 4CO.4.3
 Beitel, C., 4AV.2.32
 Bellanger, P., 3BV.2.45, 2DV.1.2, 2DO.5.3
 Bellemare, L., 6CV.1.19
 Bellenda, G., 6BV.4.6
 Bellet, D., 2CV.2.91, 3BV.1.34, 1BV.3.23
 Bellinguer, K., 5DO.2.4
 Bellmann, M.P., 6BV.4.11
 Belluardo, G., 5DO.1.3
 Belyakov, O.A., 2CV.2.14, 2CV.2.18
 Ben Slimane, A., 3BO.8.2, 3BV.2.57, 1AO.2.4
 Benda, V., 5CV.4.42
 Bengoechea, J., 4AV.1.31
 Benguesmia, S., 2CV.2.89
 Benharrat, L., 2DV.1.6
 Benick, J., 3BV.2.46, 2BP.1.3, 2EO.1.4, 1AP.1.1
 Benlarabi, A., 5CV.3.15, 5DO.1.4
 Benmansour, M., 2AO.5.6
 Bennacer, R., 6BV.4.32
 Bennett, I.J., 2CO.10.1, 4CO.3.2, 4AV.1.49
 Bercegol, A., 3CO.5.2, 3BO.8.2, 1AO.2.4
 Berenguier, B., 1BO.10.1
 Berg, A., 3BO.8.1
 Berger, K.A., 6BV.4.7
 Berghuis, W.-J.-H., 2CO.9.2
 Bergmans, T., 5CV.4.7
 Bermudez Garcia, A., 5CV.3.64
 Bernardis, S., 4CO.3.6
 Bernhard, N., 2CV.2.54
 Bernsen, O., 7DO.7.3
 Berrian, D., 5CV.3.31
 Berson, S., 3CO.6.4, 3CO.5.5, 3BV.2.15, 3BV.2.23
 Bertani, D., 5BO.5.1, 5CV.4.4
 Bervoets, R., 1AP.1.2
 Bessa, J.G., 5CV.4.31
 Bessa, J.G., 5CV.4.23
 Besseau, R., 4AV.2.49
 Besseling, T., 4AV.1.50
 Bett, A.W., 2EO.1.1
 Betti, A., 5CV.3.14
 Bettinelli, A., 2DV.1.35, 2CO.10.6, 4CO.3.6
 Betts, T.R., 3BV.1.6, 4AV.1.24, 5DO.1.3
 Beutel, P., 1AP.1.1
 Beyer, H.G., 6CO.16.6
 Bhang, B.G., 4AV.2.1, 6BV.4.9, 4AV.2.4, 5CV.4.18
 Bhavsar, V., 1BV.3.37, 4AV.2.53
 Bhoopathy, R., 4CO.1.4, 2CV.2.64
 Bianchi, G., 3BV.2.35
 Bianco, G.V., 2DV.1.54
 Bidaud, T., 2CV.2.57, 3BV.2.57
 Biel, T., 7DO.7.3
 Biezemans, A.F.K.V., 3BV.1.33
 Bila, M., 5CV.3.35
 Bilousov, O., 3AO.9.2
 Binesti, D., 4CO.1.1, 4AV.1.55
 Binetti, S., 3BV.1.6, 3BV.1.27
 Bing, J., 6BV.4.26
 Birajdar, M., 5CV.4.14
 Birk Jones, C., 4BO.13.1
 Bishop, D.M., 1AO.1.4
 Bittkau, K., 2DV.1.60
 Bivour, M., 2DV.1.48, 2EO.1.4
 Bizzarri, F., 2CV.2.74
 Bizzini, O., 6BV.4.2
 Bjørneklett, B., 6DO.9.2
 Black, L., 2CO.9.2
 Blagovest, M., 3BV.1.6
 Blakers, A., 3CO.8.2, 2DV.1.49
 Blakesley, J.C., 3CO.6.3, 4AV.2.10, 3CO.6.2
 Blanc, I., 4AV.2.49, 4DO.4.5
 Blanc, P., 5CV.4.40
 Blanc, B., 7DV.2.34
 Blanc-Pélissier, D., 2CO.9.1, 2DV.1.2
 Blankemeyer, S., 6EO.2.4
 Bläsi, B., 1AO.3.1, 3BV.2.46
 Bles, D.-J., 6BV.4.13
 Blevin, T., 2CV.2.89
 Blieske, U., 7EO.3.5, 5CV.4.38, 4AV.2.57
 Bliss, M., 5DO.1.3
 Bloch, L., 6CV.1.5
 Blondel, C., 7DV.2.34
 Blondel, F.-M., 7DV.2.34
 Blum, N., 5DO.2.1
 Boardman, J., 5BO.7.2
 Bobeico, E., 2DV.1.54, 3BV.2.54
 Boccard, M., 2CO.10.1, 2CO.12.6, 3CO.7.5, 2CO.11.1, 3CO.8.1
 Boddaert, S., 7DV.2.36, 6BV.4.6, 6BV.4.7
 Bodeux, R., 3AO.8.5, 3BV.2.53
 Bodlak, L., 2CO.10.3
 Boero, M., 7DV.2.7
 Bohnert, U., 4AV.2.15
 Böhnisch, S., 3BV.1.38
 Bokalic, M., 4BO.13.6
 Bolen, M.L., 5CV.4.24
 Bolliger, M., 4AV.2.37
 Bolouky, M., 4AV.2.38
 Bolt, P.J., 3BV.1.9, 3AO.7.6, 7DV.2.1
 Bolt, P.J., 3AO.8.1
 Bondarchuk, O., 3AO.9.3
 Bonilla, J., 4AV.2.27
 Bonilla Castro, J., 4AV.2.24

Bonnet-Eymard, B., 4CO.3.2
 Bonomo, P., 7DV.2.36, 6BV.4.6, 6BV.4.7, 7DV.2.1
 Bontron, G., 5DO.2.4
 Booker, E.P., 3BV.2.23
 Bordihn, S., 2CV.2.4, 2BO.3.1
 Borgers, T., 2CO.10.1, 1AP.1.2
 Borgna, L., 4DO.4.2
 Borland, J., 5CV.3.51
 Borne, A., 4AV.1.30
 Borowski, P., 4AV.1.33, 3BV.1.25
 Borra, M.Z., 2CV.2.81
 Borvon, G., 2DV.1.2
 Bosch, J.L., 5CV.4.21
 Bose, S., 3AO.8.1
 Bosma, L.S., 5DO.3.5
 Bosman, J., 3BV.1.33
 Bossuyt, J., 4AV.2.29
 Bothe, K., 4BO.11.3
 Bouaziz, M.-F., 5CO.14.5
 Boublii, D., 5CV.4.3, 5DO.3.3
 Boucetta, A.E., 2AO.5.5
 Bouchier, D., 3BV.2.49
 Bouclé, J., 3BV.2.27
 Boudreault, L.-E., 6CV.1.12
 Bouhamidi, M.H., 5CV.3.8
 Boumaiza, A., 7DV.2.35
 Boumaour, M., 2DV.1.25
 Bouras, K., 3BV.1.36
 Bourdin, V., 5CV.3.12, 4AV.2.25
 Bourne, B., 5CV.3.10
 Bourry, F., 5CO.13.1, 6CO.16.3
 Boussetta, M., 6CO.16.5, 7DV.2.27
 Boutin, J.B., 3BV.2.23
 Bouttemy, M., 3BV.1.12, 3BV.1.13, 3BV.2.57, 2DV.1.23
 Bowden, S.G., 2CO.10.4
 Boyce, K., 4AV.2.30

Boyère, E., 5CV.3.35, 4AV.1.55
 Boyer-Richard, S., 1AO.3.2
 Boyouk, N., 5CV.3.16
 Brabec, C.J., 4AV.2.34, 4CO.1.2, 4AV.2.9, 5BO.7.6
 Bragstad, S., 6DO.9.2
 Brand, A.A., 2CV.2.44, 2CV.2.93, 2CV.2.100
 Brassier, P., 6DO.8.4
 Bräuninger, M., 3CO.8.1, 3CO.5.3
 Brecl, K., 4BO.13.6
 Bredemeier, D., 2AO.4.4
 Breitenbücher, D., 4CO.3.3
 Brendel, R., 2BO.3.1, 4BO.11.3, 2BO.2.1, 6EO.2.4, 2BO.2.6
 Brettenny, W.J., 5BO.6.2
 Breyer, C., 7EO.3.2
 Brezard-Oudot, A., 3CO.8.3
 Briones, F., 3AO.9.3
 Brito, M.C., 5CO.14.4, 6DO.9.5
 Brito-Jorge, J., 7DV.2.5, 7DV.2.33
 Brogan, P., 5DO.2.2
 Brogniez, G., 5CV.3.9
 Bronsveld, P.C.P., 2DO.6.3, 2CO.9.2, 2DV.1.62, 2BO.2.5
 Broß, S., 7EO.3.5
 Brottier, L., 6BV.4.32
 Broussillou, C., 2DV.1.7
 Brown, T., 7EP.2.1
 Bruckman, L., 4AV.2.30
 Bruhat, E., 2CO.9.1, 2DV.1.2
 Brun, A., 6CV.1.4
 Bründlinger, R., 4DO.4.1, 4DO.4.3
 Brunelli, K., 4AV.2.55
 Brüning, S., 2CV.2.102
 Bruno, G., 2DV.1.54
 Buatis, J.K., 2EO.1.5

Buddgård, J., 1BO.9.3
 Buecheler, S., 3AO.7.3, 3BV.1.26
 Buerhop-Lutz, C., 4CO.1.2, 4AV.2.9, 5BO.7.6
 Buessler, E., 6CV.1.12
 Buffiere, J., 5CV.3.52
 Buga, V., 2DV.1.67
 Bui, M., 4DO.4.3
 Bultel, Y., 5CV.3.54
 Bulygin, B., 5CV.4.34
 Burgess, C., 3CO.6.6, 3CO.8.5
 Burgun, F., 6DO.8.4
 Burnham, L., 5CV.3.15, 5DO.1.4
 Burud, I., 2CV.2.6, 2CV.2.9, 5CV.4.46
 Burwig, T., 3BV.2.11
 Burwig, T., 2EO.1.6
 Butkuté, R., 3BV.1.51
 Byrne, P., 5CV.3.58

C

Caamaño-Martín, E., 5CO.14.4
 Cabal, R., 2CO.9.1, 2DV.1.2, 2BO.3.5, 1AO.2.6
 Caboni, O., 6BV.4.13
 Cabrera, E., 4AV.1.37
 Caccivio, M., 6BV.4.6, 4CO.4.5
 Cacovich, S., 1AO.2.5, 3CO.5.2, 1AO.2.4
 Cal, R.B., 4AV.2.29
 Calabrò, E., 3BV.2.54
 Calaf, M., 4AV.2.29
 Calcabrini, A., 1AO.2.1, 5DO.3.1
 Calderon-Obaldia, F., 5CV.3.12
 Caldes, M.T., 3AO.8.5
 Calicchio, , 3BV.1.57
 Callec, J., 5CO.14.1
 Camara, N., 1AO.3.5
 Cambarau, W., 1BV.3.51
 Cammilleri, D., 3AO.7.4
 Caneva, S., 7DV.2.5, 7DV.2.33, 7DV.2.39
 Canino, A., 2CO.10.1, 2DV.1.35, 5CV.4.33
 Cano, F.J., 1BV.3.51
 Cao, Y., 3CO.6.3, 4AV.2.10
 Cao, Y., 7DV.2.16
 Capeska Bogatinoska, D., 5CV.4.13
 Cappelen, J.-F.-B., 2CV.2.6
 Cappelluti, F., 5CV.3.62
 Carbonera, C., 3BV.2.35
 Cardoso, J.-P., 2EO.1.3
 Carigiet, F., 4AV.2.34, 4DO.4.3
 Cariou, R., 5CV.3.64
 Carr, A.J., 5DO.3.5
 Carrere, T., 7DO.7.3
 Carriere, T., 5CO.13.2
 Carron, R., 3AO.7.3, 3BV.1.26
 Carroy, P., 2DV.1.56
 Carton, L., 2CV.2.23
 Casas, M., 7DV.2.5
 Case, C., 3CO.8.4
 Castello, S., 5CV.4.16
 Castillon, L., 4AV.1.17
 Castillon Gandara, L.F., 4CO.4.2
 Cattaneo, G., 4DO.4.4, 6BV.4.3
 Catthoor, F., 6CO.15.1, 5DP.2.2
 Cattin, J., 2CO.11.1
 Cattoni, A., 1BO.10.1, 1AO.3.2, 3BV.2.50, 3AO.8.3
 Cavalli, A., 3BO.8.3
 Celi, E., 5CV.3.3
 Cendagorta, M., 3BV.2.17, 3BV.2.8, 3BV.2.10
 Cerchier, P., 4AV.2.55
 Cerná, L., 5CV.4.42
 Cesar, I., 2BO.4.3
 Cha, S.I., 3CO.7.2, 1BO.9.1

- Chabli, A., 2CV.2.23
 Chae, Y., 2DV.1.22
 Chahid, S., 1BV.3.28
 Chaib, H., 1BV.3.46
 Chaibi, Y., 5CV.4.26, 6CO.16.5, 7DV.2.27
 Chaix, R., 6DO.9.4
 Chakanga, K., 7DO.7.3
 Chakrabarti, P., 1BV.3.39
 Chakrabarti, P., 2DV.1.64
 Champliaud, J., 2CO.10.1, 4CO.3.2, 4CO.4.5, 5CV.3.68
 Chan, C., 2DO.6.1, 2AO.4.3
 Chan, L., 6DO.8.4
 Chander, N., 2CV.2.46
 Chang, M.Y., 5BO.5.3
 Chang, E.-W., 3BV.2.12
 Chang, W.C., 3CO.6.5
 Chang, H.-C., 2DV.1.69
 Channabasappa Devihosur, S., 4AV.1.12
 Chantana, J., 3BV.1.63
 Chao, Y.-H., 2CV.2.42, 4AV.1.19
 Chaouchi, S., 2DV.1.6
 Chapon, P., 3BV.1.12
 Chapuis, V., 6DO.8.2
 Chatelain, M., 2AO.5.6
 Chaudron, A., 5BO.6.3
 Chauhan, A., 2CV.2.65
 Chen, Y.H., 1AO.3.6
 Chen, D., 2EO.1.2
 Chen, S.-H., 4AV.1.5
 Chen, T.-C., 2DV.1.13, 2CV.2.73
 Chen, Y., 2EO.1.2
 Chen, R., 2DO.5.4
 Chen, S., 5BO.6.1
 Chen, D., 2CV.2.2, 2CO.11.3, 2DO.5.4, 2DO.6.1
 Chen, J., 2BP.1.5, 2BO.1.4
 Chen, Y., 2EO.1.2
 Chen, S., 2EO.1.2
 Chen, H.-L., 1BO.10.1
 Chen, P.-C.-Y., 3BV.2.9
 Chen, Y.-S., 5BO.5.3, 5BO.6.5
 Chen, K.H., 5BO.5.3
 Chen, M., 3AO.9.5
 Chen, W.-C., 3BV.1.9, 3AO.8.3
 Chen, X.-Y., 1AO.3.6
 Chen, J.-C., 1AO.3.6
 Chen, H., 2DO.5.2
 Chen, M.C., 3BV.2.55
 Chen, C., 2BP.1.5
 Chen, J., 2BP.1.5
 Chen, W.-C., 3AO.8.1
 Chen, Y.-A., 3BV.2.9
 Chen, Y.-C., 5CV.3.57
 Chen, I.-G., 3BV.2.9
 Cheng, C.-L., 2DV.1.69
 Cheng, X., 2DV.1.16
 Cherif, M.A., 3CO.7.1
 Cherkashin, N., 3BV.2.49
 Chesnoiu, G., 5CV.3.9
 Chevalier, C., 2DV.1.2, 3BV.2.50
 Chia, E.Z.D., 5CV.3.53
 Chiantore, P., 5CV.4.19
 Chichignoud, G., 1BV.3.23
 Chikhalkar, A., 1BO.10.2
 Chin, R.L., 2DO.5.4
 Chiodetti, M., 5CV.3.35, 5DO.3.3
 Chiu, Y.-Y., 3BV.2.9
 Cho, A., 3BV.1.4, 2CV.2.59, 1BV.3.30, 3BV.1.37, 3AO.7.5
 Cho, J.S., 3BV.1.4, 2CV.2.59, 1BV.3.30, 3BV.1.37, 3AO.7.5
 Cho, Y., 3BV.1.4, 1BV.3.30, 3AO.7.5
 Cho, S.H., 2DV.1.22
 Cho, C.Y., 4AV.2.4
 Choi, G.S., 2DV.1.11, 1BO.10.6
 Choi, B.-I., 3BV.1.49
 Choi, K.-S., 4AV.1.51
 Choi, D., 2CV.2.43, 2BO.3.6
 Choi, H.J., 5CV.4.18
 Choi, J.-H., 4AV.2.1, 6BV.4.9, 4AV.2.4, 5CV.4.18
 Choi, M., 6BV.4.20
 Choi, J.-H., 5CV.3.15, 5DO.1.4
 Chong, C.M., 4AV.2.51, 2AO.4.3, 4BO.12.3
 Chong, B., 5BO.5.6
 Chou, C.-C., 7DV.2.24
 Chouitar, M., 5CV.4.44
 Choulat, P., 2BO.1.4
 Christmann, G., 3CO.8.6, 4CO.3.2, 2CO.9.5, 2BP.1.2, 2CO.10.2, 2BO.2.4
 Christoeffl, P., 4BO.13.4
 Christoforidis, G.C., 7DV.2.39
 Chrostowski, M., 2DV.1.21
 Chuang, M.-K., 4AV.2.35
 Chuang, K., 5BO.5.3
 Chuang, H.-C., 1BV.3.35
 Chueh, W.-L., 2CV.2.42, 4AV.1.19
 Chung, T.-M., 3BV.1.40
 Ciausiu, F., 7DV.2.33
 Ciesla, A., 2AO.4.3
 Cieslak, J., 2BP.1.4
 Çiftçinar, E.H., 2DV.1.4
 Cimiotti, G., 2BO.2.3
 Claassen, I., 2CO.10.1
 Clasing, L., 5CV.4.38, 4AV.2.57
 Clavreul, J., 4AV.2.49
 Clement, F., 2BO.1.1, 2BO.3.4, 2BO.4.2, 2EO.1.4, 2DO.5.1
 Clemente, M., 7DV.2.14
 Clerc, R., 4AV.1.40
 Clochard, L., 2DV.1.1
 Clohessy, C.M., 5BO.6.2
 Clua Longas, A., 4DO.4.4
 Cojocaru-Mirédin, O., 3AO.9.4
 Colas, J., 5CO.13.1, 6CV.1.2
 Cole, I.R., 5DO.1.3
 Coletti, G., 3CO.8.5, 2AO.4.1
 Colin, H., 5CV.4.10, 5CV.4.15, 5CV.3.40
 Colletti, C., 2CV.2.74
 Collin, S., 1BO.10.1, 3BV.2.53, 1AO.3.2, 3BO.8.2, 3AO.8.1, 2CV.2.57, 3BV.2.57, 3AO.8.3, 1AO.2.4
 Colombara, D., 3AO.9.3
 Comak, M., 2CV.2.83
 Cominetti, A., 3BV.2.35
 Commault, B., 5CV.4.33, 4CO.3.6
 Compiègne, M., 5CV.3.18, 5CV.3.9
 Condorelli, G., 2DV.1.35
 Connolly, J.P., 3BV.2.49, 3BV.2.60
 Córdoba, M.A., 3BV.2.1
 Cornaro, C., 6CO.16.2
 Cornelli, M., 3BV.1.57
 Cornet, C., 3BV.2.57
 Correa da Costa e Silva, J.P., 7DV.2.11
 Couderc, R., 5CV.3.3, 3BV.2.15, 3BV.1.57
 Coulot, L., 5CV.3.68
 Coustier, F., 2CV.2.23
 Coutancier, D., 3BV.2.53, 3BV.2.57
 Covello, A., 7DO.7.3
 Creatore, M., 3CO.6.6, 3CO.8.5
 Cristobal Lopez, A.B., 7DO.7.6
 Cros, S., 3CO.6.4, 3CO.5.5, 3BV.2.23
 Cros, S., 5DO.2.6, 6CV.1.12
 Cruz, A., 2CO.9.4, 2CO.11.2

Cuenca Fernández, I., 7DO.7.6
 Cui, Y., 2CV.2.72
 Cuminal, Y., 1AO.3.5, 3BV.1.53,
 1BV.3.11
 Cunha, J.M.V., 3AO.8.1
 Curran, A.J., 5BO.5.1
 Custodio, B., 4CO.4.5
 Cutts, J., 3BO.8.6

D

da Silva Freitas, R.M., 3BV.2.46
 Dabala, M., 4AV.2.55
 Dagar, J., 3BV.2.6
 Dahlioui, D., 5BO.7.2
 Dalibor, T., 3AO.9.4, 3AO.7.1,
 4AV.1.33, 3BV.1.25
 Dallapiccola, M., 5CV.3.36,
 6CO.15.4
 Dallmann, J., 3BV.1.25
 Dambrine, G., 5BO.7.2
 Danel, A., 2DV.1.35, 2CO.10.6,
 2DV.1.56, 4AV.1.40
 Daniele, S., 2CV.2.91
 Danilson, , 3BV.1.27
 Danzl, F.J.K., 3CO.8.5
 Darez, P., 5CV.4.43
 Darmane, Y., 5CV.3.19
 Darr, C., 5CV.4.43
 Daßler, D., 4BO.12.1, 1BO.9.5
 Dauksher, W., 2CO.10.4
 Dayal, S., 6BV.4.35
 de Jong, M.M., 6DO.9.1
 de Lavoreille, H.S., 5DO.2.6
 de Lépinau, R., 1BO.10.1
 De Lia, F., 5CV.4.16
 de Lophem, T.-L., 5BO.6.3
 de los Santos, D.M., 1BV.3.28
 De Maria, A., 3BV.2.54
 de Nacquard, C., 6BV.4.13

de Oliveira, M.O.M., 7DO.7.1,
 7DV.2.8
 De Paoli, P., 6DO.9.2
 de Paula Diver, R., 6CV.1.15,
 6EO.2.6
 De Rose, A., 2CO.11.4
 de Santana, T., 6EO.2.1
 De Sousa-Vieira, L., 3BV.2.17,
 3BV.2.8, 3BV.2.10
 De Vries, A., 6BV.4.21
 de Wild-Scholten, M., 7DV.2.16
 Debourdeau, M., 2CO.10.6,
 4CO.3.6
 del Buono, M., 6BV.4.7
 del Cañizo, C., 7DO.7.6
 del Rio, G., 7DO.7.3
 Delamarre, A., 3BV.1.48,
 3BO.8.4
 Delaplagne, T., 5CO.14.5
 Deline, C., 5CV.3.32, 5DO.3.4
 Della Noce, M., 2DV.1.54,
 3BV.2.54
 Della-Sala, L., 7DV.2.5
 Delli Veneri, P., 2DV.1.54,
 3BV.2.54
 Delpha, C., 5BO.6.6
 Demko, M., 4AV.1.30
 Demofonti, G., 5CV.4.33
 Denafas, J., 7DV.2.1
 Deng, W., 2DO.5.2
 Deng, R., 4AV.2.51
 Deng, M., 2EO.1.2
 Deng, S., 2DV.1.72
 Denisov, A.V., 2CV.2.20
 Denny, E., 7DV.2.33
 Deotti, D., 6CV.1.15
 Depauw, V., 2CO.9.3, 2DV.1.66
 Derricks, C., 2CV.2.95
 Derrier, A., 4AV.1.37
 Descoedres, A., 4CO.3.2,
 2BP.1.2, 2CO.10.2, 2BO.2.4

Despeisse, M., 2CO.10.1,
 2BO.4.6, 3CO.8.6, 4CO.3.2,
 2BP.1.2, 2CO.12.6, 2CO.10.2,
 2BO.2.4, 3CO.8.1, 6BV.4.3,
 4CO.4.5, 3BV.1.28, 2DV.1.61,
 5CV.3.68
 Desrues, T., 2CO.9.1, 2DV.1.2,
 2DV.1.56, 2DO.5.3, 2BO.3.3
 Desthieux, A., 2DV.1.7
 Devetaković, M., 5CV.4.13
 Devoto, I., 4AV.1.61
 Dhamrin, M., 2BO.1.1
 Dhavan, R., 5BO.5.5
 Di Carlo, A., 3BV.2.54, 7DV.2.16
 Di Giacomo, F., 3CO.6.6,
 3CO.8.5
 Diallo, M., 5CV.3.6
 Diallo, D., 5BO.6.6
 Diao, H.W., 2CV.2.38
 Dias, T., 1BO.9.2
 Diaz, J., 2CO.10.6, 4CO.3.6
 Diaz Leon, J.J., 2BO.4.6,
 3CO.8.6, 2CO.9.5, 2BO.2.4
 Díaz-Granados, F.C., 1BV.3.7
 Dickeson, G., 5DO.1.5, 7DO.7.2,
 5CO.13.3, 5DO.1.2
 Dielen, M., 2CO.9.2
 Diewald, N., 5DO.2.5
 Dikshit, A.K., 1BV.3.39,
 2DV.1.64
 Dimer, M., 2DV.1.63, 2DV.1.65
 Dimmler, B., 3AO.9.4
 Dimroth, F., 5DP.2.4, 3BV.2.57,
 1AP.1.1
 Ding, L., 3CO.8.6, 2CO.9.5,
 2BO.2.4
 Ding, K., 2CO.10.1, 2DV.1.53,
 2CO.12.6, 6EO.2.4, 2DV.1.60,
 2DV.1.67
 Dittmann, S., 5CV.3.15, 5DO.1.4
 Djanklich, M.U., 1BV.3.38
 Djebbour, Z., 3BV.2.60

Dkhil, S.B., 3BV.2.36
 Dlimi, L., 5CV.3.45
 Do, T.-P., 5CO.13.1, 6CV.1.2
 Dobb, A., 7DO.7.2, 5CO.13.3
 Dobra, T., 4AV.2.46
 Doersam, T., 5DP.2.4
 Dogan, I., 3CO.6.6
 Dold, P., 2CV.2.20
 Domínguez, C., 5CV.3.68
 Domínguez-García, J.L.,
 7DV.2.1
 Donercark, E., 2DV.1.55
 Dong, G., 2CO.11.5
 Donoso Alonso, J., 7EO.3.1
 Donsanti, F., 3BV.2.19, 3AO.7.4
 Dörenkämper, M., 6DO.9.1
 dos Reis Benatto, G.A.,
 4CO.1.3, 5CV.4.37
 Dost, G., 2DO.6.4
 Doumen, G., 1AP.1.2
 Draaisma, G., 4AV.1.50
 Drahi, E., 2DV.1.7, 3BV.2.22,
 2CV.2.55, 2DV.1.21, 2DV.1.23
 Drap, J.-M., 6BV.4.32
 Dréon, J., 2CO.11.1
 Driesse, A., 5CV.4.13, 4AV.2.14,
 5CO.13.6
 Drießen, M., 2AO.6.2
 Dross, F., 4CO.4.5, 4AV.1.50
 Drost, C., 3BV.1.38
 Duan, W., 2DV.1.53, 2CO.12.6,
 6EO.2.4, 2DV.1.60
 Dubois, S., 3BV.2.45, 2CO.9.1,
 2DV.1.2, 2DV.1.56, 2BO.3.5,
 2DO.5.3, 2BO.3.3
 Dubrovskiy, A., 2DV.1.41,
 5CV.4.34, 2DV.1.63
 Dubuisson, P., 5CV.3.9
 Duck, B.C., 3CO.6.1
 Dudko, O.A., 1BV.3.38
 Duerinckx, F., 2BO.1.4

Duffy, E., 2DV.1.1
 Duffy, N.W., 3CO.6.1
 Duigou, T., 6EO.2.2
 Dullweber, T., 2BO.2.1
 Dumbrell, R., 2CO.12.4,
 4CO.1.4
 Dunderdale, C.W., 5BO.6.2
 Dunlop, E.D., 4DP.1.1, 7DO.7.4,
 3CP.1.4
 Dupeyrat, P., 4CO.1.1, 4AV.1.18,
 5DO.3.3
 Dupré, O., 3CO.7.5, 2CO.11.1
 Dupuis, J., 4CO.1.1, 4AV.1.18,
 5DO.3.3
 Durand, O., 1AO.3.2, 3BV.2.57
 Dussouillez, M., 3CO.8.6
 Duttagupta, S., 2EO.1.5
 Duvoisin, , 6BV.4.3
 Dwivedi, Y., 1BV.3.39, 2DV.1.64
 Dyskin, V.G., 1BV.3.38

E

Eberlein, D., 4AV.1.8, 2CO.11.4
 Ebert, M., 4BO.11.2, 4BO.12.1,
 4BO.13.2, 5CV.3.15, 5DO.1.4,
 4AV.1.48
 Ebert, C., 2DV.1.3
 Ebner, R., 4AV.1.4
 Ebong, A., 2DO.6.6
 Ech-Chamikh, E.M., 1BV.3.45
 Eder, G.C., 4BO.13.3, 4AV.2.46,
 4BO.13.5, 6BV.4.7, 4AV.1.25
 Edler, M., 4AV.1.25
 Edler, M., 4BO.13.5
 Edoff, M., 3AO.9.2, 3BV.1.9,
 3AO.8.1, 3BV.1.32, 3AO.8.3,
 3CP.1.1
 Efinger, R., 2DO.5.5
 Efthymiou, V., 7DV.2.39
 Efurosibina Attoye, D., 6BV.4.22
 Ehrhardt, D., 1BV.3.25

Ehrlinger, M., 5DO.2.5
 Einhaus, R., 6BV.4.11
 Eisenlohr, J., 6DO.8.5
 Eitner, U., 2DV.1.3
 Eizinger, B., 5DP.2.3
 Ekins-Daukes, N.J., 6EO.2.1,
 3BO.8.1, 3BV.2.58
 El Assali, K., 3BV.1.61
 El Bachtiri, R., 6CO.16.5,
 7DV.2.27
 El -Chami, I., 1AP.1.2
 El Hajje, G., 4CO.1.1, 4AV.1.18
 El Hussein, J., 3BV.1.53
 El Khalfi, A.-I., 1BV.3.45
 El Kissani, A., 1BV.3.46,
 1BV.3.9, 3BV.1.61
 Elias, T., 5CV.3.9
 El-Issa, A., 4BO.11.6
 Elnosh, A., 4AV.2.21
 Emamian, M., 5CV.4.28
 Emanuel, G., 2BO.1.1
 Emtsev, K., 2DV.1.41, 4AV.1.22,
 2DV.1.57, 5CV.4.34
 Ender, M., 2CV.2.83
 Endrell, J., 6BV.4.25
 Eo, Y.J., 3BV.1.4, 1BV.3.30,
 3BV.1.37, 3AO.7.5
 Eo, Y.J., 2CV.2.59
 Eom, Y.-S., 4AV.1.51
 Eraerds, P., 3AO.9.4, 3AO.7.1
 Erath, D., 4CO.3.3
 Erceg, M., 4BO.13.5
 Erçelebi, A.C., 2DV.1.55
 Eren, T., 2CV.2.83
 Eriksson, A., 6BV.4.25
 Ermachikhin, A., 2CV.2.8,
 2CV.2.12, 2CV.2.47
 Ernst, M., 3CO.8.2, 2DV.1.49
 Es, F., 2CV.2.81
 Escarre Palou, J., 6BV.4.3

Escoubas, L., 3BV.2.36
 Escribano Troncoso, J., 6DO.8.4
 Eskandari, A., 4AV.2.38,
 5CV.4.28
 Esposito, V., 6BV.4.13
 Eswara, S., 2BO.4.6
 Etarhouni, M., 5BO.5.6
 Etcheberry, A., 3BV.1.12,
 3BV.1.13, 3BV.2.57, 2DV.1.23
 Evstropov, V.V., 1AO.1.5,
 3BV.1.55
 Eymard, J., 2CO.10.6, 4AV.1.40

F

Faes, A., 2CO.10.1, 3CO.8.6,
 4CO.3.2, 2BP.1.2, 4CO.4.5,
 5CV.3.68
 Fagerstrøm, J., 6BV.4.31
 Fairbrother, A., 4AV.2.30
 Fall, N.C.Y., 3BV.2.24
 Falsini, M., 4AV.2.26
 Farhad, S.F.U., 1BV.3.44
 Farias, G., 3BV.1.25
 Farías Basulto, G.A., 4AV.2.12
 Farina, F., 5CV.3.10
 Farnung, B., 5BO.7.5
 Fath, P., 2EO.1.1, 2CV.2.83
 Faulwetter-Quandt, B., 2BP.1.4
 Fave, A., 2CV.2.91, 3BV.2.50,
 3BV.2.56
 Favre, W., 2DV.1.35
 Fedorov, V., 3BV.1.24
 Fehrenbach, T., 2AO.6.2
 Fehring, F., 6BV.4.5
 Feifel, M., 3BV.2.57
 Fejfar, A., 2CO.10.1, 2CO.12.6,
 2AO.6.5
 Felder, T., 4AV.1.30
 Feldmann, F., 2BO.2.3, 2BO.3.4,
 2CO.12.5, 2BP.1.3, 2CV.2.56,
 2EO.1.4
 Fell, C.J., 3CO.6.1
 Fell, A., 2DO.6.2, 2CO.12.5,
 2BP.1.3
 Fellmeth, T., 2BO.1.1, 2CV.2.98,
 2CV.2.93, 5DP.2.4, 2EO.1.4
 Feng, Z., 2EO.1.2
 Feng, Y., 3AO.9.5
 Feng, L., 4AV.1.14
 Ferati, A., 3BV.1.7
 Ferlay, N., 5CV.3.18, 5CV.3.9
 Fernandes, P.A., 3AO.8.1
 Fernández, E.F., 5CV.4.22,
 5CV.4.23, 5BO.7.3, 5CV.4.31
 Fernández, E., 7DO.7.3
 Ferrada, P., 4AV.1.37
 Ferrazza, F., 3BV.2.35
 Ferreira, R., 6DO.9.5
 Ferretti, N., 4BO.11.6
 Fertig, F., 2AO.4.6
 Feurer, T., 3AO.7.3, 3BV.1.26
 Fiala, P., 3CO.8.1, 3CO.5.3
 Fialho, L., 7DO.7.6
 Fichtner, J., 2BO.1.5
 Fiette, S., 5CV.3.54
 Fievez, M., 3CO.5.5
 Figgis, B.W., 5BO.7.1, 5CV.4.9,
 5CV.3.15
 Figgis, B., 5DO.1.4
 Filipic, M., 2CO.12.6
 Finsterle, T., 5CV.4.42
 Fioretti, A.N., 2CO.10.1,
 2CO.12.6, 2CO.11.1
 Fischer, T., 4CO.3.3
 Fischer, G., 2CV.2.55
 Fischer, A., 2DV.1.51
 Flade, F., 7EO.3.5
 Flandi, L., 4AV.1.55
 Flandre, D., 3BV.1.9, 3AO.8.1
 Fledderus, H., 3CO.6.6
 Flø, A.S., 5CV.4.46

Flora Calili, R., 7DV.2.31, 7DV.2.11
 Florides, M., 4AV.1.27
 Flottemesch, R., 5CV.3.17
 Fluri, V., 7DV.2.38
 Fokuhl, E., 4BO.12.2, 4CO.3.3
 Folkerts, W., 6DO.9.1
 Fong, K.C., 2DV.1.17, 2DV.1.49
 Fontanilles, D., 5CV.3.38
 Forchhammer, S., 4CO.1.3, 5CV.4.37
 Foss, S.E., 2DV.1.9, 2CV.2.9, 5CV.4.25
 Foti, M., 2DV.1.35
 Foucaran, A., 1AO.3.5
 Fourdrinier, L., 3AO.8.1
 Fourmeau, M., 2CV.2.23
 Fourmond, E., 2DV.1.59
 Fournier, O., 1AO.2.4
 Fox, B., 4DO.4.3
 Fraisse, S., 5CV.3.52
 Frammelsberger, W., 2BO.4.5, 2EO.1.3
 Francisco, V., 6DO.8.4
 Frank, A., 4AV.2.3
 Franzetti, I., 2BO.4.2
 Frearson, L., 5DO.1.5, 7DO.7.2, 5CO.13.3, 5DO.1.2
 Frégnaux, M., 3BV.1.12, 3BV.1.13
 Freitas, S.R., 6DO.9.5
 French, R.H., 5BO.5.1, 4AV.2.30
 Freund, T., 3BV.1.62
 Frey, A., 3CP.1.3
 Friedmann, G., 7DO.7.3
 Friedrich, J., 2CV.2.17, 2CV.2.19, 2AO.5.2
 Friend, M., 3BV.2.17, 3BV.2.8, 3BV.2.10
 Friesen, G., 4CO.2.5
 Frischknecht, R., 4DO.4.5

Frontini, F., 7DV.2.36, 6BV.4.6, 7DV.2.1
 Frühauf, F., 2AO.4.6
 Fu, F., 3CO.8.1, 3CO.5.3
 Fu, G., 3BV.1.38
 Fuentes Cano, A., 7DV.2.1
 Fuerholz, U., 6BV.4.3
 Fuhrmann, D., 3CP.1.3
 Fujimoto, S., 1AO.2.2
 Fujiwara, H., 1AO.2.2, 2DV.1.37
 Fung, T.H., 2DO.6.5, 2CV.2.82, 2CV.2.60
 Fuster, D., 3AO.9.3
 Fuster Roig, V., 6CO.16.4

G

Gad, A., 2CO.10.1, 2DV.1.67
 Gademer, A., 1AO.3.5
 Gagara, L., 3BV.1.24
 Gaiaschi, S., 3BV.1.12
 Gaiddon, B., 5CV.3.52
 Gaisberger, P., 6BV.4.7, 5DO.2.5
 Gaisberger, L., 5DO.2.5
 Galagan, Y., 3CO.6.6
 Gali, R.S.R., 4AV.2.18, 4CO.2.6
 Gallardo-Saavedra, S., 4AV.1.38, 4AV.2.20
 Galleano, R., 5CV.3.3
 Galley, S., 4AV.2.56
 Gambogi, W.J., 4AV.1.30
 Gao, M., 4AV.1.54
 Gao, P., 1BV.3.14
 Gao, J.Q., 4CO.1.6
 Gao, H., 3BV.2.28
 Gapanovich, M.V., 3BV.1.23
 Garcia, J.M., 3AO.9.3
 Garcia Goma, E., 4AV.2.16
 Garg, V., 3BV.1.17
 Garoum, M., 5CV.4.44
 Garralaga Rojas, E., 5CO.14.2
 Garrison, R., 3BV.2.51
 Gasparotto, S., 6DO.8.5
 Gaume, J., 6EO.2.2, 6DO.9.4
 Gaury, J., 2CO.10.1
 Gautron, E., 3BV.2.57
 Gay, E., 7DV.2.16
 Ge, J., 3BV.2.13
 Gebhardt, P., 4AV.1.28, 4AV.1.29, 4BO.12.2
 Gecke, R., 5CV.4.38
 Geerligs, L.J., 3CO.8.5
 Gehrke, K., 6BV.4.23, 6DO.9.6
 Geipel, T., 2CO.11.4, 4BO.12.2, 4CO.3.3
 Geissbühler, J., 4CO.3.2, 2BP.1.2, 2CO.10.2
 Geißendörfer, S., 6CV.1.1
 Geißler, S., 2BP.1.4
 Geizutis, A., 3BV.1.51
 Gendry, M., 3BV.2.50
 Gensowski, K., 2DO.5.5
 Gentle, A., 2CV.2.64
 Georghiou, G.E., 5BO.5.2, 4AV.1.27, 5CV.3.11, 5CV.4.32, 4AV.1.42, 7DV.2.39, 3BV.1.56, 3BV.2.58
 Gerardi, C., 2CV.2.74, 2DV.1.35
 Gerber, A., 3BV.1.6
 Gerçek, C., 6CO.15.2
 Gereige, I., 4CO.2.1
 Gerlich, F., 5CV.3.68
 Gero Ciudad, R., 6CO.16.4
 Gerritsen, E., 2CO.10.6, 4AV.1.40, 6BV.4.34
 Gerthsen, D., 3AO.9.4
 Gevaerts, V.S., 3BV.1.33
 Gevorgyan, S.A., 3BV.1.6
 Gewohn, T., 4BO.11.3
 Geyer, D., 5DO.3.2, 4CO.4.1

Gfeller, D., 4DO.4.2
 Ghali, H.A., 1BV.3.10
 Ghannam, M.Y., 2DV.1.36
 Ghennioui, A., 5CV.4.44
 Ghorbani, E., 3AO.9.4
 Ghosh, M., 2CV.2.16
 Ghotge, R., 6CO.15.6
 Giglia, V., 2DV.1.59
 Gigoni, L., 5CV.3.14
 Giona, S., 6BV.4.13
 Giosa, E., 5CV.3.17
 Girard, R., 5DO.2.4
 Giteau, M., 1AO.3.2
 Glatthaar, M., 2CO.10.1, 2CV.2.94, 2CV.2.86
 Glick, A., 4AV.2.29
 Glunz, S.W., 2BO.1.1, 5DP.2.4, 2BP.1.3, 2EO.1.4, 2CV.2.94, 2CV.2.86
 Gnocchi, L., 4AV.1.34
 Go, H.J., 4AV.2.1
 Go, H.J., 6BV.4.9, 4AV.2.4
 Goaer, G., 2DV.1.7
 Godefroy, V., 6DO.9.3
 Goffard, J., 1AO.3.2, 3AO.8.3
 Gogna, P., 3BO.8.6
 Gok, S., 2CV.2.83
 Goldmaier, A., 6EP.1.1
 Golovanov, B.I., 3BV.1.31
 Goncalves, A.-M., 2DV.1.23
 Goncalves, J., 6DO.8.1
 Gong, H., 4AV.1.54
 Gong, J., 2EO.1.2
 Gonzáles, H., 6BV.4.7
 Gonzalez, S., 4DO.4.3
 González-Díaz, B., 3BV.2.17, 3BV.2.8, 3BV.2.10
 González-Pérez, S., 3BV.2.17, 3BV.2.8

González-Rebollo, M.A., 4AV.1.38, 4AV.2.20
 Goraya, B., 7EO.3.3
 Gordillo, G., 3BV.2.16
 Gordon, I., 2CO.10.1, 2BO.1.4, 2CO.12.6, 3AO.8.1, 2DV.1.36, 2CO.9.3, 2DV.1.66, 2DV.1.68
 Gorge, A.-L., 6DO.9.3
 Gorle, D.K., 2CV.2.46
 Gostein, M., 5CV.3.10, 5CV.3.17
 Gotoh, K., 2CV.2.45
 Gottschalg, R., 3BV.1.6, 4AV.1.24, 5CV.3.15, 5DO.1.4
 Götz, D., 5CV.3.43, 1BO.9.5
 Götz, M., 6BV.4.23
 Goudswaard, I., 4AV.1.50
 Gouillart, L., 3AO.8.1, 3AO.8.3
 Govaerts, J., 4AV.2.17, 5DP.2.2, 1AP.1.2
 Goverde, H., 6CO.15.1, 5DP.2.2
 Gracia Amillo, A.M., 4AV.2.19, 5CV.3.7, 7DO.7.4
 Gradauskas, J., 1BV.3.2
 Graditi, G., 4DO.4.1
 Graf, A., 2AO.4.5
 Granados, L., 6BV.4.26
 Grand, P.P., 2DV.1.7, 2CV.2.55, 2DV.1.23
 Grandidier, J., 3BO.8.6
 Grange, B., 2BO.3.5
 Grätzel, M., 7DV.2.16
 Grau-Luque, E., 4AV.2.18, 4CO.2.6
 Graupner, U., 2DV.1.63
 Green, M.A., 1BO.10.3, 3BO.8.1, 3CO.5.1, 3AO.8.6, 3BV.2.59, 7EP.2.2
 Greiner, M., 7EP.2.1
 Grellier, C., 6CV.1.2
 Gremenok, V.F., 1AO.3.3, 3BV.1.23, 1BV.3.38, 3BV.1.31

Greulich, J., 2DO.6.4
 Grieb, M., 4AV.1.36
 Grischke, R., 4CO.3.2
 Grommes, E., 7EO.3.5
 Gropius, H., 4AV.1.58
 Grossberg, M., 3BV.1.27
 Große, T., 2CV.2.50
 Großer, S., 2CV.2.50, 4BO.13.2
 Grottko, M., 6CO.16.1
 Grousset, A., 4AV.1.55
 Grübel, B., 2BO.2.3
 Gruginskie, N., 5CV.3.62
 Grundmann, M., 1BV.3.20
 Grüneis, M., 4AV.1.14
 Grunow, P., 4AV.1.36
 Grünsteidl, S., 4AV.1.33, 3BV.1.25
 Gschwind, B., 4DO.4.5
 Gu, X., 4AV.2.30
 Gu, W., 2CV.2.75
 Guastella, S., 5CV.4.4
 Guc, M., 3BV.2.11
 Gudopp, D., 5CV.4.14
 Gudzev, V., 2CV.2.47
 Guemri, M., 6CV.1.7
 Guerin de Montgareuil, A., 6CV.1.19
 Guerra, G., 5CV.4.20
 Guerrero-Lemus, R., 3BV.2.10
 Gueunier-Farret, M.E., 2DV.1.2, 3CO.8.3, 1AO.2.6, 3BV.2.60
 Gueymard, C.A., 5CV.3.34, 5DO.1.1
 Guillaume, P., 2DV.1.52
 Guillemoles, J.-F., 3BV.1.48, 3BV.1.13, 3BO.8.4, 1AO.3.2, 3CO.5.2, 3BO.8.2, 1AO.2.4
 Guillerez, S., 6EO.2.2, 5CV.4.33
 Guillo Lohan, B., 2CV.2.52
 Guillot-Deudon, C., 3AO.8.5

Guina, M., 3BV.1.50
 Güler, S., 2DV.1.55
 Gunawan, O., 1AO.1.4
 Gunda, T., 5CV.4.24
 Guo, Y., 4AV.1.54
 Guo, W., 3BV.2.26
 Guo, F., 2CO.12.1
 Gupta, R., 4CO.3.4, 4AV.2.22
 Gupta, I., 3BV.1.60
 Gusak, V., 3AO.8.1
 Guter, W., 3BO.8.1
 Gutierrez, V., 4AV.1.37
 Gutiérrez, J.R., 5CV.4.2
 Gutjahr, A., 2BO.4.3, 2BO.2.5
 Gutlapalli, V.R., 3AO.7.2
 Gutschner, M., 7DO.7.3
 Guzman Razo, D.E., 5CV.3.1
 Gwak, J., 3BV.1.4, 2CV.2.59, 1BV.3.30, 3BV.1.37, 3AO.7.5

H

Ha, D.L., 5CO.14.5, 6CV.1.4
 Ha, N.Y., 3BV.2.29
 Haarberg, T., 7DV.2.1
 Haas, S., 2CO.10.1
 Haas, R., 4CO.4.1
 Haas, S., 7DO.7.6
 Haase, F., 6EO.2.4
 Häberle, A., 5CV.4.6
 Habte, A., 5DO.1.6
 Hacke, P., 4CO.4.4, 5BO.7.4, 4AV.1.46
 Hackett, S., 5CV.4.24
 Hadjipanayi, M., 3BV.1.56, 3BV.2.58
 Hagedorf, C., 2CV.2.96, 4BO.11.5, 2CV.2.50, 2CO.12.2, 4AV.1.60
 Hages, C.J., 3AO.9.4
 Hagfeldt, A., 3CO.5.6
 Haghghi, Z., 1BO.9.6, 6DO.8.3
 Hahn, G., 2BO.1.5, 2CV.2.95, 2AO.4.5
 Hahn, H., 5CV.3.43
 Hähnel, A., 2CV.2.50
 Hakenberg, P., 4AV.2.57
 Hakka, F., 3BV.1.18
 Halbfaß, K., 2CV.2.78
 Halbich, M.-U., 2CO.9.6
 Halilovic, S., 5CV.3.1
 Hallais, G., 3BV.2.49
 Hallam, B., 2CV.2.2, 2CO.11.3, 2DO.6.1, 2AO.4.3
 Hallbeck, S., 6BV.4.13
 Haller, A., 7DV.2.36
 Halm, A., 4AV.1.61
 Halme, J., 1AO.3.4, 1AP.1.3
 Halwachs, M., 5CV.3.3
 Hamada, K., 3CO.5.4
 Hamada, N., 3BV.1.63
 Hameiri, Z., 2CO.12.4, 2CV.2.7, 4CO.1.4, 2CV.2.64
 Hamelmann, F.U., 4AV.1.14
 Hamer, P., 2AO.4.3
 Han, H., 2BO.3.6
 Han, D., 2DO.6.6
 Han, J.H., 3BV.1.40
 Hanifi, H., 5CV.3.43, 4CO.3.1
 Hanke, B., 6CV.1.9, 6CO.16.1, 6CV.1.17
 Hannappel, T., 1AO.1.2, 3BV.2.47, 3BV.1.52
 Hansson, R., 3BV.2.55
 Hao, X., 1BO.10.3, 3BV.1.30, 3AO.8.6, 3BV.2.59
 Hao, X., 3BV.2.26
 Harada, T., 2DV.1.15
 Harada, N., 7DV.2.34
 Harder, N.-P., 4AV.2.17, 5DP.2.2
 Harder, K., 7DV.2.33

- Harig, T., 2DV.1.65
 Hariskos, D., 3AO.9.4, 3AO.9.3
 Harmand, J.-C., 3BO.8.2
 Harmanto, A., 5CV.4.27
 Harms, K., 4AV.1.23
 Harney, R., 2CV.2.99
 Harrison, S., 2CO.10.1, 2CO.10.6, 2DV.1.52
 Hartlin, B., 2CV.2.74, 4AV.2.48, 4AV.2.56
 Haschke, J., 2CO.11.1
 Hasegawa, M., 6EO.2.3
 Hashimoto, J., 5CO.13.4, 4DO.4.3
 Hassan, A., 6BV.4.22
 Hassan, M.M., 1BV.3.10
 Hatzargyriou, N., 6CV.1.8
 Hauch, J., 4CO.1.2, 4AV.2.9, 5BO.7.6
 Haug, F.-J., 2BO.4.6
 Haug, H., 2AO.4.2, 5BO.5.4, 2CV.2.11
 Haunschild, J., 2CV.2.44
 Hauschild, D., 3AO.9.4
 Hauser, H., 1AO.3.1, 3BV.2.46
 Hauser, A., 4AV.2.30
 Haverkamp, E.J., 5CV.3.3
 Haverkamp, E.J., 3BV.1.18
 Hayama, Y., 2AO.5.3
 Hayase, S., 3CO.5.4
 Hayashi, Y., 1BO.10.4
 Hayes, M., 2DV.1.2, 2CV.2.89
 He, J., 2AO.6.3
 He, M., 3BV.1.30
 He, B., 2DV.1.9
 He, Y., 2EO.1.2
 He, J., 2AO.5.4
 Heath, G., 4DO.4.5, 4DP.1.3
 Hebert, M., 4AV.1.40
 Hedberg, J., 6BV.4.13
 Heidari, R., 4DO.4.3
 Heier, J., 3BV.2.20
 Heilscher, G., 7DV.2.39
 Heinemann, D., 5DO.2.1
 Heinisch, A., 3BV.1.52
 Heinonen, A., 6CO.15.5
 Heinrich, M., 4BO.11.1, 4AV.1.15, 6DO.8.5
 Heinstein, , 6BV.4.3
 Heinz, F.D., 2AO.4.1
 Heinze, K., 3BV.2.11
 Heise, S.J., 3BV.1.25
 Helal, A., 3BV.2.39
 Heller, R., 2AO.4.4
 Helmich, L., 2CV.2.101
 Helms, J., 6CV.1.17
 Hempel, W., 3BV.1.7, 3BV.1.19
 Hempelmann, S., 4AV.1.14
 Hengyu, L., 6BV.4.3
 Henke, T., 3AO.9.4, 3AO.7.2
 Henning, A., 2DV.1.27
 Henschel, T., 2CO.11.2
 Henze, N., 4DO.4.1
 Herbst, F., 2CV.2.24
 Herceg, S., 4AV.2.47
 Herguth, A., 2CV.2.95, 2AO.4.5
 Hermle, M., 3BV.2.46, 2DV.1.48, 2BO.3.4, 2CO.12.5, 2BP.1.3, 2CV.2.56, 2EO.1.4, 1AP.1.1
 Hernández, J.A., 6CV.1.14
 Hernández-Callejo, L., 4AV.1.38, 4AV.2.20
 Hernandez-Rodriguez, C., 3BV.2.8, 3BV.2.10
 Herrera, W., 3BV.2.1
 Herrmann, W., 4AV.2.27, 4BO.13.2
 Herrmann, D., 2DO.6.2
 Herteleer, B., 5DO.1.5, 7DO.7.2, 5CO.13.3, 5DO.1.2
 Hertwig, R., 3AO.7.3, 3BV.1.26
 Hervé, G., 7DV.2.34
 Herz, M., 5BO.5.1
 Herzog, C., 4AV.1.15, 4CO.2.4
 Heske, C., 3AO.9.4
 Hess, A., 2AO.5.3
 Het Manneetje, H., 3BV.1.33
 Hetterich, M., 3AO.9.4
 Hibino, Y., 1BO.10.4
 Hieber, H., 4AV.1.58
 Hildebrandt, T., 3BV.2.19, 2CV.2.55
 Hilt, F., 3BV.2.22, 2CV.2.55
 Hipfinger, A., 7DO.7.3
 Hirai, Y., 3BV.1.64
 Hirata, Y., 6BV.4.24
 Hirotsu, D., 3CO.5.4
 Hirsch, D., 3BV.1.38
 Hirsch, J., 2CV.2.54
 Hirschl, C., 4BO.13.3, 4AV.1.4, 4AV.2.3, 4AV.1.7, 4AV.2.46, 4BO.13.5, 4AV.1.23
 Hirslandt, K., 3BV.2.6
 Hirwa, H., 3BV.1.25
 Hjelkrem, A.-G., 6BV.4.31
 Hladys, B., 4AV.1.37
 Ho, W.-J., 1AO.3.6
 Ho-Baillie, A.W.Y., 6BV.4.26, 3BV.2.58
 Hock, R., 3BV.1.25
 Hoek, E.G., 2CO.9.2, 2DV.1.62, 2BO.2.5
 Hoex, B., 2DO.6.5, 2DV.1.72
 Hofbauer, S., 7DV.2.39
 Höfer, M., 2DV.1.65
 Höffler, H., 2DO.6.2, 2DO.6.4
 Hoffmann, W., 7EO.3.6
 Hoffmann, M., 4CO.1.2
 Hofmann, M., 2CV.2.88, 2DV.1.1, 2CV.2.87
 Hofmüller, E., 2DV.1.27
 Högl, A., 5CV.4.14
 Hohl-Ebinger, J., 3BV.1.6, 2CO.12.1
 Höhn, O., 1AO.3.1, 3BV.2.46
 Hollemann, C., 6EO.2.4
 Höller, R., 5CV.4.14, 5DO.2.5, 5CV.3.66
 Holm, N., 2BO.4.5, 2EO.1.3
 Holman, Z.C., 2CV.2.2, 2CO.11.3
 Holweger, J., 6CV.1.5
 Hong, K.-K., 4AV.1.9
 Hönig, R., 2BP.1.4
 Honsberg, C.B., 1AO.2.3
 Horbelt, R., 7DO.7.3
 Horvath, I.T., 5DP.2.2
 Horzel, J., 2BO.4.6, 2BP.1.2, 2BO.2.4
 Hossain, M.M., 1BV.3.44
 Hosseini Abardeh, R., 5CV.4.28
 Hotta, Y., 2DV.1.15
 Hou, C.-Y., 1BV.3.14
 Hrzina, P., 5CV.4.42
 Hsieh, H.-H., 4AV.1.3, 1BO.9.4, 2CV.2.42, 4AV.1.19
 Hsieh, C.F., 4BO.11.4, 4AV.2.2, 4AV.1.5
 Hsieh, P.-T., 3BV.2.9
 Hsu, S.-T., 4BO.11.4
 Hsu, H.P., 2CV.2.76
 Hsu, C.-C., 5BO.5.3, 5BO.6.5
 Hsu, H.-C., 3CO.6.5
 Hsu, T.P., 5BO.5.3
 Hu, H., 4AV.1.30
 Hu, B., 2CV.2.83
 Hu, Y.Y., 2EO.1.2
 Hu, D., 2DV.1.8
 Hu, Y., 2CV.2.72
 Huang, S., 6BV.4.26

Huang, J., 1BO.10.3, 3BV.1.30, 3AO.8.6
 Huang, W.-C., 3BV.1.11
 Huang, C.-J., 2DV.1.69
 Huang, J.-Y., 3BV.2.12
 Huang, Q., 2CV.2.72
 Huang, S., 2BP.1.5
 Hubbard, S.M., 1BV.3.22
 Huber, M., 2CV.2.90
 Hübner, S., 2CV.2.90
 Huerta, H., 6CO.15.5
 Huet, L., 5DO.2.6
 Hughes-Riley, T., 1BO.9.2
 Huhn, V., 5CV.4.29
 Huhtamäki, T., 1AO.3.4
 Hülsmann, P., 4AV.1.28
 Hummel, S., 5DO.3.2, 4CO.4.1
 Hung, J.-Y., 2CV.2.73
 Hunger, R., 3AO.9.4, 3AO.7.2
 Hünig, R., 3BV.1.19
 Hünnekes, C., 7DO.7.3
 Huong Nguyen, V., 3BV.1.34
 Hüpkes, J., 2DV.1.60, 3CO.8.5
 Huschenhöfer, D., 5DO.3.2
 Huyeng, J.D., 2BO.3.4, 2DV.1.3, 2BO.4.2
 Hwang, H., 2CV.2.33
 Hyun, J.Y., 2BO.3.6

I

Ibrahmi, E.A., 5CV.3.45
 Ichikawa, Y., 2DV.1.38, 2BO.4.4
 Ighodaro, A.O., 6EP.1.1
 Iikubo, S., 3CO.5.4
 Ijdiyaou, Y., 1BV.3.45
 Ikki, O., 7DV.2.23
 Illich, P., 6BV.4.7
 Ilse, K., 5BO.7.1, 4BO.11.5, 4AV.1.60

Imai, Y., 2DV.1.37
 Imalka Jayawardena, K.D.G., 3CO.6.3
 Imanishi, S., 3BV.1.64
 Imbuluzketa, G., 1BV.3.51
 Imenes, A.G., 6BV.4.7
 Infante Ferreira, C., 6DO.8.3
 Ingenhoven, P., 5CV.3.36
 Ingenito, A., 2BO.4.6, 2BO.2.4, 3CO.8.1
 Inoue, M., 3BV.1.63
 Irvin, N.P., 1AO.2.3
 Isabella, O., 2CO.10.1, 1BO.9.6, 3AO.8.2, 2CO.12.6, 1AO.2.1, 4AV.1.45, 5DO.3.1, 6DO.8.3, 2BO.4.1
 Ishii, H., 6BV.4.17
 Ishizuka, S., 3AO.9.1
 Ishmuratov, P., 2DV.1.41, 2DV.1.63
 Isoaho, R., 3BV.1.50
 Issa, E., 2CV.2.94, 2CV.2.86
 Ito, A., 2CV.2.61
 Itten, R., 4DO.4.4
 Iuvara, D., 2CV.2.74
 Ivanov, G., 2DV.1.57
 Iwamoto, K., 2CV.2.62
 Izquierdo-Roca, V., 3BV.2.11
 IZZI, M., 2CV.2.74, 3BV.2.61

J

Jaekel, B., 4BO.11.2, 4BO.12.1, 4CO.3.1, 4AV.1.48
 Jafari, S., 2CV.2.7
 Jaffré, A., 3BV.2.49
 Jaffré, A., 3CO.8.3
 Jäger, K., 3CO.7.6
 Jäger-Waldau, A., 7EO.3.1
 Jahelka, P., 3BO.8.6
 Jahn, M., 2BO.3.4

Jahn, R., 1AO.3.1
 Jain, A., 4BO.13.1
 Jakiela, R., 3BV.1.51
 Jander, S., 3AO.7.2
 Jang, J., 5CV.3.33, 5CV.3.30
 Jang, S.H., 2AO.6.6
 Jang, B., 3BV.1.49
 Janke, S., 2CO.11.2
 Jankovec, M., 4CO.4.2
 Jansen, J., 1BV.3.25
 Jansma, T., 5DO.3.5
 Janssen, G.J.M., 4CO.2.3, 2DO.6.3, 2CO.12.3
 Janz, S., 2AO.6.2
 Järvelä, M., 5CV.4.1
 Jarwal, D.K., 3BV.2.30
 Jaubert, J.-N., 4AV.1.55
 Javid, T., 2BO.1.1
 Jawinski, T., 1BV.3.20
 Jeangros, Q., 2BO.4.6, 3CO.7.5, 3CO.8.1, 3CO.5.3
 Jenke, G., 2CV.2.102
 Jensen, I.T., 2CV.2.9
 Jeon, N.J., 1AO.1.4
 Jeong, W.-L., 3BV.1.15, 3BV.1.16
 Jeong, I., 3BV.1.4, 1BV.3.30, 3BV.1.37, 3AO.7.5
 Ji, J., 4AV.2.51
 Ji, F., 2BO.1.2
 Ji, L., 4AV.2.30
 Jian, C., 3BV.2.26
 Jiang, Y., 3BO.8.1
 Jiang, F., 2DO.5.2
 Jiang, J., 4AV.2.51
 Jie, J., 2DV.1.18
 Jimenez, C., 2CV.2.91, 3BV.1.34
 Jimenez, P.A., 5DO.2.3
 Jiménez Franco, A., 5CV.4.38

Jiménez-López, J., 4AV.1.38, 4AV.2.20
 Jiménez-Martín, M.M., 4AV.1.38, 4AV.2.20
 Jimeno, J.C., 5CV.4.2
 Jimeno, J., 5CO.13.4
 Jin, H., 2CV.2.5
 Jin, X., 3AO.9.4
 Jit, C.K.S., 3BV.2.30
 Jo, H., 4AV.2.1, 6BV.4.9
 Jo, H., 4AV.2.4
 Joanny, M., 6EO.2.2, 6DO.9.4
 Joel, J., 3AO.7.2
 John, J.J., 6BV.4.10, 4AV.2.21
 John, J., 2CO.9.3
 John, M., 2CV.2.54
 Johnson, J., 4DO.4.3
 Jomâa, M., 6BV.4.14
 Jomard, F., 3BV.1.12, 3BV.2.57
 Jones, T.W., 3CO.6.1
 Joo, J., 4AV.1.51
 Joonwichien, S., 2DV.1.5
 Jooss, W., 2EO.1.1, 2CV.2.83
 Jost, M., 3CP.1.2
 Jost, N., 5CV.3.68
 Jouhara, H., 6BV.4.11
 Jourdan, J., 2DV.1.56
 Ju, Y.-C., 2CV.2.33
 Jubault, M., 7EO.3.3, 3AO.8.1, 3AO.8.3, 3AO.7.4
 Juhl, M.K., 2AO.4.1
 Julien, A., 3BO.8.2
 Julien, S., 4AV.2.30
 Jung, J.Y., 2DV.1.45
 Jung, S.H., 3BV.1.49
 Jung, S.H., 2DV.1.11, 1BO.10.6, 4AV.1.59
 Jung, I., 2CV.2.59
 Jung, Y., 2CV.2.77
 Jung, M., 4DO.4.1

Jüngst, G., 5CV.3.3
 Jürißen, C., 5CV.4.38
 Justianto, M., 2DV.1.65
 Jutteau, S., 3BV.2.53, 3CO.5.2

K

Kaaya, I., 4AV.1.26
 Kacharia, M., 1BV.3.22
 Kafle, B., 2DV.1.1, 2CV.2.87
 Kagan, S., 5CV.3.17
 Kaharudin, D., 5CV.4.27
 Kai, W., 4AV.1.3
 Kaizuka, I., 7DV.2.23, 7EO.3.1
 Kalboussi, Y., 2DV.1.2
 Kalliojärvi-Viljakainen, H., 5CV.4.12
 Kaltenbach, T., 4AV.1.32
 Kalyuzhnyy, N.A., 1AO.1.5, 3BV.1.55
 Kamada, R., 3BV.1.64
 Kamal, K., 2DV.1.64
 Kamibepu, S., 2AO.5.5
 Kamikawa-Shimizu, Y., 3AO.9.1
 Kamino, B.A., 3CO.8.6, 3CO.8.1
 Kaminski-Cachopo, A., 2CV.2.52, 2DV.1.2, 1BV.3.23, 2BO.3.3
 Kamioka, T., 2AO.6.1, 2CV.2.53, 1BO.10.4
 Kamp, M., 2DO.5.5
 Kang, G.-H., 2CV.2.21, 2CV.2.33
 Kang, M.G., 2DV.1.11, 4AV.1.59
 Kang, Y., 2CV.2.43, 2CV.2.77, 4AV.2.54, 2BO.3.6
 Kang, J., 5CV.3.30
 Kang, H.K., 3BV.1.49
 Kang, D., 2CV.2.5
 Kang, D., 2BO.3.6
 Kang, D.-W., 2CV.2.31
 Kang, J.-W., 4AV.1.9

Kapil, G., 3CO.5.4
 Kapranov, V., 1BV.3.50
 Kapur, J., 4CO.4.4
 Karabanov, A.S., 2CV.2.12
 Karabanov, S.M., 2CV.2.14, 2CV.2.18, 2CV.2.12
 Karabanov, A.S., 2CV.2.14, 2CV.2.18
 Karaösz, K., 7DO.7.3
 Karas, J., 2CO.10.4
 Karin, T., 4BO.13.1
 Kariniotakis, G., 5CO.13.2, 5DO.2.4
 Karoui, F., 5CO.14.5
 Karsenti, A., 3CO.7.6
 Karuturi, S., 2AO.6.3
 Kato, S., 2CV.2.45
 Kato, Y., 1AO.2.2
 Kato, K., 6CV.1.16
 Kato, T., 3BV.1.64
 Katsaounis, T., 4CO.2.1
 Katz, E., 3CO.7.6
 Kaufmann, K., 4CO.3.5, 2EO.1.6
 Kaule, F., 2CV.2.24
 Kaune, G., 3BV.1.7
 Kaushal, Y., 5BO.5.5
 Kawatsu, T., 2AO.6.1
 Kawayama, I., 2CV.2.61
 Ke, Y., 2CV.2.72
 Kebe, C.M.F., 4AV.1.10
 Kechouane, M., 2DV.1.25
 Keding, R., 2BO.3.4
 Kedir, C., 4AV.2.32
 Keevers, M.J., 3BO.8.1
 Keizman, D., 2CV.2.65
 Keller, J., 3AO.9.2, 3BV.1.32, 3AO.8.3
 Kempe, M.D., 4CO.4.4, 4AV.2.30

Kenny, R.P., 4AV.2.18, 4AV.2.19, 4CO.2.6
 Keohane, S., 2AO.5.4
 Kermadi, S., 2DV.1.25
 Kersten, F., 2AO.4.6
 Kessels, W.M.M., 2CO.9.2
 Kessler, F., 3BV.1.10, 3AO.7.4
 Kester, J., 5CO.14.3
 Keutgen, J., 3AO.9.4
 Kezzoula, F., 2DV.1.73
 Khaiyat, A., 4CO.2.1
 Khan, M.Z., 4BO.11.5
 Khan, M.U., 2CV.2.82
 Khan, N.W., 2DV.1.1
 Khan, M.U., 2DO.6.5
 Khan, F., 4AV.1.56, 1BV.3.13
 Khanfara, M., 6CO.16.5
 Khanna, S., 1BV.3.37, 4AV.2.53, 1BV.3.41
 Khoo, Y. S., 4AV.2.28
 Khoo, K., 2DV.1.72
 Khoroshko, V.V., 1BV.3.38, 3BV.1.31
 Kiaee, Z., 2BO.3.4
 Kida, Y., 2DV.1.5
 Kiefer, K., 5BO.7.5, 4AV.2.15
 Kikkert, B.W.J., 2DV.1.62
 Killenberg, A., 4AV.2.52
 Killinger, S., 5CV.3.1
 Kim, S.H., 4AV.2.33
 Kim, J.T., 6BV.4.7
 Kim, D.H., 2CV.2.43, 2CV.2.77, 4AV.2.54, 2BO.3.6
 Kim, K.S., 5CV.3.15, 5DO.1.4
 Kim, Y.B., 2DV.1.11, 1BO.10.6
 Kim, J., 2DV.1.11, 1BO.10.6, 4AV.1.59
 Kim, K.-J., 6BV.4.27
 Kim, K.-S., 3BV.1.49

Kim, K., 3BV.1.4, 2CV.2.59, 1BV.3.30, 3BV.1.37, 3AO.7.5
 Kim, M., 2CO.11.3, 2DO.6.1, 3BV.2.29
 Kim, J.-H., 3BV.1.49
 Kim, G., 2CV.2.32, 2AO.6.6
 Kim, D.-S., 4AV.1.9
 Kim, S., 3AO.9.1
 Kim, J.H., 4AV.2.30
 Kim, J.H., 4AV.1.56, 1BV.3.13
 Kim, S.-H., 2DV.1.45
 Kim, Y.-J., 4AV.1.9
 Kim, K.-P., 3BV.1.15, 3BV.1.16
 Kim, S.M., 2DV.1.11, 1BO.10.6, 4AV.1.59
 Kim, G.-G., 4AV.2.1, 5CV.4.18
 Kim, S.-M., 3BV.1.49
 Kim, J.-H., 5DO.2.3
 Kim, K.-H., 2DV.1.21
 Kim, C.G., 3BV.1.40
 Kim, D., 6BV.4.27
 Kim, J.H., 4AV.2.33
 Kim, Y., 4AV.1.59
 Kim, J.H., 3BV.2.29
 Kim, J., 3BV.2.29
 Kindl, M., 6CV.1.21
 King, R.R., 1BO.10.2, 1AO.2.3
 Kiowski, O., 3AO.9.4, 3BV.1.7, 3AO.9.3
 Kirk, A.P., 3BO.8.6
 Kirste, L., 2AO.6.2
 Kitze, M., 4AV.1.33
 Kleider, J.-P., 2DV.1.2, 3CO.8.3, 1AO.2.6, 2DV.1.21, 3BV.2.49, 3BV.2.60
 Kleiman, R.N., 3BV.2.51
 Kleinschmidt, P., 1AO.1.2, 3BV.2.47
 Klement, P., 6CV.1.17
 Klenk, R., 4AV.2.12, 3BV.1.25

- Klimm, E., 4AV.1.32
 Klipp, B., 2CV.2.20
 Klitzke, M., 2DV.1.1
 Kloos, M.J.H., 3CO.8.5
 Klöter, B., 2DO.5.6
 Kluge, T., 2BO.2.6
 Kluska, S., 2BO.2.3
 Knecht, R., 4AV.2.34
 Kneller, J.W.E., 4AV.2.10
 Ko, J.W., 4AV.2.54
 Ko, S.H., 2CV.2.33
 Kobayashi, T., 3BV.1.39
 Kobor, D., 3BV.2.25, 3BV.2.24
 Kocka, J., 2AO.6.5
 Kodolbas, A.O., 3BV.1.6
 Koepge, R., 2CV.2.24
 Koffman-Frischknecht, A., 3BV.2.1
 Köhler, G., 2CV.2.50
 Köhnen, E., 3CP.1.2
 Koida, T., 2DV.1.42, 3AO.9.1
 Kojima, N., 3BO.8.5, 1BV.3.1, 6EO.2.3
 Kojima, H., 2CV.2.62
 Kojima, T., 2AO.5.5, 2CV.2.15
 Komarala, V.K., 2DV.1.46
 Komatsu, Y., 4BO.12.5
 Konagai, M., 2AO.6.4, 2DV.1.38, 6BV.4.18, 2BO.4.4
 Kondratenko, O.S., 1BV.3.42
 Koné, J.-L., 5CV.3.54
 Kong, J., 3BV.2.35
 Königstein, C., 7DV.2.7
 Kononov, I., 1AO.1.3
 Köntges, M., 4BO.11.3, 6EO.2.4, 4BO.13.2, 7DV.2.1
 Kopte, T., 2CV.2.92, 3BV.1.38
 Korevaar, M., 5CV.4.7
 Korn, R., 2CV.2.90
 Korovin, A.V., 1BV.3.42
 Korte, L., 2CO.10.1, 3CO.7.6, 2CO.12.6, 6EO.2.4, 3CP.1.2
 Koschnick, F., 2BO.1.5
 Kössler, T., 2BO.4.5, 2EO.1.3
 Kost, C., 7DV.2.38
 Kotipalli, R., 3AO.8.1
 Kotova, N.V., 1BV.3.42
 Kotsovos, K., 4CO.2.1
 Kottantharayil, A., 2DV.1.68
 Koutsourakis, G., 3CO.6.3, 4AV.2.10, 3CO.6.2
 Kovacic, M., 3BV.1.9, 3AO.8.1
 Kovarova, M., 7DV.2.39
 Kozawa, M., 1AO.2.2, 2DV.1.37
 Kozolinsky, M., 3BV.2.19
 Kraft, A., 4AV.1.8, 2CO.11.4, 4CO.3.3
 Kräling, U., 4AV.2.15
 Kramer, R., 2BO.4.5, 2EO.1.3
 Kranert, C., 2CV.2.17, 2AO.5.2, 2CV.2.16
 Kratzert, P., 3AO.9.4, 3AO.7.2
 Krause, M., 3AO.9.4
 Krauß, K., 2CV.2.100
 Krc, J., 3BV.1.9, 2DV.1.47, 3AO.8.1
 Kreinin, L., 3CO.7.6
 Krenckel, P., 2CV.2.15, 2AO.5.3
 Krenz, A., 7EO.3.5
 Kret, J., 3BV.1.53
 Krich, J.J., 2AO.4.1
 Krieg, A., 2CV.2.98, 4CO.3.3
 Krieg, K., 2DO.5.1
 Krishnakumar, V., 3BV.1.38
 Kroke, E., 2CV.2.78
 Kromrey, V., 7DV.2.33
 Kroon, J.M., 3BV.1.6, 3CO.8.5
 Krotkus, A., 3BV.1.51
 Krueger, W., 5CO.14.2
 Krügener, J., 6EO.2.4
 Kruse, C., 2BO.2.1
 Ku, C.-H., 2DV.1.13, 2CV.2.73
 Ku, B., 5BO.6.1
 Kuan, T.-M., 2CV.2.42, 4AV.1.19
 Kuan, C.-H., 3CO.6.5
 Kubicek, B., 4AV.1.42
 Kubo, H., 6EO.2.5
 Kuczynski, M., 2CV.2.19
 Kudo, H., 2AO.5.5, 2CV.2.15
 Kuhn, T.E., 6DO.8.5
 Kuhn, P., 5DO.2.1
 Kühnel, M., 6CV.1.9
 Kulagina, N.A., 1BV.3.38
 Kumar, S., 4CO.3.4, 4AV.2.22
 Kumar, V., 3BV.1.21, 1BV.3.36
 Kumar, N.M., 1BO.10.2
 Kumar, A., 5BO.7.4
 Kumar, N.M., 5CV.4.41
 Kumar, S., 4DO.4.3
 Kumar, J., 4DO.4.3
 Kumar, A., 3BV.2.30
 Kumm, T., 6CV.1.1
 Kunaifi, K., 5CV.4.27
 Künecke, U., 3BV.1.25
 Kunert, R., 2CV.2.20
 Kung, B.-C., 2DV.1.69
 Kunz, O., 4CO.1.4, 5CV.4.2
 Kuo, T.-W., 2DV.1.13, 2CV.2.73
 Kuo, C.-W., 2CV.2.42, 4AV.1.19
 Kuo, P.-T., 3CO.6.5
 Kuo, M.-T., 2DV.1.69
 Kupka, I., 2CV.2.17
 Kurinji, M., 4AV.1.12
 Kurokawa, Y., 2CV.2.45
 Kuruganti, V., 2CV.2.44
 Kuske, J., 2DV.1.43
 Kutsukake, K., 2AO.5.5
 Kutsukake, K., 2AO.5.3
 Kwarikunda, N., 2CV.2.51
 Kwon, J.-D., 2CV.2.31
 Kwon, O., 4AV.2.1, 6BV.4.9, 4AV.2.4
 Kwon, Y.K., 4AV.2.4
 Kyprianou, A., 5CV.4.32
 Kyranaki, N., 4AV.1.24

L

- La Ferrara, V., 3BV.2.54
 Laarabi, B., 5BO.7.2
 Lachenal, D., 2CO.10.1, 2BO.4.5, 4CO.3.2, 2CO.12.6, 2EO.1.3
 Lachhab, S.E., 5CV.3.45
 Lachowicz, A., 3BV.1.28, 2DV.1.61
 Lackner, D., 1AP.1.1
 Lacoste, I., 7DV.2.33
 Lad, M., 4AV.2.53
 Lafon, Y., 7DV.2.16
 Lafond, A., 3AO.8.5
 Lafont, O., 1BO.10.1
 Lafosse, X., 3BO.8.2
 Lagerstedt, T., 1BO.9.3
 Lagunas, A.R., 4AV.1.31
 Lagut, F., 5CV.3.52
 Lai, C.-H., 3BV.1.11
 Lajoie-Mazenc, E., 5CV.4.3
 Lakhdar Chaouche, S., 2CV.2.91, 3BV.1.34
 Lakhoyan, L.M., 5CV.4.11
 Lalanne, P., 5CV.3.58
 Lamanna, E., 3BV.2.54
 Lambert, F., 5DP.2.1
 Lambert, A., 5DP.2.2, 5BO.6.3
 Lambertz, A., 2DV.1.53, 2CO.12.6, 6EO.2.4, 2DV.1.60
 Lan, C.-W., 2AO.5.1, 2CV.2.76
 Lan, D., 3CO.5.1

- Lancellotti, L., 2DV.1.54, 3BV.2.54
- Landberg, L., 5CV.4.20
- Lanfranchi, F., 3BV.1.18
- Langenhorst, M., 3CO.7.4
- Langhans, A., 2CV.2.24
- Lanterne, A., 2DV.1.56, 2DO.5.3
- Lantzsch, R., 2AO.4.6
- Lanz, M., 4AV.2.37
- Lanzetta, C., 5CV.3.14
- Lappalainen, K., 5CV.4.8
- Larionova, Y., 2BO.2.6
- Lauermaun, I., 3BV.1.6
- Lauret, J., 5CO.14.3
- Lausch, D., 4CO.3.5
- Lausch, D., 2EO.1.6
- Lauss, G., 4AV.2.36
- Lavrenko, T., 3BV.1.3
- Le, T., 5CV.3.40, 6CO.16.3
- Le, A.H.T., 2CO.12.4
- Le Corre, A., 1AO.3.2
- Le Gall, S., 3CO.8.3
- Le Huérou, A., 7DV.2.34
- Le Meur, M.-A., 7DV.2.7
- Le Pivert, X., 5CO.13.1
- Le Roux, J.-C., 4AV.1.55
- Le Roux, T., 7DV.2.34
- Lebert, N., 5CV.3.52
- Lebrun, L., 3BV.2.24
- Lechner, P., 5DO.3.2, 4CO.4.1
- Lechner, R., 3AO.9.4, 3AO.7.1, 3BV.1.25
- Ledinsky, M., 2CO.10.1, 2AO.6.5
- Lee, D.Y., 3CO.7.2, 1BO.9.1
- Lee, S. K., 3BV.2.41
- Lee, J.C., 3BV.2.41
- Lee, J.S., 2CV.2.21
- Lee, A.R., 2CV.2.59
- Lee, J.-H., 2DV.1.45
- Lee, E.-J., 4AV.1.9
- Lee, H.-S., 2CV.2.43, 2CV.2.77, 4AV.2.54, 2BO.3.6
- Lee, S., 6BV.4.27
- Lee, Y.S., 1AO.1.4
- Lee, J.-K., 2CV.2.21
- Lee, C.H., 2BO.3.6
- Lee, D.-S., 3BV.1.15, 3BV.1.16
- Lee, H., 2CV.2.53, 1BO.10.4
- Lee, H., 6BV.4.20
- Lee, C.-Y., 2DV.1.72
- Lee, B.G., 2BP.1.4
- Lee, K.-H., 3BO.8.5, 1BV.3.1, 6EO.2.3
- Lee, S.-L., 2DV.1.13, 2CV.2.73
- Lee, E., 4CO.1.6
- Lee, K., 5CV.3.33, 5CV.3.30
- Lee, S., 3BV.1.4, 2CV.2.59
- Lee, W.B., 4AV.2.1, 6BV.4.9, 4AV.2.4, 5CV.4.18
- Lee, Y.-C., 2CV.2.42
- Lee, C., 2CV.2.43
- Lee, B., 2CV.2.13
- Lee, S.H., 6BV.4.9
- Lee, J.E., 2DV.1.23
- Lee, H.K., 3BV.2.41
- Lee, Y.K., 3BV.1.40
- Lee, C., 6BV.4.36
- Lefillastre, P., 4CO.3.6
- Legradic, B., 2BO.4.5, 2EO.1.3
- Legrand, M., 1AO.2.4
- Le-Guen, V., 2CV.2.57
- Lehmann, M.J., 2BO.4.6
- Lehr, J., 3CO.7.4
- Lei, Y., 4AV.1.50
- Leidl, R., 3BV.1.6
- Leimgruber, F., 4AV.2.36
- Lelièvre, J.-F., 4AV.1.37
- Leloux, J., 5CV.4.13, 5CV.4.31, 5CV.3.34
- Lemaire, E., 4DO.4.6
- Lemaitre, N., 3CO.6.4
- Lemiti, M., 2DV.1.10, 2CV.2.52, 2DV.1.2, 3BV.2.50, 3BV.2.56
- Lemmer, U., 3CO.7.4
- Lenck, N., 4AV.2.46
- Leon, C., 3CO.8.3
- Leon Rodriguez, N.R., 7DV.2.10
- Lepercq, T., 7EP.2.3
- Lepikko, S., 1AO.3.4
- Leptos, P., 7DO.7.3
- Lerat, J.-F., 2CV.2.74, 2DV.1.35, 2CO.9.5
- Lereng, I.H., 6BV.4.31, 6DO.9.2
- Lespinats, S., 5CV.4.10
- Lester, S.P., 6BV.4.11
- Leszczynska, B., 2DV.1.43
- Leszczynski, S., 2DV.1.43
- Létoublon, A., 3BV.2.57
- Levrat, J., 2CV.2.74, 3CO.8.6, 4CO.4.5, 5CV.3.68
- Lgheith Rhazi, O., 5CV.3.35
- Li, H.-Y., 3CO.8.6, 4AV.1.34
- Li, Y.T., 4AV.2.2, 4AV.1.5
- Li, F., 2CV.2.79
- Li, W., 3AO.9.5
- Li, W., 3AO.9.5
- Li, H., 2CV.2.85
- Li, C., 3BV.2.59
- Li, X., 3BV.2.50, 3BV.2.56
- Li, L., 3BV.1.54
- Li, Y.-H., 1AO.1.6
- Li, J.-L., 5BO.6.5
- Li, Y., 2DV.1.39, 2CO.11.5, 3BV.2.26
- Li, Y.-T., 1BO.9.4
- Li, Y., 2DV.1.18
- Li, M.-H., 3BV.2.9
- Li, Z., 1BV.3.47
- Li, S., 2DV.1.26, 2CV.2.63
- Li, H., 2DV.1.26, 2CV.2.63
- Lian, W., 2DV.1.8, 2DV.1.18
- Liandrat, O., 5DO.2.6, 6CV.1.12
- Liang, W., 2DV.1.17, 2DV.1.49
- Liao, S.-T., 2DV.1.69
- Liao, J.-T., 4AV.2.35
- Libal, J., 5CV.3.31
- Lifka, H., 3CO.6.6
- Lignier, H., 2CV.2.89
- Lim, J.W., 2CV.2.32, 2AO.6.6
- Lim, I., 4AV.1.12, 5CV.3.53
- Lim, J.-R., 2CV.2.33
- Lim, K.N., 4BO.12.3
- Lin, A., 1AO.1.6
- Lin, C.-F., 3CO.6.5, 1BV.3.35
- Lin, J., 5BO.6.1
- Lin, S., 3BV.1.62
- Lin, H.-J., 1AO.2.5
- Lin, W.-Y., 4BO.11.4
- Lin, C.-M., 4CO.3.5, 2EO.1.6
- Lin, M.-J., 1BV.3.35
- Lin, D.-L., 1AO.3.6
- Lin, C.-C., 2DV.1.13
- Lin, C.-C., 2CV.2.73
- Lincot, D., 7EO.3.3, 3BV.1.13, 3BV.2.57, 3BV.1.34, 3AO.7.4, 7DV.2.34, 3BV.1.36
- Lindahl, J., 7EO.3.1
- Linden, H., 3CO.7.3, 3AO.7.6, 3BV.1.33
- Lindig, S., 5BO.5.1, 5CV.4.19
- Lindroos, J., 2AO.4.6
- Linguet, L., 5CV.3.6
- Linke, M., 6CV.1.21
- Linse, M., 2DO.5.1
- Lipovsek, B., 3BV.1.9
- Litvinov, V., 2CV.2.8, 2CV.2.12, 2CV.2.47

- Liu, Z., 3BV.2.59
 Liu, H., 5BO.7.4
 Liu, W., 2EO.1.2
 Liu, S., 2DO.6.1, 2AO.4.3
 Liu, J.-J., 1AO.3.6
 Liu, R., 2BP.1.5
 Liu, Z., 2BP.1.5, 2BO.1.4
 Liu, C.-E., 2AO.5.1
 Liu, C., 2EO.1.2
 Liu, C., 2DV.1.39
 Liu, B., 2DV.1.39
 Liu, L., 2DV.1.39
 Liu, X.(., 5DO.2.2
 Liu, C., 2DV.1.26, 2CV.2.63
 Livera, A., 5BO.5.2
 Lizarralde, I., 7DV.2.33
 Ljunggren, M., 6BV.4.25
 Lo, C.-C., 2DV.1.69
 Löckinger, J., 3AO.7.3, 3BV.1.26
 Löffler, J., 2BO.1.6, 2BO.4.3, 2CO.12.3, 2BO.2.5
 Lohmüller, S., 2BO.1.3
 Loiko, V.A., 1BV.3.8
 Loiko, N.A., 1BV.3.8
 Lok, H., 5DO.3.5
 Lollini, R., 6BV.4.13
 Lombardo, S., 2CV.2.74
 Lombez, L., 1BO.10.1, 1AO.3.2, 3CO.5.2, 3BO.8.2, 2CV.2.57, 1AO.2.4
 Lomuscio, A., 3BV.1.36
 Long, W., 2DV.1.39, 2CO.11.5
 Longeaud, C., 1AO.2.5, 3CO.5.2, 3CO.8.3
 Lontchi, J., 3BV.1.9, 3AO.8.1
 Lopes, T.S., 3AO.8.1
 López, G., 5CV.4.21, 5DO.1.1, 5CV.4.45
 Lopez Lorente, J., 5DO.2.2
 Lopez-Garcia, J., 4AV.2.18, 4AV.2.19, 4CO.2.6
 Lorenz, R., 4CO.3.3
 Lorenz, A., 2DO.5.1
 Lorfeuvre, C., 2DO.5.3
 Lossen, J., 2DV.1.24
 Lotter, E., 3BV.1.6, 3BV.1.7
 Loubat, A., 3BV.1.12
 Loucaidou, E., 7DV.2.39
 Lourdudoss, S., 3BV.2.55
 Louzada, D., 7DV.2.31
 Lovati, M., 5CV.3.36, 6BV.4.13, 6CO.15.4
 Lövenich, W., 2CO.9.6
 Lu, C., 2DV.1.20
 Lu, X., 2BO.1.6
 Lu, C.-H., 2CO.11.5
 Lucas, C., 6CV.1.7
 Luchies, J.M., 2BO.3.2
 Luciano de la Cruz, L., 6BV.4.16
 Luderer, C., 2DV.1.48
 Luiz Cyrino Oliveira, F., 7DV.2.11
 Lundberg, O., 3AO.9.2, 3AO.7.2
 Luo, H., 3AO.9.5
 Luo, W., 5BO.7.4
 Luscuere, P., 1BO.9.6
 Lutter, E., 7DO.7.3
 Luxembourg, S.L., 3CO.8.5, 2BO.2.5
 Lyu, Y., 4AV.2.30
- M**
- Ma, Q., 2CV.2.85
 Ma, L., 2BP.1.5
 Ma, Z., 2CV.2.75
 Ma, Z., 2CV.2.75
 MacAlpine, S., 5DO.3.4
 Macchi, G., 7DV.2.34
 Macco, B., 2CO.9.2
 Macdonald, D., 2CV.2.2, 2BO.2.2, 2CV.2.3, 2BP.1.1, 2CV.2.5, 2AO.4.1
 Macé, P., 7DV.2.36, 7DV.2.1
 Machado, M., 7DV.2.36, 6BV.4.6, 6BV.4.7, 6DO.8.4, 6DO.8.6
 Machirant, A., 1BO.9.3
 Mack, S., 2EO.1.4
 MacMaster, S., 4AV.1.30
 Madugula, S., 2CV.2.83
 Maebe, S., 6CV.1.9
 Maeda, T., 3BV.1.20
 Maeda, K., 2DV.1.15
 Maeno, S., 6EO.2.5
 Magiera, R., 3BV.1.38
 Magorian-Friedlmeier, T., 3BV.1.19
 Mai, Y., 1BV.3.47
 Maiberg, M., 3AO.9.4, 3AO.8.4
 Maier, A., 4CO.1.2
 Mainz, R., 3AO.9.4
 Maitanova, N., 6CO.16.1
 Majorel, M., 3BV.2.23
 Mäkelä, S., 3BV.1.50
 Mäkinen, P., 1AP.1.3
 Makita, K., 1AP.1.1
 Makrides, G., 5BO.5.2, 5BO.5.1, 4AV.1.27, 5CV.3.11, 5CV.4.32
 Malen, R., 2AO.5.4
 Malerba, C., 3BV.2.61
 Mallick, S., 4AV.1.47, 4AV.2.31
 Malvisi, E., 3BV.1.57
 Malvoni, M., 5CV.4.26, 6CV.1.8, 5CV.4.41
 Mamontova, I.B., 1BV.3.42
 Mamykin, S.V., 1BV.3.42
 Manceau, M., 3CO.6.4, 3CO.5.5, 3BV.2.15
 Mandal, S., 2DV.1.46
 Mandorlo, F., 2DV.1.10
 Maneval, V., 6EO.2.2, 5CV.3.64
 Manganiello, P., 6CO.15.1, 5DP.2.2, 1AP.1.2
 Manshanden, P., 2CV.2.49, 2BO.4.3
 Mansour, D.E., 4AV.1.31, 4BO.13.4
 Mantel, C., 4CO.1.3, 5CV.4.37
 Manzolini, G., 7EO.3.4
 Marathey, P., 1BV.3.37, 1BV.3.41
 Marchand, J.-F., 7DV.2.5
 Marchat, C., 2DV.1.2, 1AO.2.6
 Marciano, J., 3BV.1.12
 Marczak, R., 2CV.2.99
 Mariottini, F., 5DO.1.3
 Marquez-Prieto, J., 3AO.9.4
 Martel, B., 2CO.9.1, 2CV.2.89, 2BO.3.3
 Martí Vega, A., 1AO.1.1, 7DO.7.6
 Martin, A., 5CV.4.29
 Martín Chivelet, N., 6BV.4.7, 5CV.4.21, 5DO.1.1, 5CV.4.45
 Martineau, D., 3BV.2.20
 Martinez, F., 3BV.1.53
 Martínez, M., 7DV.2.36
 Martinez Sanchez, J.F., 5DP.2.4
 Martinez-de-Pison, F.J., 5CV.3.7
 Martinez-Sacristan, O., 4AV.1.38, 4AV.2.20
 Marzo, A., 5DO.1.1
 Maslov, A., 2CV.2.8, 2CV.2.47
 Masolin, A., 6BV.4.7
 Masse de la Huerta, C., 1BV.3.23
 Masson, G., 7EO.3.2, 7EO.3.1
 Masuda, A., 4BO.12.5
 Masuda, T., 6BV.4.18, 6EO.2.3, 3BV.1.63

- Matheron, M., 3CO.6.4, 3BV.2.23
- Mathew, M., 1BV.3.32, 3BV.1.14, 1BV.3.33
- Mathiak, G., 4BO.13.2
- Matsui, T., 2DV.1.37, 2CO.10.5
- Matsumoto, T., 2AO.5.5, 2CV.2.15
- Matteocci, F., 3BV.2.54
- Maturi, L., 6BV.4.13, 6CO.15.4
- Matusovsky, M., 2DV.1.24
- Maugeri, G., 5CV.4.4, 5CV.4.33
- Mauguin, O., 3BO.8.2
- Maus, S., 2BO.1.3
- Mayberry, R.W., 2DV.1.27
- Mayer, F., 2BO.4.6
- Mayorga Sánchez, C.A., 5CV.4.38
- Mazaletskiy, L.A., 1AO.3.3
- McIntosh, K., 2DV.1.17, 2DV.1.49
- McKenzie, D.R., 6BV.4.26
- McLeod, L., 5DO.1.5, 7DO.7.2, 5CO.13.3, 5DO.1.2
- McMaster, A., 6CV.1.9
- Meddeb, H., 2CV.2.102
- Medjoubi, K., 3CO.8.3
- Meena, R., 4AV.2.22
- Meftah, M., 5CV.4.3
- Mehl, T., 2CV.2.6, 2CV.2.9, 5CV.4.46
- Mehl, C., 4DO.4.5
- Mehlich, H., 2CV.2.50, 6EO.2.4, 2BO.2.6
- Mehrvarz, H., 6BV.4.26
- Meijers, G., 4AV.1.49
- Meisenzahl, K., 4AV.2.57
- Meixner, M., 2CV.2.97
- Mejía, A., 1BV.3.7
- Melnyk, I., 2CV.2.83
- Melskens, J., 2CO.9.2
- Melzer, B., 2CV.2.74
- Menard, E., 5BO.7.2
- Menari, H., 2DV.1.73
- Mencaraglia, D., 3BV.2.49, 3BV.2.60
- Méndez, H., 1BV.3.7
- Menezes, S., 1BO.10.5
- Menossi, D., 3BV.1.38
- Mercade Ruiz, P., 5CV.4.20
- Mercaldo, L.V., 3BV.1.6, 2DV.1.54, 3BV.2.54
- Merdasa, A., 3BV.2.6
- Merdzhanova, T., 2DV.1.67
- Meric, S., 4AV.2.23
- Merino, J., 5CO.13.4
- Merlier, L., 6BV.4.12
- Mermoud, A., 5CV.3.55
- Mertens, V., 2BO.2.1
- Mes, J., 5CV.4.7
- Messaoudi, P., 6BV.4.2
- Meßmer, T., 6CV.1.21
- Messmer, C., 2CO.12.5
- Messner, C., 4AV.2.36, 5CO.13.4, 4DO.4.3
- Messou, D., 3BV.1.12
- Metaferia, W., 3BO.8.3
- Metayer, S., 6BV.4.13
- Mette, A., 2BP.1.4
- Metz, A., 7EO.3.6
- Metzger, F., 6EO.2.4
- Metzner, C., 3BV.1.38
- Meusel, M., 3BO.8.1, 3CP.1.3
- Mewe, A.A., 2BO.4.3, 2BO.2.5
- Meyer, T., 3BV.2.20
- Meyer, E.L., 7DV.2.9
- Meyer, S., 2CV.2.24
- Meza, D., 2CO.12.6
- Meziani, S., 2DV.1.6
- Micard, G., 6CV.1.21
- Michaud, A., 3BO.8.2, 1AO.2.4
- Micheli, L., 5CV.4.22, 5CV.4.23, 5BO.7.3, 5CV.4.31
- Michiorri, A., 7DV.2.39
- Miclea, P.-T., 2CV.2.96
- Migan-Dubois, A., 5CV.3.12, 4AV.2.25, 5BO.6.6
- Mihailetchi, V.D., 3BV.2.60
- Mihaylov, B., 3CO.6.1
- Mikli, V., 3BV.1.27
- Mikolasch, G., 2DO.5.5
- Mikosch, A., 6EO.2.4, 2DV.1.60
- Milde, L.T., 5CV.4.25
- Miletic, Z., 4AV.2.36, 4DO.4.3
- Milimonfared, J., 4AV.2.38, 5CV.4.28
- Min, B., 2BO.3.1, 2BO.2.6
- Min, Y.-K., 4AV.1.9
- Minde, A., 6CV.1.21
- Minemoto, T., 3CO.5.4, 3BV.1.63
- Mintairov, S.A., 1AO.1.5, 3BV.1.55
- Mintairov, M.A., 1AO.1.5, 3BV.1.55, 5CV.3.67
- Minuto, A., 5CV.3.3
- Mirbagheri Golroodbari, S.Z., 5DO.3.6
- Mishra, A., 3BV.2.30
- Miskevich, A.A., 1BV.3.8
- Mittag, M., 4BO.11.1, 4CO.4.3, 4CO.2.4, 4AV.1.20
- Mittal, A., 4AV.1.7, 3BV.1.42
- Mitterhofer, S., 4CO.4.2
- Mittiga, A., 3BV.2.61
- Miyashita, Y., 2AO.6.1
- Mizuno, H., 1AP.1.1
- Mocci, S., 7DV.2.39
- Mochizuki, T., 2CV.2.61
- Modes, T., 2CV.2.92, 3BV.1.38
- Mohamed Okasha Mohamed Okasha, A., 2CV.2.87
- Mohandes, N., 7DV.2.35
- Mohanty, B.C., 3BV.1.60
- Moldovan, A., 2CO.10.3, 2DV.1.51, 2CV.2.87
- Moldovan, A., 2EO.1.4
- Molina, M., 7DO.7.6
- Molinari, A., 2CO.10.1
- Molinero, R.R., 4CO.2.5
- Molto, C., 2DV.1.23
- Mondon, A., 6DO.8.5
- Monnard, R., 2CO.12.6, 3CO.8.1
- Monokroussos, C., 4CO.1.6
- Montaru, M., 5CV.3.54
- Montes, C., 3BV.2.17, 3BV.2.8, 3BV.2.10
- Moon, S.-J., 3BV.2.41
- Moon, S.-J., 3CO.8.6
- Moon, S.H., 4AV.1.51
- Moor, D., 6BV.4.7
- Moore, T., 4DO.4.3
- Moors, R., 1AP.1.2
- Morales-Aragonés, J.I., 4AV.1.38, 4AV.2.20
- Morales-Vilches, A.B., 2CO.9.4, 2CO.11.2
- Morawski, M., 3AO.8.4
- Morche, C., 2CV.2.16
- Moreno-Ramírez, S., 3BV.2.8
- Moreton-Fernandez, A., 4AV.1.38, 4AV.2.20
- Morishima, T., 2CV.2.62
- Morisset, A., 2DV.1.2, 2BO.3.5, 1AO.2.6, 2BO.3.3
- Morita, M., 1BV.3.49
- Moriya, M., 2DV.1.5
- Morjaria, M., 5CV.3.56
- Morlier, A., 4BO.13.2
- Morrow, D.J., 5DO.2.2
- Morse, J., 5CV.4.22

Mortari Carrilho, M., 7DV.2.11
 Moschner, J., 5DP.2.2
 Mosel, F., 2CV.2.20
 Moser, D., 5CV.4.13, 5CV.3.36, 4CO.4.2, 5BO.5.1, 5CV.4.19, 7EO.3.4, 6CO.16.2, 6BV.4.13, 7EO.3.2, 6CO.15.4
 Moser, S., 5DO.2.5
 Motahhir, S., 6CO.16.5
 Motoasca, E., 7DO.7.5
 Motoda, S., 1BV.3.49
 Motta Pompeu e Silva, J.O., 6CV.1.15
 Motte, L., 3BV.2.25
 Moulin, N., 2DV.1.10
 Moussi, A., 2DV.1.6
 Mücke, D., 3BV.1.7, 3BV.1.3, 3BV.1.22
 Mudgal, S., 2DV.1.46
 Mudiarto, K., 5CV.4.27
 Mueller, T., 5DP.2.2
 Mühlbach, K., 3BV.2.46
 Mühleisen, W., 4BO.13.3, 4AV.1.4, 4AV.2.3, 4AV.1.7, 4AV.1.25
 Mukherjee, N., 1BV.3.39, 2DV.1.64
 Mukherjee, S., 3BV.1.17
 Mukhopadhyay, I., 1BV.3.37, 4AV.2.53, 1BV.3.41
 Mulder, P., 5CV.3.62
 Muliqi, E., 4CO.3.2
 Müllejans, H., 3BV.1.6, 4DP.1.1
 Muller, M., 5CV.4.22
 Müller, B., 5BO.5.1, 5BO.7.5, 5CV.3.1
 Müller, C., 1AO.3.1
 Müller, R., 3BV.2.46, 1AP.1.1
 Müller, J.W., 2AO.4.6, 2BP.1.4
 Müller, M., 2AO.6.5
 Müller, T., 4AV.1.15

Müller-Ost, J., 4AV.2.57
 Munir, R., 3BV.2.6
 Muñoz, D., 2CO.10.1, 2CV.2.74, 2DV.1.52, 2CO.9.5, 2DV.1.56, 4AV.1.37, 2CO.11.6
 Muñoz-Cerón, E., 7DV.2.6
 Munoz-Rojas, D., 2DV.1.2, 3BV.1.34, 1BV.3.23
 Muntwyler, U., 4DO.4.2, 4AV.2.37, 6CO.15.3, 4AV.2.39, 5CO.13.5, 7DV.2.22
 Münzberg, J., 4AV.2.57
 Munzke, N., 5CV.3.16
 Muramatsu, K., 2DV.1.40
 Murata, T., 2CV.2.62
 Murthy, J.N., 2BP.1.3
 Murthy, V., 5BO.5.5
 Mutarraf, M.U., 4AV.1.6
 Mütter, G., 5DP.2.3
 Myers, K., 2DV.1.27

N

Naber, R.C.G., 2BO.3.2
 Naeem, T., 4BO.12.2
 Nagai, T., 2AO.6.1
 Nagel, H., 2EO.1.4, 2CV.2.94, 2CV.2.86
 Nagel, T., 2CV.2.86
 Nägelein, A., 1AO.1.2
 Naghavi, N., 3AO.8.1, 3AO.8.3
 Nair, P.R., 1BV.3.48
 Nairi, A., 4AV.1.31
 Najafi, M., 3CO.7.3, 3CO.6.6, 3CO.8.5
 Nakada, K., 3BV.1.39
 Nakamichi, Y., 2CV.2.62
 Nakamura, K., 2DV.1.40, 2AO.6.1, 2CV.2.53, 1BO.10.4
 Nakanishi, H., 2CV.2.61
 Nakano, Y., 3BV.1.46, 3BV.1.48
 Nakhimovich, M.V., 5CV.3.67

Nam, W., 2CV.2.13
 Nandakumar, N., 2EO.1.5
 Nandy, M., 3BV.2.47
 Napoli, S., 4AV.2.30
 Nardin, G., 5CV.3.68
 Narjis, A., 1BV.3.9
 Narvesjö, J., 5CV.4.36
 Naumann, V., 4BO.11.5, 2CO.12.2, 4AV.1.60
 Nay Wunn, H., 1BV.3.49
 Nayak, M., 2DV.1.46
 Nazarzadeh, M., 2BO.3.4
 Nazeeruddin, M.K., 3BV.2.60
 Ndiaye, A., 4AV.1.10
 Ndiaye, M.L., 4AV.1.10
 Ndioukane, R., 3BV.2.25, 3BV.2.24
 Neirac, F.-P., 5CO.13.2
 Nekarda, J.-F., 2CV.2.93, 2CV.2.100, 2DV.1.23
 Nelias, D., 2CV.2.23
 Neretnieks, P., 6BV.4.25
 Neubert, S., 3BV.1.6, 2CO.9.4
 Neubert, B., 2CV.2.78
 Neugebohrn, N., 6BV.4.23, 6DO.9.6
 Neuhaus, D.-H., 4BO.11.1, 4AV.1.8, 4CO.2.4, 4AV.1.20
 Neuhaus, H., 4AV.1.15
 Neumaier, L., 4AV.2.3, 4AV.1.7, 4AV.2.46, 4BO.13.5, 4AV.1.23
 Ney, L., 2DO.5.1
 Ng, C.H., 3CO.5.4
 Nguyen, N., 3CO.6.4, 3BV.2.23
 Nguyen, H.T., 2CV.2.3, 2BP.1.1
 Nguyen, V.H., 2DV.1.2, 1BV.3.23
 Nguyen, V.K., 6DO.8.6
 Nguyen, V.H., 2CV.2.45
 Ni, Z., 2DV.1.8, 2DV.1.9, 2DV.1.18

Niazi, K.A.K., 4AV.1.6
 Nicolay, S., 2BO.4.6, 3CO.8.6, 2CO.9.5, 2BP.1.2, 2CO.10.2, 2BO.2.4, 3CO.8.1
 Niedermeier, K., 7DV.2.38
 Nielsen, O., 2CV.2.74
 Niemi, E., 3AO.8.1
 Niesen, T.P., 3AO.9.4
 Niewelt, T., 2CV.2.56, 2AO.4.1
 Niki, S., 3AO.9.1
 Nikitina, V., 4CO.3.3
 Nikolaeva, A., 3AO.9.4
 Ninad, N., 4DO.4.3
 Nishihara, T., 2DV.1.40, 2AO.6.1, 1BO.10.4
 Nishimura, K., 3CO.5.4
 Nishimura, T., 3BV.1.63
 Nishinaga, J., 3AO.9.1
 Nishiwaki, S., 3AO.7.3, 3BV.1.26
 Nisi, A., 4AV.2.55
 Niu, Z., 2CV.2.72
 Nivelle, P., 1AP.1.2
 Nkhaili, L., 1BV.3.9, 3BV.1.61
 Noda, Y., 2AO.5.5
 Nogay, G., 2BO.4.6, 2BO.2.4, 3CO.8.1
 Noge, H., 6BV.4.18, 2BO.4.4
 Noh, J.H., 1AO.1.4
 Nold, S., 2EO.1.1
 Nonnenmacher, H.-J., 6EO.2.4
 Norris, H., 5DO.1.5
 Nouali, S., 2DV.1.73
 Nouri, B., 5DO.2.1
 Novikov, G.F., 3BV.1.23, 3BV.1.31
 Nowak, S., 7DO.7.3
 Nowoczin, J., 3AO.7.2
 Nowottnick, M., 2CO.11.4
 Noy, A., 2DV.1.24
 Nüesch, F., 3BV.2.20

Nyapshaev, I., 2DV.1.41,
2DV.1.44, 2DV.1.63

O

Oberbeck, L., 7EO.3.3
Oberholzer, S., 7DO.7.3
O'Brien, G., 4AV.2.30
Ocaña, L., 3BV.2.17, 3BV.2.8,
3BV.2.10
Odin, I.N., 3BV.1.23
Oehler, F., 1BO.10.1
Oehrlé, K., 2DO.5.1
Øgaard, M.B., 5CV.4.25,
5CV.4.30, 5BO.5.4
Ogura, A., 2DV.1.40, 2DV.1.14,
2AO.6.1, 2CV.2.53, 1BO.10.4
Oh, S.-Y., 5CV.3.15, 5DO.1.4
Ohdaira, K., 4BO.12.5
Ohigashi, T., 7DV.2.23
Ohland, J., 3BV.1.25
Ohno, Y., 2AO.5.5
Ohshita, Y., 2DV.1.40, 2AO.6.1,
2CV.2.53, 1BO.10.4
Okel, L.A.G., 2CO.12.3, 3CO.8.5
Okoso, K., 6EO.2.5
Oku, T., 2CO.10.5
Okullo, W., 2CV.2.51
Olalla, C., 5DO.3.4
Oliveau, C., 2BO.3.3
Oliveira Martins, A.C., 6DO.8.2
Olivieri, L., 5CO.14.4
Olsen, E., 2CV.2.6, 2CV.2.9,
5CV.4.46
Omanakuttan, G., 3BV.2.55
Omazic, A., 4AV.2.46, 4BO.13.5
Ong, S., 5DO.1.5
Onishi, K., 2AO.6.1
Onoye, T., 6CV.1.16, 6CO.15.1
Opiyo, N., 7DV.2.28, 7DV.2.29,
5CV.3.44

Orehhov, D., 4AV.1.22,
5CV.4.34, 2DV.1.63
Oreski, G., 4BO.13.3, 5CV.4.13,
4AV.2.46, 4CO.4.2, 4BO.13.5,
4AV.1.16, 4AV.1.17, 4AV.1.25
Oroutzoglou, I., 5DP.2.2
Ortega, L.M., 2EO.1.5
Ortega, E., 5CV.4.2
Ortiz Lizcano, J.C., 1BO.9.6,
6DO.8.3
Ory, D., 3CO.5.2, 2CV.2.57,
1AO.2.4
Osawa, Y., 2BO.4.4
Oscarsson, J., 6BV.4.25
Oshima, R., 1AP.1.1
Osorio-Aravena, J.C., 7DV.2.6
Osowski, M.L., 3BO.8.6
Ossenbrink, H., 6CV.1.18
Osterthun, N., 6DO.9.6
Otálora, C.A., 3BV.2.16
Otani, K., 4DO.4.3
Othonos, A., 3BV.1.56
Otnes, G., 5CV.4.25
Otter, P., 6EP.1.1
Ou, C., 1BV.3.47
Ouberrri, Y., 4AV.2.13
Ourinson, D., 2BO.1.1
Outzourhit, A., 1BV.3.46,
1BV.3.9, 6CV.1.13, 3BV.1.61
Ouyang, C.-P., 2DV.1.22
Ovchinnikov, D., 1BV.3.50
Oviedo Hernández, G., 5CV.4.19
Özcan, C., 3BV.1.35

P

Pacebutas, V., 3BV.1.51
Padhamnath, P., 2EO.1.5
Pae, S.R., 1AO.1.4
Paetel, S., 3AO.9.4, 3BV.1.19
Paezold, U.W., 3CO.7.4

Palitzsch, W., 4AV.2.52, 7DV.2.1
Palm, J., 3AO.9.4, 3AO.7.1,
4AV.1.33
Pan, Z., 4AV.1.30
Pan, B.-Y., 1AO.3.6
Panapakidis, I., 7DV.2.39
Panayi, C., 7DV.2.39
Pander, M., 4BO.11.2,
4BO.12.1, 4BO.13.2, 4AV.1.48,
4AV.1.60
Pandya, V., 4AV.2.53
Paneliya, S., 1BV.3.37, 4AV.2.53
Panos, A., 4AV.1.17
Papageorgiou, G., 3BV.1.38
Papaiz, L., 6BV.4.13
Papanastasiou, P., 4AV.1.42
Papargyri, L., 4AV.1.42
Papet, P., 2BO.4.5, 4CO.3.2,
2EO.1.3
Paquez, X., 4AV.1.50
Paracchino, A., 3CO.8.6
Parashar, P., 1AO.1.6
Paraskeva, V., 3BV.1.56,
3BV.2.58
Paratte, V., 2CO.11.1, 3CO.8.1
Parikh, H.R., 4CO.1.3, 5CV.4.37
Parisi, J., 3BV.1.25
Park, N., 3BV.2.29
Park, J.H., 3BV.1.4, 2CV.2.59,
3AO.7.5
Park, H., 4AV.2.54
Park, C.-S., 4AV.1.9
Park, H., 2BO.3.6
Park, J.H., 1BV.3.30, 3BV.1.37
Park, S.J., 2CV.2.43, 4AV.2.54,
2BO.3.6
Park, N., 5CV.4.18
Park, S.Y., 4AV.2.1, 6BV.4.9,
4AV.2.4, 5CV.4.18
Park, M.A., 2CV.2.32, 2AO.6.6
Park, J.C., 2CV.2.13

Park, B.K., 3BV.1.40
Park, J., 6BV.4.27
Park, Y., 6BV.4.36
Parol, F., 5CV.3.9
Parola, S., 1AO.3.5, 3BV.1.53
Parolini, F., 6BV.4.6
Paschen, J., 2CV.2.93
Pasmans, P., 4CO.4.5, 4AV.1.50
Pasquinelli, M., 3BV.2.36
Paszuk, A., 3BV.2.47, 3BV.1.52
Patel, N., 5CO.13.6
Patel, B., 1BV.3.41
Patriarche, G., 3BV.2.50
Patzold, M., 4CO.3.5, 2EO.1.6
Paul, N., 2CV.2.57
Paulauskas, T., 3BV.1.51
Pause, F., 7DV.2.5
Pavanello, D., 5CV.3.3, 3BV.1.6,
4AV.2.18
Paviet-Salomon, B., 2CO.10.1,
3CO.8.6, 4CO.3.2, 2BP.1.2,
2CO.12.6, 2CO.10.2
Payet, J., 7DV.2.36
Payeur, M., 4AV.2.49, 4DO.4.5
Payne, D., 2DO.6.5, 2CV.2.82,
2CV.2.60
Paynter, C., 7DO.7.2
Pearce, P., 3BO.8.1
Pearsall, N.M., 5CV.4.13
Peibst, R., 2CV.2.4, 2BO.3.1,
2BO.2.1, 6EO.2.4, 2BO.2.6
Peillon, S., 1BV.3.11
Pelletier, D., 2AO.5.6
Pen, K.-H., 1AO.1.6
Peng, S., 3BV.1.38
Peng, S., 2CV.2.72
Peng, C.-W., 2CO.11.5
Perez, M.D., 3BV.2.1
Perez, R., 6CO.16.2
Perez, M., 6CO.16.2

- Perez Carballo, A., 6BV.4.13
 Perez-Basante, A., 5CO.13.4
 Perez-Lopez, P., 4AV.2.49, 4DO.4.5
 Pernau, T., 2CV.2.101
 Pernoud, F., 2CO.10.6, 4CO.3.6
 Perret-Aebi, L.-E., 6BV.4.3
 Perrin, R., 5CV.4.3
 Persat, N., 7DV.2.7
 Persson, C., 3BV.1.32
 Petersson, A.M., 5CV.4.36
 Petersson, J., 5CV.4.36
 Petit, M., 6CV.1.4
 Petri, D., 5CV.3.68
 Petrosyan, H.S., 5CV.3.65
 Pezzato, L., 4AV.2.55
 Pflugradt, N., 6CO.15.3
 Pfreundt, A., 4CO.4.3, 4AV.1.20
 Phang, S.P., 2CV.2.2, 2BO.2.2, 2CV.2.3, 2BP.1.1
 Philipp, D., 4AV.1.28, 4AV.1.29, 4BO.12.2, 4BO.13.4
 Piatlitskaya, T.V., 1AO.3.3, 1BV.3.38
 Piazza, V., 3BV.2.50
 Piazzzi, A., 5CV.3.14
 Pickel, T., 4CO.1.2, 4AV.2.9, 5BO.7.6
 Pickenhain, R., 1BV.3.20
 Pierret, S., 7DV.2.36
 Pierro, M., 6CO.16.2
 Pierron, P., 3BV.2.36
 Pieters, B.E., 6EO.2.4
 Pilo, F., 7DV.2.39
 Pinault-Thaury, M.A., 3BV.2.57
 Pinter, G., 4BO.13.5
 Pinto, S., 4AV.2.47
 Pipkova, A.S., 1AO.3.3
 Piquemil, M., 1AO.3.5
 Pirootta, C., 7DV.2.36
 Pistor, P., 3AO.9.4, 3BV.2.11
 Pitaval, S., 5CO.13.2
 Pitta Bauermann, L., 4AV.1.31, 4BO.13.4, 4CO.3.3
 Pitteloud, S., 2BO.4.5, 2EO.1.3
 Pittet, S., 6BV.4.3
 Pitz-Paal, R., 5DO.2.1
 Plag, F., 4AV.2.5, 4CO.1.5
 Platzer-Björkman, C., 3AO.9.2
 Pletz, B., 4AV.1.7
 Plissonnier, A., 5CV.4.10
 Ploss, B., 1AO.1.3
 Po, R., 3BV.2.35
 Podlowski, L., 4BO.11.6, 4AV.1.36
 Politi, B., 1AO.3.5
 Pollard, M.E., 2DO.6.5
 Polly, S.J., 1BV.3.22
 Polman, A., 2CV.2.60
 Polo, J., 5CV.4.21, 5DO.1.1, 5CV.4.45
 Polo, M., 7DV.2.36
 Polo López, C.S., 6BV.4.7
 Polojärvi, V., 3BV.1.50
 Polverini, D., 7DO.7.4
 Polzin, J.-I., 2BP.1.3, 2CV.2.56, 2EO.1.4
 Pomaska, M., 2CO.10.1, 2DV.1.53, 2DV.1.60
 Pongthanacharoenkul, N., 4AV.1.36
 Poodt, P., 3CO.6.6
 Poortmans, J., 4DO.4.6, 5DP.2.2, 2DV.1.71, 1AP.1.2, 2CO.9.3, 2DV.1.66, 2DV.1.68
 Pop, S.C., 4CO.4.4
 Popescu, F., 6CV.1.6
 Posada, J., 2DV.1.7
 Pospischil, M., 2BO.1.1, 2DO.5.1
 Potlog, T., 3BV.1.24
 Pouloupoulos, C., 4AV.2.48, 4AV.2.56
 Poulsen, P.B., 4CO.1.3, 5CV.4.37
 Powalla, M., 3AO.9.4
 Praher, P., 5DO.2.5
 Prajapati, A., 2CV.2.65
 Prakoso, A.B., 2DV.1.20
 Preu, R., 2DO.5.1
 Preußner, T., 2CV.2.92
 Prieur-Vernat, A., 4AV.2.49
 Primerose, A., 5CV.3.6
 Prince, M.G., 2DV.1.3
 Procel Moya, P.A., 2CO.10.1, 3AO.8.2, 2CO.12.6
 Proietti, D., 2CO.10.1
 Ptak, A.J., 3BO.8.3
 Puel, J.-B., 3BO.8.2, 1AO.2.4
 Puerta, X., 7DV.2.14
 Punamiya, V., 5BO.6.3
 Pushko, S.V., 5CV.3.67
 Puthen-Veettill, B., 2DO.6.5
 Puttkammer, P., 5CO.14.3
 Pyatlitski, A.N., 1AO.3.3, 1BV.3.38
 Pysch, D., 2CV.2.100
- Q**
- Qian, J., 3CO.8.2
 Qian, H., 2DV.1.9, 2DV.1.18
 Qian, X., 2CV.2.75
 Qiao, Z., 2BP.1.5
 Qiu, D., 2DV.1.53
 Qu, M., 2CO.11.5
- R**
- Raappana, M., 3BV.1.50
 Rabenok, E.V., 3BV.1.23, 3BV.1.31
 Rabiou, M.I., 7DV.2.25
 Raccurt, O., 5CV.3.64
 Rachdi, L., 2CV.2.88
 Rachid, A., 6CV.1.11
 Radkar, L.A., 5DP.2.2
 Radouane, K., 5CV.4.3, 4AV.1.18, 5DO.3.3
 Rafhay, Q., 2DV.1.2, 2BO.3.3
 Rafizadeh, S., 3CO.8.6, 3CO.8.1
 Ragonesi, A., 2DV.1.35
 Rahmani, A., 6BV.4.28
 Rahmoun, K., 2CV.2.58
 Rakitin, V.V., 3BV.1.31
 Rakotoniaina, J.P., 4AV.2.55
 Ramesh, S., 4CO.2.3, 2CO.12.3
 Rametta, G., 3BV.2.54
 Ramírez Pérez, E.A., 3BV.2.16
 Ramon, D., 5CV.3.18, 5CV.3.9
 Ramspeck, K., 2CV.2.98, 2CV.2.97
 Ransome, S., 5BO.5.2, 5CV.4.35
 Ranta, S., 6CO.15.5
 Raoult, E., 3BV.2.53
 Ras, R.H.A., 1AO.3.4
 Rasool, S., 3BV.2.41
 Ratschinski, I., 3AO.7.2
 Rau, B., 5CV.4.29
 Rau, U., 2DV.1.67
 Rauer, M., 2CO.12.1
 Rauschen, I., 5BO.7.5
 Raval, M.C., 2CV.2.83
 Ravanbach, B., 6CV.1.9
 Ravi, S., 3CO.6.3
 Ray, A., 4AV.2.53, 1BV.3.41
 Raybaud, B., 6BV.4.12
 Razera, R.A.Z., 3CO.8.1, 3CO.5.3
 Razongles, G., 3BV.1.6
 Razuvaev, A., 1BV.3.50
 Razzaq, A., 2CO.9.3, 2DV.1.66

- Rebai, A., 1AO.2.5, 1AO.2.4
 Recamán Payo, M., 2DV.1.71
 Recktenwald, G., 4AV.2.29
 Reeb, L., 4CO.1.2
 Regreny, P., 3BV.2.50
 Reichel, C., 2BO.3.4
 Reichmuth, S.K., 3CP.1.3
 Reid, D., 4AV.2.48, 4AV.2.56
 Reijenga, T., 6DO.8.4
 Reil, F., 4BO.13.2
 Reimann, C., 2CV.2.17, 2CV.2.19, 2AO.5.2, 2CV.2.16
 Rein, S., 2CV.2.98, 2CV.2.44
 Reinartz, K., 5BO.7.5
 Reinders, A.H.M.E., 5CV.4.13, 6EO.2.1, 5CV.4.27, 6CO.15.2, 5DP.2.2
 Reindl, T., 5CV.3.15, 5BO.7.4, 5DO.1.4
 Reise, C., 4AV.2.15, 5CV.3.30
 Ren, K., 2DO.6.6
 Ren, Y., 2CV.2.72
 Renard, C., 3BV.2.49
 Randler, L.C., 4AV.1.8, 2DV.1.3, 2BO.4.2
 Rennhofer, M., 5CV.3.3, 3BV.1.6, 5CV.4.29, 3BV.1.42
 Rentsch, J., 2CV.2.74, 2CO.10.3, 2DV.1.51, 2EO.1.1, 2EO.1.4
 Repmann, T., 3BV.1.62
 Resch, A., 5CV.3.66
 Resch-Fauster, K., 4AV.1.16
 Resende, J., 3BV.1.34
 Reuna, J., 3BV.1.50
 Revuelta, G., 7DO.7.6
 Reyes-Figueroa, P., 4AV.2.12, 3BV.1.25
 Reyhe, C., 4CO.3.1
 Rezaei, N., 3AO.8.2
 Rhourri, M., 5BO.7.2
 Ribeyron, P.-J., 2DV.1.35, 2CO.10.6, 2DV.1.52
 Richards, B.S., 3CO.7.4
 Richter, S., 2CV.2.50
 Richter, A., 2CV.2.74
 Richter, A., 2BP.1.3, 2CV.2.56, 2EO.1.4
 Richter, M., 5BO.5.1
 Rico, E., 7DV.2.36, 6BV.4.13, 6DO.8.4
 Ridoy, A.I., 2DV.1.1
 Riechelmann, S., 4AV.2.5, 4AV.2.11
 Riedel, N., 5CV.4.37
 Riekehr, L., 3AO.8.3
 Riepe, S., 2CV.2.15, 2AO.5.3
 Rigole, P.-J., 7DO.7.3
 Rimmelspacher, L., 4AV.2.27
 Rinio, M., 3BV.2.55
 Ríos - Ramírez, J.J., 3BV.2.27
 Ritzen, M., 6BV.4.7
 Riva, R., 2CV.2.23
 Rivalland, A., 3BV.2.45
 Rives, S., 3BV.2.53
 Robin, H., 6EO.2.2, 6DO.9.4
 Robledo, J., 5CV.3.34
 Roca, F., 3BV.1.6
 Roca i Cabarrocas, P., 2DV.1.7, 2DV.1.21
 Roder, S., 2CV.2.100
 Rodiet, C., 1BV.3.11
 Rodriguez, M.J., 4AV.1.31
 Rodriguez, D.J., 6CV.1.14
 Rodriguez, X., 5CV.4.33
 Rodríguez, E., 5CO.13.4
 Rodríguez, H., 1BV.3.7
 Roest, S., 4AV.2.16
 Rojas Tarazona, F.E., 1BV.3.7
 Román Medina, E., 7EO.3.2
 Romano, A., 3BV.1.6
 Romanyuk, V.R., 1BV.3.42
 Romanyuk, Y.E., 3AO.7.6
 Romanyuk, O., 3BV.2.47
 Romeo, A., 3BV.1.21, 1BV.3.36
 Romer, O., 2CV.2.101
 Romer, P., 4BO.11.1, 4CO.4.3
 Romer, U., 2DV.1.72
 Roosen-Melsen, D., 3AO.7.6
 Roshchina, N.M., 1BV.3.42
 Rouas, Y., 5BO.7.2
 Rougieux, F.E., 2DO.5.4, 2CV.2.3, 2CV.2.7, 2AO.4.1
 Rouillard, Y., 3BV.1.53
 Roujol, Y., 5CV.3.64
 Rousseau, F., 3BV.2.19
 Rousset, J., 1AO.2.5, 3BV.2.22, 3BV.2.53, 3CO.5.2, 1AO.2.4
 Roux, C., 2CO.10.6, 2DV.1.52, 2DV.1.56, 2CO.11.6
 Roux, L., 2DO.5.3, 2BO.3.3
 Roux, C., 3CO.6.4, 3CO.5.5, 3BV.2.15
 Roux, J.J., 6BV.4.12
 Röver, I., 4AV.2.52
 Roy, S., 4CO.3.4, 4AV.2.22
 Roy, D., 1BV.3.37
 Roy, S., 4AV.1.12
 Roy-Choudhury, K., 4AV.1.30
 Royes Moreno, A., 5CV.4.14
 Rubio Rico, A., 6CO.16.4
 Rubio Rico, A., 6CO.16.4
 Rudolph, T., 2BP.1.4
 Rudolph, D., 2DV.1.24
 Rudolph, M., 4CO.3.5, 2EO.1.6
 Ruffini, F., 5CV.3.14
 Rühle, U., 7DV.2.36
 Ruhstaller, B., 3CO.5.3
 Ruiz, D., 7DO.7.3
 Ruiz, R., 7DV.2.33
 Rummens, F., 4AV.1.29
 Rusli, R., 2DV.1.20
 Rüter, R., 6BV.4.8, 5BO.6.4, 7DO.7.1, 7DV.2.8, 5CV.4.6, 5CV.3.15, 5DO.1.4
 Ruttens, H., 7DV.2.5
 Ryu, E., 6BV.4.27
 Ryu, Y., 6BV.4.36
- S**
- Saal, J., 4AV.2.24
 Sabia, G., 4AV.2.55
 Sacchetti, A., 2DV.1.54
 Sadewasser, S., 3AO.9.3, 3AO.8.1
 Sadri, H., 5CO.14.2
 Saelens, D., 6DO.8.1
 Safieh, A., 4AV.2.21
 Safran, G., 4AV.2.3, 4AV.1.7
 Sahli, F., 2BO.4.6, 3CO.8.1, 3CO.5.3
 Sai, H., 2DV.1.37, 2CO.10.5
 Said, A., 5BO.7.2
 Saint-Cast, P., 2DO.6.2
 Saint-Drenan, Y.-M., 5CV.4.40
 Saito, K., 2DV.1.38
 Sakurai, K., 4AV.1.46
 Saladukha, V.A., 1AO.3.3, 1BV.3.38
 Salcedo, J.C., 1BV.3.7
 Sali, S., 2DV.1.25
 Saliba, M., 3CO.5.6
 Saliou, K., 2CV.2.55
 Salis, E., 3BV.1.6, 7DO.7.4, 3CP.1.4
 Salloum, M., 5CV.3.6
 Salomé, P.M.P., 3AO.8.1
 Salomon, O., 3BV.1.7
 Saludes, S., 7DV.2.33
 Salza, E., 3BV.2.61
 Samadi, A., 2AO.4.3

- Samantilleke, A., 1BO.10.5
 Sample, T., 4AV.2.18, 4AV.2.19, 4CO.2.6, 7DO.7.4
 Samundsett, C., 2CV.2.3, 2CO.12.4
 Sandre, E., 4AV.1.18
 Sanfilippo, A., 7DV.2.35
 Sans, J., 2CV.2.19
 Santamaria Lancia, A.A., 5CV.3.3, 5CV.4.37
 Santos, J.D., 4AV.2.50, 4AV.2.6
 Sanz, C., 5CV.4.21
 Sanz, A., 5CV.3.7
 Sanz Martinez, A., 6BV.4.7, 6DO.8.4
 Saretta, E., 6BV.4.6, 7DV.2.1
 Sasaki, R., 2AO.6.4
 Sasidharan, S., 2CV.2.99
 Satharasinghe, A., 1BO.9.2
 Sato, Y., 2CO.10.5
 Satou, A., 6BV.4.18, 6EO.2.3
 Sauer-Stieglitz, R., 2CO.9.6
 Sauvage, F., 7DV.2.16
 Savchenko, I., 3BV.1.25
 Savoy, A., 2BO.4.6
 Savych, I., 5CV.4.33
 Sayritupac, J., 5CV.4.15
 Scaccabarozzi, A., 1BO.10.1, 3BV.2.50
 Scardera, G., 2DO.6.5, 2CV.2.82
 Schaeffer, G.J., 5CV.3.41
 Schäfer, S., 2BO.2.1
 Schäfer, S., 3AO.9.4
 Schäfer, R., 2CV.2.96
 Schäffler, R., 3BV.1.7
 Schaper, M., 2BP.1.4
 Scheer, R., 3AO.9.4, 3BV.2.11, 1BV.3.20, 3AO.8.4, 3BV.2.13, 3BV.1.44
 Scheerlinck, S., 5DP.2.2, 6BV.4.4, 5BO.6.3
 Scheffel, B., 2CV.2.92
 Schenk, S., 2CV.2.97
 Schermer, J.J., 5CV.3.62
 Schielly, S., 4AV.2.39
 Schiessl, A., 6EO.2.4
 Schiffel, S., 6BV.4.5
 Schiller, C., 4AV.1.8
 Schindler, S., 5CV.3.43, 1BO.9.5, 4BO.13.2
 Schindler, F., 2AO.5.3
 Schineller, B., 3BV.1.57
 Schinke, C., 4BO.11.3
 Schioppo, R., 5CV.4.16
 Schlatmann, R., 4AV.2.12, 2CO.9.4, 2CO.11.2
 Schlegel, R., 2CV.2.102
 Schlegl, T., 7DV.2.38
 Schlezinger, A., 2CV.2.22
 Schlosser, V., 3BV.1.42
 Schmager, R., 3CO.7.4
 Schmid, A., 2CV.2.98, 4BO.12.2
 Schmid, E., 7DV.2.33
 Schmidt, J., 2CV.2.4, 2CV.2.101, 2CO.9.6, 2AO.4.4
 Schmidt, T., 6CO.16.1, 5DO.2.1
 Schmidt, L., 4AV.1.36
 Schmidt, T., 5DO.2.1
 Schmitt, E., 6BV.4.2
 Schnabel, E., 4AV.2.15, 4CO.3.3
 Schneble, N., 4AV.2.57
 Schneider, J., 4CO.3.1
 Schneider, T., 3BV.1.44
 Schneider, K., 7DO.7.1, 7DV.2.8
 Schneider, R., 3AO.9.4
 Schneider, R., 3BV.2.20
 Schneiderlöchner, E., 2DV.1.63
 Schneikart, A., 3BV.1.7
 Schnepf, J., 5DO.3.2, 4CO.4.1
 Schoerg, F., 2DV.1.65
 Schön, J., 2BO.1.3, 2CO.12.5
 Schott, T., 4AV.2.37, 5CO.13.5
 Schreiblemüller, C., 6EO.2.4
 Schroll, G., 2CV.2.19
 Schubbert, C., 3AO.7.1, 3BV.1.25
 Schubert, M.C., 2CV.2.56, 2AO.4.1
 Schubert, G., 6CV.1.21
 Schuck, K., 2AO.5.2
 Schulte, M., 7DO.7.3
 Schulte, K.L., 3BO.8.3
 Schulte-Huxel, H., 4BO.11.3, 6EO.2.4, 2BO.2.6
 Schulz, P., 3BV.2.3, 3BV.2.60
 Schulze, R.N., 4CO.4.4
 Schüpbach, E., 4AV.2.39, 5CO.13.5, 7DV.2.22
 Schuster, C.S., 1BV.3.12
 Schuster, M., 3BV.1.25
 Schüttauf, J.-W., 2BP.1.2, 2CO.10.2
 Schutz, P., 2DV.1.2
 Schütze, M., 2AO.4.6
 Schwabedissen, A., 2BP.1.4
 Schwanke, S., 2CV.2.19, 2AO.5.2
 Schwark, M., 4AV.1.7
 Schweiger, M., 4AV.2.27, 4AV.2.24
 Schweiger, M., 3AO.9.4
 Schweigstill, T., 2BO.4.2
 Schweizer, S., 2CV.2.96
 Sciuto, M., 2DV.1.35
 Scotto, E., 6EP.1.2
 Scragg, J.J.S., 3BV.1.32
 Seeger, J., 3AO.9.4
 Segawa, H., 3CO.5.4
 Segon, V., 7DV.2.5, 7DV.2.33
 Seidel, J., 3BV.2.29
 Seif, J.P., 2CO.12.4
 Seidl, C., 4AV.2.36, 5CO.13.4, 4DO.4.3
 Sekar, K., 3BV.2.27
 Sekkat, A., 3BV.1.34, 1BV.3.23
 Selj, J.H., 5CV.4.25, 5CV.4.30, 6BV.4.31, 6DO.9.2, 5BO.5.4
 Semenov, A.V., 2DV.1.57
 Semiz, E., 2CV.2.81
 Sen, C., 2AO.4.3
 Senaud, L.-L., 2CO.10.1, 4CO.3.2, 2BP.1.2, 2CO.12.6, 2CO.10.2
 Sengar, B.S., 3BV.1.17
 Sengupta, M., 5DO.2.3, 5DO.1.6
 Senkader, S., 2CO.10.1
 Sennova, N., 2CV.2.20
 Sera, D., 4AV.1.6, 4CO.1.3, 5CV.4.37
 Serebryakov, A.E., 2CV.2.18
 Serenelli, L., 3BV.2.61
 Sergeev, O.V., 2CV.2.102
 Serra, L., 6EO.2.2
 Sessa, T., 4AV.2.55
 Shahid, J., 4AV.1.20
 Shakhray, I., 2DV.1.44, 4AV.1.22, 2DV.1.57, 5CV.4.34, 2DV.1.63
 Shalev, G., 2CV.2.65
 Shammugam, S., 7DV.2.38
 Shan, H., 3BV.1.62
 Shanmugam, V., 2EO.1.5
 Shargaieva, O., 3BV.2.6
 Sharma, R., 2DV.1.71
 Shen, H., 2DV.1.60
 Shen, Q., 3CO.5.4
 Shen, H., 2EO.1.2
 Shen, K., 1BV.3.47
 Sheng, J., 2CV.2.75
 Shetty, K., 5BO.5.5

- Shi, J., 2CV.2.79
 Shi, J., 2CO.11.3
 Shibata, H., 2DV.1.42, 3AO.9.1
 Shimizu, Y., 2AO.5.5
 Shimoyama, T., 3BV.1.39
 Shimura, S., 6CV.1.15, 6EO.2.6
 Shin, W. S., 3BV.2.41
 Shin, M., 2CV.2.31, 2AO.6.6
 Shin, D.H., 3BV.1.4, 2CV.2.59, 1BV.3.30, 3BV.1.37
 Shin, W.G., 2CV.2.33
 Shin, B., 1AO.1.4
 Shin, S., 3AO.7.5
 Shin, C.H., 2DV.1.22
 Shin, D., 6BV.4.20
 Shirasawa, K., 2DV.1.5, 2CV.2.61
 Shoji, Y., 1AP.1.1
 Shu, X., 2DV.1.39
 Shu, Z., 2DV.1.22
 Shvarts, M.Z., 1AO.1.5, 3BV.1.55, 5CV.3.67
 Sicot, L., 2DV.1.35
 Siddharth, G., 3BV.1.17
 Siebentritt, S., 3BV.1.36
 Siefer, G., 3CP.1.3, 3BV.1.57
 Siepchen, B., 3BV.1.38
 Siess, C., 4AV.1.32
 Šilenas, A., 1BV.3.2
 Silva, P., 3CO.6.3
 Silvestre, S., 5CV.3.38
 Sim, Y.H., 3CO.7.2
 Sim, Y.H.C., 1BO.9.1
 Simon, J.J., 3BV.2.36
 Simon, J., 3BO.8.3
 Simor, M., 3CO.7.3, 3AO.8.1
 Sinapis, K., 6DO.9.1
 Singareddy, A., 1BV.3.48
 Singh, S., 2BO.1.4
 Singh, A., 1BV.3.39
 Singh, S., 2DV.1.46
 Singh, R., 2BO.3.4
 Singh, K., 2DV.1.46
 Singh, A., 2DV.1.64
 Singh, A.K., 4AV.2.31
 Sio, H.C., 2BP.1.1, 2CV.2.5
 Širmulis, E., 1BV.3.2
 Sittinger, V., 2DV.1.65
 Sivaramakrishnan Radhakrishna, H., 2CO.10.1, 2CO.12.6, 2DV.1.71, 2DV.1.36, 2DV.1.66, 2DV.1.68
 Skomedal, A., 5CV.4.30, 5BO.5.4
 Slikker, T., 4AV.2.16
 Slimane, M., 2DV.1.6
 Slivkin, E.V., 2CV.2.14
 Smertenko, P.S., 1BV.3.42
 Smole, F., 2DV.1.47
 Sng, E., 4AV.1.12
 Sodabanlu, H., 3BV.1.46, 3BO.8.4
 Sode, M., 3AO.7.1
 Söderström, K., 6BV.4.3
 Soeriyadi, A.H., 2CO.11.3
 Solano, J.C., 5CO.14.4
 Solard, J., 3BV.2.25
 Son, H.J., 4AV.2.33
 Son, W., 4DO.4.3
 Søndena, C.R., 2CV.2.6, 2DV.1.9, 2CV.2.9, 2AO.4.2, 2CV.2.11
 Song, D., 2CV.2.79
 Song, H.-E., 2DV.1.11, 4AV.1.59
 Song, C.E., 3BV.2.41
 Song, S., 3BV.1.4, 2CV.2.59, 3AO.7.5
 Sonnleitner, H., 4BO.13.3
 Sood, A. K., 1BV.3.22
 Sood, M., 3BV.1.36
 Sopiha, K., 3BV.1.32
 Soppe, W.J., 3BV.1.6
 Soudris, D., 5DP.2.2
 Sovetkin, E., 5CV.4.29
 Spadoni, A., 2DV.1.50
 Spagnuolo, G., 5CV.4.12
 Spataru, S.V., 4AV.1.6, 4CO.1.3, 5CV.4.37
 Späth, B., 3BV.1.38
 Speranza, R., 1AO.3.4
 Sperlich, H.-P., 2CV.2.50
 Spiering, S., 3BV.1.10
 Spinardi, A., 3BV.1.27
 Sporleder, K., 2CO.12.2
 Spribille, A., 2DV.1.3, 2BO.4.2
 Stahr, F., 2DV.1.43
 Stang, J.-C., 2CO.12.6
 Stannowski, B., 2CO.10.1, 6EO.2.4, 2CO.9.4, 2CO.11.2, 3CP.1.2
 Stapf, A., 2CV.2.78
 Stassen, P., 7DV.2.36
 Stauch, C., 1AO.3.1
 Stauch, A., 7DV.2.17
 Stavrou, A., 4DO.4.1, 7DV.2.39
 Steckemetz, S., 2DO.5.1
 Stecklum, S., 4AV.1.8
 Steffens, H., 7DV.2.38
 Steidl, M., 1AO.1.2
 Steijvers, H., 3BV.1.18, 3AO.7.6
 Stein, J.S., 5BO.5.1, 6CO.15.5, 4AV.2.14, 5CV.3.32
 Stein, M., 6EO.2.4
 Steiner, M., 5DP.2.4
 Steinhäuser, B., 2BO.2.3, 2BP.1.3, 2CV.2.56, 2EO.1.4
 Stellbogen, D., 5DO.3.2
 Stensrud Marstein, E., 5CV.4.5, 2AO.4.2, 6DO.9.2, 5BO.5.4
 Stenzel, F., 2BP.1.4
 Stevens, M., 3BO.8.6
 Stevens, L., 1AO.3.1
 Steyaert, E., 7DV.2.5
 Stocks, M., 2DV.1.49
 Stodolny, M.K., 2BO.1.6, 2BO.4.3, 2BO.2.5
 Stolt, L., 6BV.4.25, 3AO.7.2
 Stolz, P., 4DO.4.5
 Stölzel, M., 3AO.7.1
 Stolzenburg, H., 2DO.6.2
 Strahm, B., 2CO.10.1, 2CV.2.74, 2BO.4.5, 4CO.3.2, 2CO.12.6, 2EO.1.3
 Strasser, T., 5CO.13.4
 Sträter, H., 4AV.2.5
 Strobel, C., 2DV.1.43
 Strömberg, A., 3BV.2.55
 Stuchlík, J., 2AO.6.5
 Stuckelberger, J., 2BO.2.2
 Stucki, M., 4DO.4.4
 Stueve, W., 5CV.3.10, 5CV.3.17
 Sturm, F., 2AO.5.2
 Subramaniam, V., 3BV.2.27
 Suchet, D., 1AO.2.4
 Sugaya, T., 3BV.1.46, 1AP.1.1
 Sugibuchi, K., 7DV.2.23
 Sugimoto, H., 3BV.1.64
 Sugiyama, M., 3BV.1.46, 3BV.1.48, 3BO.8.4, 3BV.1.52
 Suitner, H., 4AV.2.55
 Suleymanov, S.X., 1BV.3.38
 Suman, V., 3BV.1.24
 Sumita, I., 2DV.1.14, 2DV.1.19
 Sun, Y.-T., 3BV.2.55
 Sun, C., 2CV.2.2, 2CV.2.3, 2AO.4.1
 Sun, Q., 1BV.3.14
 Sun, K., 3AO.8.6
 Sun, H., 3AO.8.6
 Supplie, O., 3BV.2.47, 3BV.1.52

Surguy, P., 6DO.8.4
 Süss, J., 6EO.2.4
 Sutejo, A., 2CV.2.76
 Sutterlueti, J., 5BO.5.2, 5CV.4.35
 Sutton, G.J.M., 4AV.2.10
 Suvorov, D.V., 2CV.2.14, 2CV.2.18
 Sužiedelis, A., 1BV.3.2
 Suzuki, T., 4BO.12.5
 Švedas, V., 1BV.3.2
 Swaminathan, R., 4AV.1.12
 Syre Wiig, M., 2AO.4.2, 2CV.2.11
 Syu, H.-J., 1BV.3.35
 Szlufcik, J., 2BO.1.4, 1AP.1.2, 2CO.9.3, 2DV.1.66
 Szyszka, B., 4AV.2.12, 2CO.9.4

T

Tabet Aoul, K.A., 6BV.4.22
 Taguchi, N., 3AO.9.1
 Tajima, K., 2AO.5.5, 2CV.2.15
 Takamura, T., 2DV.1.38
 Takamura, N., 6BV.4.26
 Takato, H., 2DV.1.5, 2CV.2.61, 1AP.1.1
 Takeda, Y., 2CV.2.62
 Takei, K., 3AO.8.1
 Tallián, M., 2CV.2.74
 Tamaro, M., 4AV.2.55
 Tan, X., 2DO.5.4
 Tan, K.H., 5CV.3.53
 Tan, M., 4BO.12.3
 Tanabe, M., 2DV.1.37, 2CO.10.5
 Tanahashi, T., 4AV.1.46
 Tanahashi, K., 2CV.2.61
 Tang, Z., 3BV.2.26
 Taniguchi, I., 6CV.1.16, 6CO.15.1
 Tannous, S., 4AV.2.49
 Tanvir, N., 1BV.3.44
 Tarabrin, D.Y., 2CV.2.14
 Tarasov, V., 2DV.1.41
 Taretto, K., 3BV.2.1
 Taubitz, C., 2AO.4.6
 Tavakoli, M.M., 3BV.2.35
 Tayagaki, T., 1AP.1.1
 Taylor, N., 7DO.7.4
 Tchenka, A., 1BV.3.45
 Tchernycheva, M., 3BV.2.50
 Tee, J.Z., 5CV.3.53
 Teixeira, R., 7DV.2.31
 Tejada, A., 3CO.7.6
 Telle, J.-S., 6CO.16.1
 Temmler, J., 2CO.10.3
 Tempel, S.H., 2CO.9.2
 Tepner, S., 2DO.5.1
 Teppe, A., 2CV.2.83
 Terheiden, B., 7DV.2.1
 Terrom, G., 5CV.3.35
 Terukov, E.I., 2DV.1.44, 2DV.1.57, 2DV.1.63
 Teßmann, C., 2CV.2.87
 Teubner, J., 5BO.7.6
 Teunissen, E., 6BV.4.21
 Theelen, M., 3BV.1.18, 5CV.4.29
 Theelen, K., 6BV.4.25
 Theeuwes, R.J., 2CO.9.2
 Theocharides, S., 5CV.3.11
 Theristis, M., 5CV.3.3, 5BO.5.2, 5CV.3.11, 4AV.1.42
 Theys, B., 3BV.1.12
 Thierry, E., 5CV.3.18
 Thøgersen, A., 2CV.2.9
 Thomere, A., 3AO.8.5
 Thönnies, A., 5CV.4.38
 Thony, P., 6BV.4.12, 6BV.4.2
 Thorsteinsson, S., 5CV.4.37
 Thumsch, M., 2DV.1.63
 Tillmann, P., 3CO.7.6
 Timm, C., 1AO.1.2
 Timò, G., 3BV.1.57
 Ting, S.-Y., 4AV.2.2
 Titov, A., 5CV.4.34
 Tiwari, A.N., 3AO.7.3, 3BV.1.26
 Tjendgdrawira, C., 5CV.3.34
 Toledo Arias, C.A., 3CP.1.4
 Tomasi, A., 2CO.10.1
 Tomassini, M., 2CO.9.5
 Tomioka, R., 2CV.2.62
 Tong, J., 2DV.1.17, 2DV.1.49
 Tonouchi, M., 2CV.2.61
 Tool, K.J.J., 2CO.12.3
 Topič, M., 4BO.13.6, 4CO.4.2, 3BV.1.9, 4AV.1.17, 2DV.1.47, 6CV.1.20, 7DV.2.1
 Torchio, P., 3CO.7.1
 Torda, B., 2CV.2.87
 Torregrosa, F., 2DV.1.2, 2DO.5.3, 2BO.3.3
 Torres, O.G., 3BV.2.16
 Torres Sevilla, G., 3AO.7.6
 Toth, P., 5CV.4.36
 Touihri, S., 3CO.7.1
 Touré, M., 3BV.2.24
 Tournet, J., 3BV.1.53
 Tournié, E., 3BV.1.53
 Tous, L., 2BO.1.4
 Toutain, E., 5CO.14.1
 Trad-Khodja, A., 2DV.1.73
 Tran, S., 2CV.2.89
 Tran, Q.T., 6CV.1.7, 5CV.3.40, 6CO.16.3, 6CV.1.4
 Traunmüller, W., 5DO.2.5
 Tregulov, V., 2CV.2.8
 Trempa, M., 2CV.2.17, 2CV.2.19, 2AO.5.2
 Trespidi, F., 3BV.1.57
 Trifiletti, V., 3BV.1.27
 Trigo, J.F., 3BV.1.6
 Tripathy, M.R., 3BV.2.30
 Trötschler, T., 2AO.5.3
 Trube, J., 2EO.1.1
 Trupke, T., 4CO.1.4
 Tsai, M.-A., 2CV.2.42, 4AV.1.19
 Tsanakas, J.A., 4DO.4.6, 4AV.2.17
 Tu, L.-H., 3BV.1.11
 Tucci, M., 3BV.2.61
 Tucci, M., 5CV.3.14
 Tucher, N., 1AO.3.1, 3BV.2.46, 2BP.1.3
 Tugaenko, V., 1BV.3.50
 Tuinstra, S., 5CO.14.3
 Tukiainen, A., 3BV.1.50
 Tummaliéh, A., 3BV.1.52
 Tummers, P., 4CO.4.5, 4AV.1.50
 Tuomiranta, A., 3CO.7.5
 Turan, R., 2DV.1.4, 2DV.1.55
 Turcu, M., 2BO.2.6
 Turek, M., 2CO.12.2, 4BO.13.2
 Türkay, D., 3BV.1.35
 Turpin, M., 5DO.2.6
 Turren Cruz, S.H., 3CO.5.6
 Tyutyundzhiev, N., 7DO.7.6
 Tzavaras, A., 4CO.2.1
 Tzou, Y.-Y., 5CV.3.57

U

Ubukata, A., 3BV.1.46
 Ueno, Y., 2DV.1.42
 Újvári, G., 4AV.1.4, 4AV.1.7, 6BV.4.7
 Ulbikaite, V., 7DV.2.1
 Ulbikas, J., 7DV.2.1
 Ulbrich, C., 4AV.2.12, 3BV.1.25
 Ulyashin, A.G., 7DV.2.1

Unger, E., 7DO.7.6, 3CO.7.6, 3BV.2.6
 Unold, T., 3AO.9.4
 Upadhaya, D.C., 3BV.2.30
 Urraca Valle, R., 5CV.3.7
 Usami, N., 2CV.2.45, 2AO.5.5, 2CV.2.15, 2AO.5.3
 Usatii, I., 2DV.1.54, 3BV.2.54
 Utsunomiya, S., 2DV.1.5

V

Vaduda, D., 5CV.3.34
 Vagapova, N.T., 5CV.3.67
 Vaicikauskas, V., 1BV.3.2
 Vaillon, R., 3BV.1.53
 Valckenborg, R.M.E., 6BV.4.7, 4CO.2.2
 Valencia, D., 6DO.8.4
 Valentini, M., 3BV.2.61
 Valkealahti, S., 5CV.4.12, 5CV.4.8, 5CV.4.1
 Valle, N., 2BO.4.6
 Valverde, A., 4AV.2.6
 Van Aken, B.B., 4CO.2.3, 4CO.2.2, 2CO.12.3, 5DO.3.5
 van de Kar, R., 5CO.14.3
 van de Loo, B.W.H., 2BO.1.6
 van Deelen, J., 3BV.1.9, 3AO.8.1
 van den Brand, J., 6BV.4.7
 Van den Brande, N., 1BV.3.25
 van den Bruele, F.J., 3AO.7.6
 van den Dobbelsesteen, A., 6DO.8.3
 van der Heide, A.S.H., 4DO.4.6, 4AV.2.17, 5DP.2.2, 1AP.1.2
 van der Poel, E., 6BV.4.21
 van der Vleuten, M., 3CO.7.3
 van der Werf, D., 6DO.9.1
 Van der Woude, D., 5CV.3.3
 Van Durme, K., 1BV.3.25

Van Dyck, R., 1AP.1.2
 van Dyk, E.E., 2CV.2.51, 5BO.6.2
 van Erven, R.A.J.M., 4AV.1.39, 2CV.2.102
 van Hooff, T., 6DO.8.1
 Van Iseghem, M., 5CV.4.3, 5BO.5.1, 4DP.1.2
 van Leest, R., 3CP.1.3
 van Maris, V., 3AO.9.4
 van Mechelen, X., 5CV.4.7
 Van Mele, B., 1BV.3.25
 van Nierop y Sanchez, C., 1BO.9.6
 van Nieuwenhoven, Q., 6BV.4.4, 5BO.6.3
 van Sark, W.G.J.H.M., 5CV.4.13, 5CV.3.13, 5BO.5.1, 6BV.4.21, 5DO.3.6
 van Slooten, F., 5CV.4.13
 van Wijk, A.J.M., 6CO.15.6
 Vandervelde, T.E., 3BO.8.6
 Vanstraelen, L., 7DV.2.5
 Varache, R., 2CO.10.6, 2DV.1.56, 2DV.1.59
 Vardanyan, A.A., 5CV.4.11
 Vardanyan, R.R., 5CV.3.65
 Varshney, U., 2AO.4.3, 2CV.2.82
 Vartiainen, E., 7EO.3.2
 Vaskelien, K., 7DV.2.5
 Vastmans, L., 1AP.1.2
 Vasudevan, R., 2CO.10.1, 2DV.1.52
 Vauche, L., 3CO.8.3
 Vauthelin, A., 3BV.1.53
 Veau, A., 2DV.1.2, 2DO.5.3, 2BO.3.3
 Veeken, T.P.N., 2CV.2.60
 Veenstra, S.C., 3CO.7.3, 3CO.6.6, 6BV.4.4, 3CO.8.5
 Vega de Seoane, J.M., 6BV.4.13, 1BV.3.51

Vehse, M., 6BV.4.23, 6DO.9.6, 2CV.2.102
 Veinberg Vidal, E., 3CO.8.3
 Veirman, J., 2AO.5.6, 2DV.1.59
 Vela, N., 5CV.4.21, 5DO.1.1, 5CV.4.45
 Veldhuizen, L.W., 4AV.1.39, 2CV.2.102
 Velispahic, E., 2CV.2.24
 Venema, P.R., 2BO.1.6
 Verbitskiy, V.N., 2DV.1.44
 Vergnault, E., 6BV.4.12
 Verhees, W., 3CO.6.6
 Verissimo Mesquita, L., 4BO.13.4
 Verlinden, P.J., 2EO.1.2
 Verma, A., 3BV.2.20
 Vermang, B., 3AO.8.1
 Vernay, C., 5CO.13.2
 Veronese, E., 7EO.3.4
 Versluis, F., 2CO.10.1
 Vettori, M., 3BV.2.50
 Vicari Stefani, B., 2CO.11.3
 Victoria, M., 7EP.2.1
 Vidal de Oliveira, A.K., 5BO.6.4, 5CV.4.6
 Vidal Lorbada, R., 3BV.1.7, 3BV.1.3, 3BV.1.22
 Vidaurrazaga Temez, I., 4DO.4.3
 Vignal, R., 3AO.8.1
 Vignerot, J., 3BV.1.12, 3BV.1.13
 Vikhrov, S.P., 2CV.2.12, 2CV.2.47
 Vincent, L., 3BV.2.49
 Virgus, Y., 1AO.1.4
 Viriden, K., 7DV.2.36
 Virtuani, A., 4BO.12.4, 6DO.8.2, 4AV.1.34, 5CV.4.33
 Virtuoso, J., 3AO.9.3
 Vishnyakov, N., 2CV.2.12, 2CV.2.47

Visoly-Fisher, I., 3CO.7.6
 Visser, L., 5CV.3.13
 Vlieg, E., 5CV.3.62
 Voarino, P., 5CV.3.3, 5CV.3.64
 Vogt, M.R., 4BO.11.3
 Vogt, L., 4CO.2.4
 Voicu, N.E., 4CO.3.2, 4CO.4.5, 4AV.1.50
 Volk, M., 4AV.2.57
 Völker, R., 6CV.1.1
 von Maydell, K., 6CV.1.9, 6CO.16.1, 6CV.1.17
 von Wenckstern, H., 1BV.3.20
 Voronko, Y., 4BO.13.3, 4AV.1.25
 Voroshazi, E., 2CO.10.1, 4DO.4.6, 4AV.2.17, 5DP.2.2, 1AP.1.2
 Vorster, F.J., 2CV.2.51
 Vroon, Z., 3AO.8.2
 Vuichard, P., 7DV.2.17
 Vukovic, M., 5CV.4.46

W

Waack, E., 3BV.1.25
 Wächter, R., 3AO.9.3, 3BV.1.62
 Wada, T., 3BV.1.20
 Wägele, L.A., 1BV.3.20
 Wagner, R., 6BV.4.28
 Wagner, P., 2CO.12.6
 Wahl, S., 2CV.2.96
 Wakita, R., 2CV.2.53
 Waleska, P., 2CV.2.97
 Walla, T., 7DO.7.3
 Walter, D., 2DV.1.49
 Walter, D.C., 2CV.2.101, 2AO.4.4
 Walter, T., 3BV.1.7, 3BV.1.3, 3BV.1.22
 Walter, A., 3CO.8.6, 3CO.8.1
 Wan, Y., 2AO.6.3

- Wan, Y., 2CV.2.72
 Wan, K.-T., 4AV.2.30
 Wang, X.-S., 2CV.2.82
 Wang, E.C., 2CO.9.4, 2CO.11.2
 Wang, Z., 2EO.1.2
 Wang, H., 2CV.2.79
 Wang, W.J., 2BO.1.2, 2CV.2.38
 Wang, G.H., 2CV.2.38
 Wang, S., 4AV.2.51
 Wang, Y., 2CV.2.79
 Wang, X., 4CO.4.4
 Wang, Y., 4AV.2.30
 Wang, W., 2CV.2.75
 Wang, H., 1BV.3.14
 Wang, H., 4AV.2.8, 2DV.1.16
 Wang, Y., 4AV.2.28
 Wang, W., 2AO.6.3
 Wang, Y.-C., 1BV.3.1
 Wang, Y., 3BV.2.26
 Wang, S., 2DO.6.5, 2CV.2.82
 Wang, Y., 2EO.1.2
 Wang, J., 3CO.6.1
 Wang, S., 4BO.12.3
 Wang, L., 2EO.1.2
 Wang, D., 2AO.5.4
 Wang, H., 2DV.1.39
 Wang, K., 4DO.4.6
 Wang, Y., 2CV.2.72
 Wang, J., 2CO.11.5
 Wang, Y., 2CV.2.85
 Wantier, A., 6CV.1.2
 Wapperom, S., 6DO.8.3
 Warmers, R., 2CV.2.102
 Warta, W., 3BV.1.6
 Wasmer, S., 2DO.5.6
 Watanabe, Y., 6BV.4.24
 Watanabe, K., 3BV.1.46, 3BV.1.48, 3BO.8.4
 Watanabe, K., 2CV.2.53
 Watari, D., 6CV.1.16, 6CO.15.1
 Weber, T., 5CV.4.29, 4AV.1.36
 Weber, A., 3AO.7.1, 3BV.1.25
 Weber, R., 2DO.5.5
 Wecker, R., 6EO.2.4
 Weeber, A.W., 5CV.4.29, 2CO.12.3, 2DV.1.62, 2BO.4.1
 Weegink, R., 1AO.2.1
 Wehrspohn, R.B., 2DV.1.45
 Wei, Q., 2DV.1.8, 2DV.1.9, 2DV.1.18
 Wei, K., 5BO.5.3
 Weigand, D., 2DV.1.67
 Weigand, W., 2CV.2.2, 2CO.11.3
 Weigel, O., 6CV.1.9
 Weinhardt, L., 3AO.9.4
 Weinreich, B., 4CO.4.1
 Weiß, K.-A., 4AV.1.17, 4AV.2.47, 4AV.1.26, 4AV.1.32
 Weiss, I., 7DV.2.36, 6BV.4.13, 6DO.8.4, 7DV.2.1
 Weiss, C., 2AO.6.2
 Welatta, F., 3BV.1.61
 Wellacher, M., 4AV.2.46
 Wellens, C., 1AO.3.1
 Wellmann, P., 3BV.1.25
 Welsler, R., 1BV.3.22
 Wen, J.-F., 4AV.1.3
 Wen, C.-C., 2DV.1.13, 2CV.2.73
 Wendlandt, S., 6CV.1.6
 Wengenmeyr, N., 2DO.5.1
 Wenzel, A., 6CV.1.21
 Wenzel Andreasen, J., 3BV.1.6
 Werner, J., 2BO.4.6, 3CO.8.1, 3CO.5.3
 Wetzel, G., 6EO.2.4
 Whitney, E., 6CO.15.5
 Widlak, E., 6BV.4.13
 Wiese, M., 5DP.2.4
 Wiesenfarth, M., 5DP.2.4
 Wilbert, S., 5CV.4.7, 5DO.2.1
 Wille-Haussmann, B., 7DV.2.38
 Wilson, G.J., 3CO.6.1
 Wimmer, M., 7DV.2.5
 Winkler, T., 4AV.2.9
 Winter, S., 4AV.2.5, 4CO.1.5
 Winter, M., 2CV.2.4
 Wirth, H., 4CO.4.1
 Wirtz, T., 2BO.4.6
 Wissen, D., 2BP.1.4
 Witte, W., 3AO.9.4, 3BV.1.7
 Witteck, R., 4BO.11.3, 7DV.2.1
 Wittmer, B., 5CV.3.55
 Wittwer, C., 5CV.3.1
 Wohlfart, P., 2CV.2.90
 Wöhrle, N., 2CV.2.98
 Wolf, A., 2BO.1.3
 Wolf, F., 3BO.8.1
 Wolfberger, A., 4AV.2.46
 Wolfertstetter, F., 5CV.4.7
 Won, C.-S., 4AV.2.1, 6BV.4.9, 4AV.2.4
 Woo, S.C., 6BV.4.9
 Wood, S., 3CO.6.3, 4AV.2.10
 Woodhouse, M., 4AV.1.46, 7DV.2.12
 Wright, M., 2CO.11.3, 2AO.4.3
 Wu, Y., 3CO.8.5
 Wu, L.-G., 2CV.2.42, 4AV.1.19
 Wu, W., 2BP.1.5
 Wu, Y.-R., 3BV.2.12
 Wu, H.-L., 1BO.9.4, 4AV.2.2, 4AV.1.5
 Wu, H., 2DV.1.39
 Wu, N., 3CO.8.2
 Würz, R., 3BV.1.10, 3AO.7.4
 Wütrich, C., 4CO.3.2
 Wyrtsch, N., 4AV.1.10, 6CV.1.5
 Wyss, P., 2BO.4.6
 Wyss, P., 4CO.3.2, 2BP.1.2, 2CO.10.2
- X**
- Xia, H., 2BP.1.5
 Xiang, J., 2EO.1.2
 Xie, Y., 5DO.2.3
 Xing, G., 2CV.2.82, 2DO.5.2
 Xu, H., 2AO.5.4
 Xu, G., 2EO.1.2
 Xu, M., 2CO.12.6
 Xu, Z., 2CV.2.79
 Xu, H., 3BV.1.48
 Xu, X., 2DV.1.39, 2CO.11.5, 3BV.2.26
 Xu, S., 3AO.9.5
 Xu, D., 2CV.2.85
 Xu, L., 2DV.1.39
 Xu, H., 2CO.12.6
 Xu, J., 2DV.1.26
 Xue, C., 1BV.3.14
 Xuereb, S., 4AV.1.36
- Y**
- Yadav, T.S., 2DV.1.68
 Yaghoubi, M., 5CV.4.39
 Yaiche, A., 3BV.2.53
 Yakovlev, S., 4AV.1.22
 Yakovlev, V., 2DV.1.41
 Yamada, A., 3BV.1.39
 Yamada, H., 6EO.2.3
 Yamada, N., 2AO.6.1
 Yamaguchi, M., 3BO.8.5, 1BV.3.1, 6EO.2.3
 Yamaguchi, S., 4BO.12.5
 Yamaya, H., 7DV.2.23
 Yamhure, G., 1BV.3.7
 Yan, D., 2BO.2.2
 Yan, H., 2CO.11.5

Yan, C., 3BV.1.30, 3AO.8.6
 Yan, D., 2CV.2.3
 Yanagita, M., 3BV.1.20
 Yang, Y., 2EO.1.2
 Yang, G., 4DO.4.1
 Yang, G., 2BO.4.1
 Yang, Z.-P., 2CV.2.73
 Yang, C., 3AO.9.5
 Yang, H.-T., 4AV.2.35
 Yang, N., 2DV.1.26, 2CV.2.63
 Yang, T.-C., 3CO.8.1, 3CO.5.3
 Yang, J., 2CV.2.89
 Yang, W., 2CV.2.85
 Yang, J., 5DO.2.3
 Yang, S.-C., 3AO.7.3
 Yang, J., 2CV.2.31
 Yang, J., 2BO.2.2
 Yang, H.-L., 2AO.5.1
 Yang, Y., 4AV.1.6
 Yang, M., 2CO.11.5
 Yang, N., 2BP.1.5
 Yao, Y., 2DV.1.18
 Yao, Z., 2DV.1.60
 Yasaki, Y., 3BV.1.64
 Yasin, L., 3AO.9.3
 Yatimi, H., 4AV.2.13
 Ye, X., 2CV.2.63
 Yeo, S., 6BV.4.36
 Yerci, S., 3BV.1.35
 Yılmaz, O., 3BV.1.6
 Yin, S., 2DV.1.39
 Yokogawa, R., 2AO.6.1
 Yokoi, T., 2AO.5.5
 Yoo, J.S., 2CV.2.59, 1BV.3.30, 3BV.1.37, 3AO.7.5
 Yoo, J.S., 3BV.1.4
 Yoon, J., 6BV.4.20

Yordanov, G.H., 5DP.2.2
 Yoshida, H., 2DV.1.15
 Yoshino, K., 3CO.5.4
 Younas, M., 3BV.2.39
 Yu, P., 4AV.2.2, 4AV.1.5, 1AO.1.6
 Yu, C.-Y., 2CV.2.42, 4AV.1.19
 Yu, H.J.J., 7DV.2.13
 Yu, B.-L., 4AV.1.30
 Yu, I.-S., 2CV.2.73
 Yu, Z.J., 2CV.2.2
 Yu, J., 2DV.1.13, 2CV.2.73
 Yu, L.-C., 1BO.9.4
 Yu, H.-T., 2AO.5.1
 Yu, C., 2DV.1.39, 2CO.11.5
 Yuan, L., 2EO.1.2
 Yuan, S., 2CV.2.72
 Yuan, X., 2BP.1.5
 Yuan, X., 2DV.1.26, 2CV.2.63
 Yucebas, D., 4CO.4.3
 Yun, J.H., 3BV.1.4, 2CV.2.59, 1BV.3.30, 3BV.1.37, 3AO.7.5
 Yun, J.S., 3BV.2.29
 Yun, M.J., 3CO.7.2, 1BO.9.1
 Yurrita, N., 1BV.3.51
 Yyang, H., 4AV.2.8, 2DV.1.16

Z

Zaaiman, W., 5CV.3.3, 4DP.1.1
 Zahedi-Azad, S., 3AO.9.4
 Zakeeruddin, S.M., 7DV.2.16
 Zakevicius, G., 7DV.2.5
 Žalys, O., 1BV.3.2
 Zamini, S., 3BV.1.6, 4AV.1.7
 Zancan, N., 3BV.1.62
 Zanon, V., 6BV.4.13
 Zardetto, V., 3CO.7.3, 3CO.6.6
 Zaretskaya, E.P., 1AO.3.3

Zarzalejo, L.F., 5DO.2.1
 Zele, S., 4AV.2.31
 Zelenina, A., 3AO.7.1
 Zeller, U., 4BO.11.2, 4BO.12.1, 4AV.1.48
 Zeman, M., 2CO.10.1, 1BO.9.6, 3AO.8.2, 2CO.12.6, 1AO.2.1, 4AV.1.45, 5DO.3.1, 6DO.8.3, 2BO.4.1
 Zhang, X., 2EO.1.2
 Zhang, S., 2EO.1.2
 Zhang, P., 3BV.2.59
 Zhang, X., 2BO.2.2, 2CV.2.5
 Zhang, D., 3CO.6.6, 3CO.8.5
 Zhang, J., 3BV.2.26
 Zhang, T., 2DV.1.72
 Zhang, C., 2CV.2.75
 Zhang, S., 2DV.1.18
 Zhang, L., 2DV.1.22
 Zhang, S., 2CV.2.64
 Zhang, Y., 2DO.6.5
 Zhang, X., 2DV.1.18
 Zhang, Y., 1BO.10.3
 Zhang, H., 3BV.2.26
 Zhang, L., 5BO.5.6
 Zhang, W., 2CV.2.72
 Zhang, X., 2CV.2.72
 Zhang, Q.-M., 1BV.3.14
 Zhang, Y., 3BV.2.13
 Zhang, T., 2CV.2.5
 Zhao, L., 2CV.2.38
 Zhao, H., 2DV.1.27
 Zheng, J., 3AO.9.5
 Zheng, P., 2BO.2.2
 Zheng, L., 4AV.1.50
 Zheng, J., 3BV.2.58
 Zhong, G., 3AO.9.5
 Zhong, S., 2CO.11.1
 Zhou, C., 2BO.1.2
 Zhou, S., 2BO.1.2

Zhou, C.L., 2CV.2.38
 Zhou, A., 3BV.2.57
 Zhou, Y., 3AO.8.1
 Zhou, J., 2CV.2.83
 Zhu, J., 2DV.1.9, 2CV.2.9
 Zhu, Y., 2CV.2.7
 Zhu, L., 2CV.2.72
 Zhu, K., 7EP.2.1
 Zhuang, D., 3BV.1.62
 Zhukova, M., 3BV.1.9
 Ziar, H., 4AV.1.45, 5DO.3.1
 Zilles, R., 7DO.7.6
 Zimin, S.P., 1AO.3.3
 Zimmermann, S., 2CV.2.97
 Zomer, C.D., 6BV.4.8
 Zou, S., 2CV.2.82
 Zou, C., 4CO.1.6
 Zou, Y., 2EO.1.2
 Zougar, L., 2DV.1.25
 Zuma, S., 7DV.2.9
 Zunft, H., 2BO.1.5
 Zureick, F., 5CV.3.17
 Zuschlag, A., 2BO.1.5
 Zutter, M., 3AO.9.3
 Zwangerman, N., 7DV.2.33
 Zywitzki, O., 2CV.2.92, 3BV.1.38

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PARALLEL EVENTS

For more information please refer to
www.photovoltic-conference.com/programme/parallel-events

PARALLEL EVENTS

The EU PVSEC Parallel Events are open to all registered Conference Participants of the EU PVSEC 2019.

For detailed information and programme please visit www.photovoltaic-conference.com/programme/parallel-events.

Monday, 09 September 2019

14:30 - 17:00
French National Day - Highlighting French PV Innovation

13:30 - 17:30
Trends in PV Development – Self-Consumption and Innovative Distributed Applications

Tuesday, 10 September 2019

08:30 - 12:30
Eco-Design, Eco Labeling, Green Public Procurement – Sustainability Leadership for the Terawatt Age

08:30 - 12:30
Research meets Business – Solar Industry Forum

13:30 - 17:00
Photovoltaics | Forms | Landscapes - Energy as a Landscape Infrastructure

13:30 - 18:30
Research meets Business – Solar Industry Forum

17:45 - 20:30
New Solutions of Energy

Wednesday, 11 September 2019

08:30 - 12:30
Innovations in Photovoltaic Materials

08:30 - 12:30
Research meets Business – Solar Mobility Forum

13:30 - 15:00
Probabilistic PV Production Forecasts: Technics and Use-Cases

16:00 - 18:30
The EU Support Instruments – Unlocking Developing Markets

Thursday, 12 September 2019

08:30 - 12:30
BIPV – Moving into the Next Phase

10:10 - 12:10
Standardization of the Protocols for Emerging PV Technologies

15:15 - 18:30
Advanced PV Energy Rating for Emerging Technologies

More information on the following pages.

French National Day - Highlighting French PV Innovation

Overview of the French PV Innovation: Roadmap, Market and Policies, and Technical Achievements

Day: Monday, 09 September 2019

Time: 14:30 - 17:00

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 2 *Callelongue Gradin*, first floor

Access: Registration free of charge but mandatory via <https://registration.n200.com/survey/3pdbs8hks87to>

This workshop will present the main research, development and innovation activities in France. It will start with a brief overview of the current market situation, the main policy issues and the ambitious goal around 40 GW stated for 2028. Then, it will address all the aspects of the innovation process, from basic and applied research carried out within the main research institutes (IPVF and INES), to the last innovative results obtained by the main stakeholders, upstream of the value chain with the equipment and module manufacturers, and downstream with developers, SMEs and start-ups.

Trends in PV Development – Self-Consumption and Innovative Distributed Applications

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 1 in cooperation with IRENA

Day: Monday, 09 September 2019

Time: 13:30 - 17:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 5 *Morgiou*, first floor

Access: Open to all Conference participants (on days registered)

While distributed PV represented one third of global PV installations in 2018, it is poised to develop fast in the coming years under new policies and adequate regulatory frameworks. Self-consumption policies are evolving towards more complex and decentralized regulations allowing collective and virtual self-consumption, while innovative business models allow to rethink electricity production and consumption.

This event will first discuss the development of the PV market, and the impact of policies on the speed at which PV could develop. Will policies continue to shape the market and especially long-term targets? How are self-consumption policies developing and what does that mean for the energy transition? Are electricity markets adapted?

As an official event of the EU PVSEC 2019, this PVPS Programme Workshop is jointly organised by IEA - International Energy Agency and the EU PVSEC. Partners: SET-Plan Action 4, Self-Consumption Initiative, PVProsumer4Grid Horizon2020 Project.



Programme Outline

13:30 **Welcome Speech & the Role of the IEA PVPS Program**

13:35 **Session 1 – Current Trends in innovative PV Policies for Self-Consumption**

Self-consumption policies have evolved rapidly and encompass now the ability to develop PV for self-consumption in multi-stories buildings, as well as virtual compensation between different sites. The following subjects will be discussed.

- Summary of PV self-consumption policies and innovations
- PVP4GRID project summary: collective self-consumption results
- Self-Consumption Initiative: Use cases
- Policy innovation for self-consumption policies: Country cases

15:00 **Coffee Break**

15:30 **Session 2 – Innovative Distributed Applications for PV, Smart Buildings and Electric Mobility**

What could drive PV development in the coming years? From innovative applications in buildings to the integration in the transport sector, this session will explore innovation and forward-looking ideas, including innovative business models for self-consumption.

- Electricity markets and RES profitability
- Hydrogen as a vector to support PV development
- A new dawn for Solar Heating and Cooling using PV electricity
- Innovative cross-cutting applications for electric mobility and PV

17:30 **Closing Speech**
Stefan Nowak, IEA-PVPS Chairman, Net Energy

Contact for further information: Gaëtan Masson, Task 1 Operating Agent g.masson@iea-pvps.org

Eco-Design, Eco Labeling, Green Public Procurement – Sustainability Leadership for the Terawatt Age

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 12

Day: Tuesday, 10 September 2019

Time: 08:30 - 12:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 5 *Morgiou*, first floor

Access: Open to all Conference participants (on days registered)

The preparatory study of the European Commission on Eco-Design, Eco-Labeling, Green Public Procurement and Energy Labeling for PV modules, inverters and PV systems will be concluded in June/July 2019 with policy recommendations for sustainable product policies for these components.

At the same time, the International Sustainability Leadership Standard for PV Modules and Inverters (NSF457) will be finalized and form the basis for an EPEAT listing of these components and an international eco-label as well as Green Public Procurement rules for PV modules and inverters, potentially applicable in 33+ countries globally.

The parallel event should provide an overview on these policy developments and give perspectives from the industry, procurement and customer side on proposed policy measures as well as lining out the potential effects these would have on product developments and industrial policy in the European Union.

What will be the effect of potential policy measures in the EU and how can those be streamlined with the international sustainability leadership standard and discussions around the taxonomy for sustainable finance?



Research meets Business – Solar Industry Forum

jointly with ETIP-PV, Becquerel Institute along with the support of SOLARUNITED

Day: Tuesday, 10 September 2019

Time: 08:30 - 12:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 6 *Sormiou*, first floor

Access: Open to all Conference participants (on days registered)

- Dedicated to Global Manufacturing Challenges



Programme Outline

08:30 – 10:00

SESSION 1 – GLOBAL MANUFACTURING CHALLENGES: The state of the PV industry – an ongoing challenged Industry

This session presents the latest developments and challenges of the PV industry in Europe and on the international stage focusing on the declining market prices and the pertinence of the learning curve.

10:00 – 10:20 **Coffee Break**

10:20 – 11:20

SESSION 2 – GLOBAL MANUFACTURING CHALLENGES: Industry 4.0 concepts – how to improve manufacturing? The role of equipment manufacturers in the entire manufacturing value chain.

This session discusses options for improving manufacturing through automation and digitalisation of processes: the role of equipment manufacturers and innovations to lower production costs in the coming years.

11:20 – 12:15

SESSION 3 – GLOBAL MANUFACTURING CHALLENGES: Bringing back the industry – the policy debate. From ecodesign to technology tenders, a few paths for PV industry development.

PHOTOVOLTAICS | FORMS | LANDSCAPES

Energy as a Landscape Infrastructure

jointly with ENEA, Becquerel Institute, ETA-Florence and WIP
Renewable Energies

Day: Tuesday, 10 September 2019

Time: 13:30 – 17:00

Site: EU PVSEC at Marseille Chanot Convention and
Exhibition Centre, Marseille, France

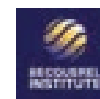
Room: Auditorium 5 *Morgiou*, first floor

Access: Open to all Conference participants (on days
registered)

This is a special event, at its 8th edition, in conjunction with the 36th EU PVSEC, organised by ENEA, Becquerel Institute, ETA-Florence and WIP Renewable Energies. The event highlights how architects, designers, developers, and researchers take up the challenge of letting photovoltaic systems interact with landscapes and buildings. “Energy as a landscape infrastructure” is the challenge for this year’s edition, in Marseille. Architects, developers and researchers wishing to present already completed or ongoing projects, as well as innovative research results and ideas should apply by filling the submission form. A committee of distinguished experts will select the works to be delivered as oral/visual presentations.

Please, do not hesitate to contact us at info@pv-landscapes.com should you have any queries.

With kind regards and looking forward to an exciting event.



etaflorence ✱ renewableenergies



with the support of



Research meets Business – Solar Industry Forum

jointly with ETIP-PV, Becquerel Institute along with the support of SOLARUNITED

Day: Tuesday, 10 September 2019

Time: 13:30 - 18:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 6 *Sormiou*, first floor

Access: Open to all Conference participants (on days registered)

- Dedicated to Increasing the Competitiveness



Programme Outline

13:30 - 15:00

SESSION 4 – INCREASING COMPETITIVENESS: innovation and future of cells & modules

Will n-type finally find its way to mass manufacturing, can we expect HJT to surpass n-PERT? What's next for IBC innovations? With p-type PERC dominating the market? How innovations can increase efficiency and lower the costs? Will tandem cells finally meet expectations?

15:15 - 16:00

SESSION 5 – INCREASING COMPETITIVENESS: Quality and efficiency in manufacturing 4.0

16:00 - 16:45

SESSION 6 — CIRCULAR ECONOMY AND SMART ENGINEERING: pushing the industry forward

17:00 - 18:15

SESSION 7 INCREASING COMPETITIVENESS: thin films

Thin films are not dead and production capacities are increasing, allowing some technologies to thrive thanks to low production costs. What about perovskites in manufacturing and OPV?

New Solutions of Energy

CEA-Liten

Day: Tuesday, 10 September 2019

Time: 17:45 – 20:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 5 *Morgiou*, first floor

Access: Registration free of charge but mandatory via <https://ypl.me/bYt>

This event will be an opportunity to unveil the Liten's strategy, its latest research, and to celebrate the Institute's 15th anniversary. Presentations will be followed by a networking cocktail reception.



Programme Outline

17:45 - 18:00

Welcome

18:00 - 18:15

Liten, Innovation for Energy Transition

Florence LAMBERT, CEO CEA Liten

18:15 - 18:30

Keynote ext

TBD

18:30 - 18:40

PV In Europe - The New Era with SHJ Technology

Anis JOUINI, Head of Solar Technology division at CEA Liten

18:40 - 18:50

Smart Grid for the Integration of Renewable Generation

Franck BOURRY, Head of Intelligent Electrical System Laboratory, Solar Technology division at CEA Liten

18:50 - 19:00

Energy Storage & Sector Coupling

Simon PERRAUD, Deputy Director, Research Funding Programs at CEA Liten

19:00 - 19:10

Circular Economy for Energy Transition

Chrystal DEGUET, Head of New Materials division at CEA Liten

19:10 - 19:15

Closing

19:15 - 20:30

Cocktail & Networking

Innovations in Photovoltaic Materials

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 13

Day: Wednesday, 11 September 2019

Time: 08:30 - 12:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 5 *Morgiou*, first floor

Access: Open to all Conference participants (on days registered)

As a parallel event of the EU PVSEC 2019, the Workshop “Innovations in Photovoltaic Materials” organized by the International Energy Agency (IEA) Photovoltaic Power Systems Programme (PVPS) Task 13, will present ideas, concepts, and results from a global set of researchers aiming to both reduce cost and improve the performance and reliability of PV modules and systems by using new materials.



Programme Outline

Moderation: Ulrike Jahn, TÜV Rheinland, Germany

08:30 - 08:40

Short Introduction of IEA PVPS of Task 13

Ulrike Jahn, Task 13 Operating Agent

08:40 - 09:00

Functional Requirements of PV Materials

Joshua S. Stein, Sandia National Laboratories, NM, USA

09:00 - 09:20

Light-Weight PV Modules – Approaches and Reliability Aspects

Hartmut Nussbaumer, ZHAW, CHE

09:20 - 09:40

Encapsulant Innovations for Replacement of EVA

Gernot Oreski, Polymer Competence Center Leoben, AUT

09:40 - 10:00

Feedbacks and Discussion

10:00 - 10:30

Coffee and Networking Break

Moderation: Joshua S. Stein, Sandia National Laboratories, NM, USA

10:30 - 10:50

How to Extend PV Modules Service Life beyond 25 Years using Adapted Coextruded PP Backsheets and Encapsulants

Francois Rummens, Renolit, Belgium

10:50 - 11:10

Low-Cost Advanced Metallization to Reduce Cell-Crack-Induced Degradation for Increased Module Reliability

Sang Han, Osazda Energy, Albuquerque, NM USA

11:10 - 11:30

Reliability Aspects of New Cell Interconnection Technologies

Andreas Halm, ISC Konstanz, DEU

11:30 - 12:15

Panel discussion

Task 13 speakers and invited experts (tbc):

Michael Woodhouse, NREL, USA

12:15 - 12:30

Wrap-up & Closing session

Gernot Oreski, Polymer Competence Center Leoben, AUT

12:30

End of Workshop

Research meets Business – Solar Mobility Forum

jointly with ETIP-PV, Becquerel Institute along with the support of SOLARUNITED

Day: Wednesday, 11 September 2019

Time: 08:30 - 12:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 6 Sormiou, first floor

Access: Open to all Conference participants (on days registered)

Dedicated to

- E-Mobility through Solar Energy
- PV for transports
- Solar fuels for transports



Programme Outline

08:30 – 10:00

SESSION 1 – E-mobility through solar energy: a step towards the energy revolution

The energy revolution cannot exist without solar and electric mobility. How do they complement each other, what could be the connection between two sectors so different? From integrated actors acting in both fields to newcomers, the debate is open whether PV will drive the EV development or the other way around. Time for vehicles-to-grid!

10:00 – 10:20 **Coffee Break**

10:20 – 11:20

SESSION 2 – PV for transports

Using PV in transport vehicles implies new constraints and new opportunities. How can we integrate PV and how far PV-driven cars could go? Are we ready for PV-powered vehicles? Is this the beginning of a new era for PV and EV development?

11:20 – 12:15

SESSION 3 – Solar fuels for transports

With PV electricity costs reaching record-low levels in several places in the world, the production of solar fuels from PV – hydrogen, renewable gas and ammonia – becomes a tangible reality which could change the face of the energy world. With hydrogen as an alternative to battery EVs, the road may be bright for solar powering the future of transports.

Probabilistic PV Production Forecasts: Technics and Use-Cases

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 16

Day: Wednesday, 11 September 2019

Time: 13:30 - 15:00

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 5 *Morgiou*, first floor

Access: Open to all registered participants of the EU PVSEC 2019

The workshop will give an introduction into probabilistic forecasts for solar energy, shows some examples of existing forecasts and how to implement them.



The EU Support Instruments – Unlocking Developing Markets

jointly with SolarPower Europe and GET.invest

Day: Wednesday, 11 September 2019
Time: 16:00 - 18:30
Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France
Room: Auditorium 5 *Morgiou*, first floor
Access: Open to all registered participants of the EU PVSEC 2019

GET.invest, in partnership with SolarPower Europe, is organising a workshop at the EU PVSEC 2019 conference in Marseille. The event will inform participants about the financing and technical assistance instruments available through the EU External Investment Plan (EIP) to investors and entrepreneurs active in the clean energy markets of Africa and the EU Neighbourhood region. It will feature presentations, panel discussions and a Q&A session about the various pillars of the EIP, including the European Fund for Sustainable Development, various existing investment facilities and guarantee schemes, such as ElectriFI and Africa GreenCo, as well as technical assistance instruments such as GET.invest.

The EU's ambitious EIP encourages investment in partner countries in Africa and the EU Neighbourhood region. Its objective is to leverage €44billion worth of investments with an input of €4.5billion in the form of grants and guarantees.

After the event, the speakers and participants are invited to get to know each other at a networking reception.



Programme Outline

16:00 - 16:15

Welcome

DG DEVCO, European Commission
 SolarPower Europe

16:15 - 16:30

Overview of the EU External Investment Plan's guarantees for sustainable energy investments

Representative of DG DEVCO, European Commission

16:30 - 16:15

Presentation of GET.invest

Representative of GET.invest

16:45 - 17:00

Presentation of ElectriFI

Representative of ElectriFI

17:00 - 17:15

Presentation of the European Guarantee for Renewable Energy (EGRE)

Representative of DG DEVCO, European Commission

17:15 - 17:30

Presentation of the solar industry on industry initiatives and the needs of the industry

Representative of SolarPower Europe

17:30 - 18:15

Moderated panel discussion with various stakeholders

- DG DEVCO, European Commission
- GET.invest
- SolarPower Europe
- Representatives from partner countries in the African, Caribbean, Pacific region
- Moderator (SolarPower Europe Secretariat)

18:15 - 18:25

Q&A with the audience

18:25 - 18:30

Conclusions

Moderator

18:30 - 19:15

Networking reception

BIPV – Moving into the Next Phase

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) – IEA PVPS Task 15, ETIP PV, WIP Renewable Energies, Zuyd University and Helmholtz-Zentrum Berlin

Day: Thursday, 12 September 2019

Time: 08:30 - 12:30

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 6 *Sormiou*, first floor

Access: Open to all Conference participants (on days registered)

In 2015, the IEA PVPS Task 15 collaboration started, focusing on the creation of an enabling framework for the acceleration of BIPV. Together with a number of other international research activities this has contributed to the international uptake of BIPV. In 2019, the first phase of IEA PVPS Task 15 will come to an end and a second phase is in development.

In 2014, ETIP PV started with a working group on BIPV, which was extended in 2018 to include all forms of integrated PV. With its activities, the Working Group IPV pushes the agreed target of the EU's SET-Plan - Declaration on Strategic Targets in the context of an Initiative for Global Leadership in Photovoltaics (PV). This includes enabling mass realisation of "(near) Zero Energy Buildings" by Building-Integrated PV (BIPV) through the establishment of structural collaborative innovation efforts between the PV sector and key sectors from the building industry.

This session showcases some results of the international collaboration in the field of BIPV that was initiated by ETIP PV and IEA PVPS Task 15. It will also discuss how national and international collaborations can help BIPV to move into its next phase of development.



Zuyd
Research

**Programme Outline****SESSION I: Results of five years of international collaboration**

Chair: Zeger Vroon, Zuyd UAS, IEA PVPS Task 15

8:30

Opening Session I

Zeger Vroon, Zuyd UAS

8:40

BIPV case studies from an architectural perspective

Tjerk Reijenga, BEAR

9:00

Research and Development of BIPV in an international context

Simon Boddaert, CSTB, France

9:20

Regulatory aspects of BIPV

Francesco Frontini SUPSi/ Nuria Martin Ciemat

9:40

Solar Skins, an opportunity for greener cities (joint study by ETIP PV/SolarPower Europe)

Aurelie Beauvais, SolarPower Europe

SESSION II: Entering the next phase of BIPV

Chair: Rutger Schlatmann, PVcomB, Helmholtz Zentrum Berlin, WG Leader of Integrated PV of ETIP PV

10:15

Opening Session II

Rutger Schlatmann, PVcomB, WG Leader of Integrated PV of ETIP PV

10:25

Using the potential of Photovoltaics in Cities

Francisco Goncalves, energycities (tbc)

10:45

The BIPV business model canvas

Jessica Benson, RISE, Sweden

11:05

National consultancy office for Building Integrated Photovoltaics - independent advice on a local level

Björn Rau, Helmholtz Zentrum Berlin (tbc)

11:25

BIPV success stories! – Results of R&D collaboration on European level

Eduardo Roman, Tecnalia

11:45

IEA PVPS Task 15 phase 2 – the next step in international collaboration

Johannes Eisenlohr, Fraunhofer ISE, Germany

12:05

Moderated Discussion

by Rutger Schlatmann

Standardization of the Protocols for Emerging PV Technologies

Worldwide actions from material research community, companies and reference testing labs to the new measurement guidelines deployment

jointly with the EC Joint Research Centre

Day: Thursday, 12 September 2019

Time: 10:10 - 12:10

Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France

Room: Auditorium 5 *Morgiou*, first floor

Access: Open to all Conference participants (on days registered)

Parallel event during the 36th EU PVSEC possibly on Thursday 12th initiated by EC Joint Research Centre. The purpose of this event will be to introduce the most relevant works done in the development of measurement guidelines for a reliable characterization of emerging PV technologies, with a strong focus on how material research labs, testing labs and industrial project partners can benefit from a common approach. The workshop will highlight how existing IEC standards can be applied to innovative PV devices and what are the most critical issues not covered by the current version.



Programme Outline

10:10

Chair welcome

Speaker: TBD

10:15

New IEC TR 63228: Measurement protocols for photovoltaic devices based on organic, dye-sensitized or perovskite materials

Speaker: Giorgio Bardizza (EC - JRC), Chris Fell (CSIRO), Toshiro Matsuyama

10:30

Materials research lab perspective: methods used in materials research labs

Speaker: Antonio Abate (Helmholtz-Zentrum Berlin)

10:45

Industrial perspective 1: protocols used in companies, critical issues observed and proposed solutions

Speaker: David Bushnell (OxfordPV)

11:00

Industrial perspective 2: protocols used in companies, critical issues observed and proposed solutions

Speaker: TBD

11:15

Reference testing lab perspective: protocols used in reference testing labs

Speakers: Yoshihiro Hishikawa and Masahiro Yoshita (AIST)

11:30

Panel discussion

Moderator: TBD

12:05

Concluding remarks

Speaker: TBD

12:10

End of event

Advanced PV Energy Rating for Emerging Technologies

jointly with LNE in the framework of the PV-ENERATE project supported by the EURAMET EMPIR program

Day: Thursday, 12 September 2019
Time: 15:15 - 18:30
Site: EU PVSEC at Marseille Chanot Convention and Exhibition Centre, Marseille, France
Room: Auditorium 5 *Morgiou*, first floor
Access: Open to all Conference participants (on days registered)

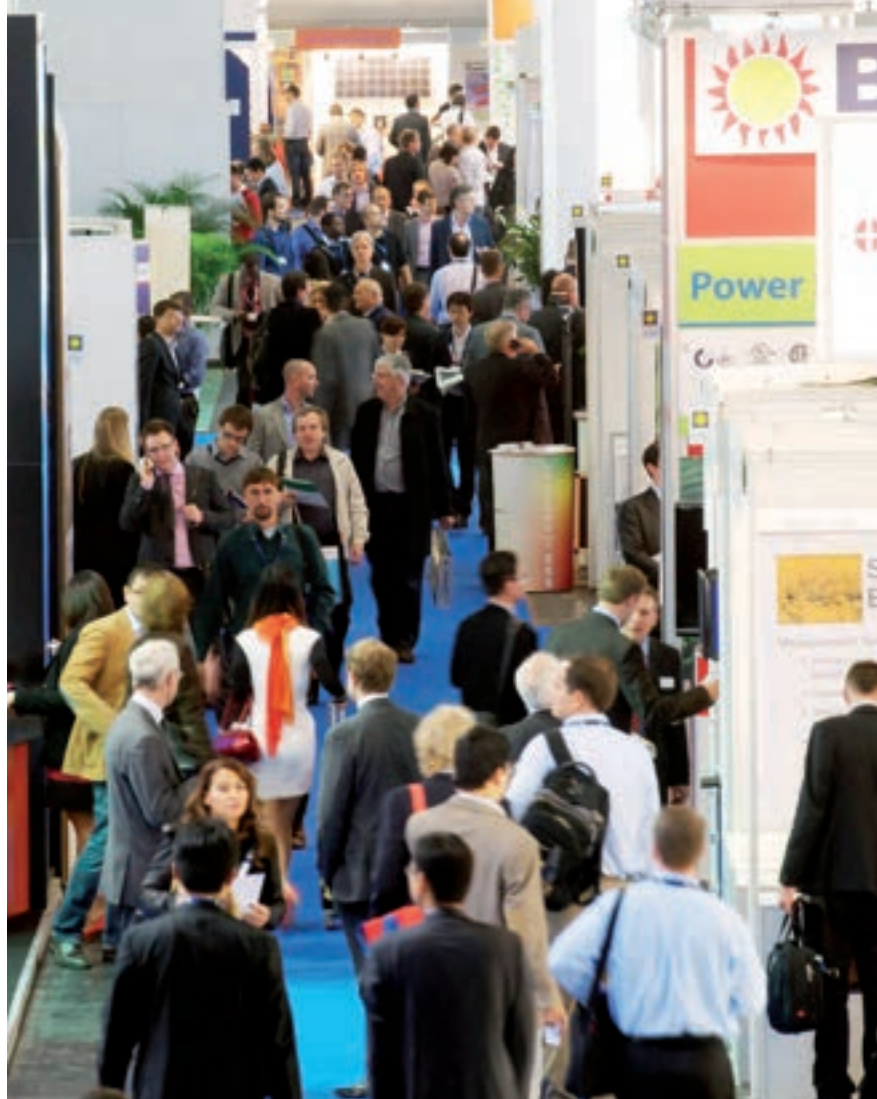
The IEC 61853 standard series provides a framework for the energy rating of traditionally mounted classical PV modules. Today stakeholders have identified a need to extend the energy rating to emerging technologies (bifacial) or applications (BIPV). This implies the implementation of the metrological infrastructure and techniques to improve the measurement equipment and methodologies, to enable precise measurements of the parameters required.

This workshop is a parallel event of the EU PVSEC conference and is organized in the framework of the PV-ENERATE project supported by the EURAMET EMPIR program.

Participants to the event are invited to present their work on the following subjects (this list is not exhaustive):

- Improvement in the energy rating evaluation
- Development of traceable measurement methods
- Definition of testing conditions for the measurement of power and short-circuit current
- Evaluation of the measurement uncertainty including the spectral mismatch correction taking into account the correlation of the spectral data





EXHIBITION

For more information please visit
www.photovoltaic-conference.com/programme/exhibition

List of Exhibitors · alphabetical

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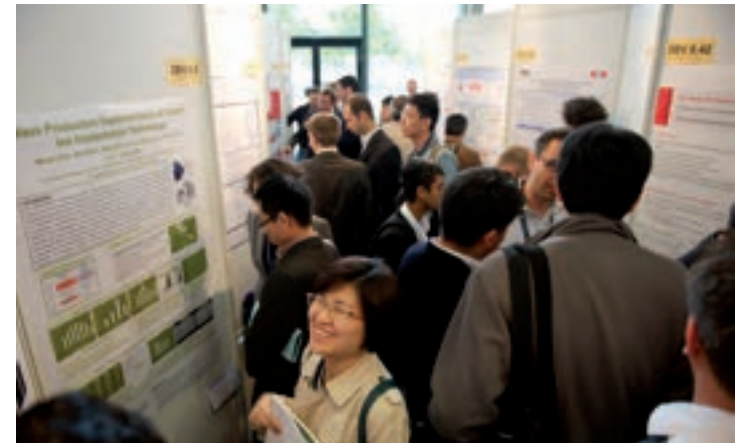
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The Joint Research Centre (JRC) is the European Commission's science and knowledge service which employs scientists to carry out research in order to provide independent scientific advice and support to EU policy. As part of its activities the JRC operates the European Solar Test Installation (ESTI) for assessing PV device performance at its site in Ispra, Italy. It's online tool PV-GIS provides free data on solar energy resource and potential PV electricity output for Europe and beyond.

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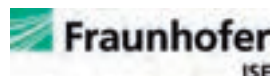
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Reception*

**Monday 09 September 2019
18:30 - 20:00
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SINGULUS TECHNOLOGIES builds innovative machines for efficient and resource-friendly production processes for new photovoltaic formats like PERC – HJT – IBC – TOPCon – Tandem.

SINGULUS TECHNOLOGIES builds machines for economical and resource-efficient production processes. The application areas include coating, surface processing, wet-chemical as well as the related chemical and physical processing steps.

We invite you to talk to our specialist during EU PVSEC 2019, booth D2.



**PERC, HJT,
IBC, HBC,
TOPCon and
Perovskite
Layers**

Come & see us at
36th EU PVSEC 2019
Booth D2

Sinton Instruments

F3

4720 Walnut Suite 102
Boulder, CO 80301
USA



phone: +1-303 945 2113
e-mail: quotes@sintoninstruments.com
web: www.sintoninstruments.com

Sinton Instruments provides state-of-the-art test and measurement instruments for use in Silicon PV manufacturing and R&D for each stage of the solar cell production process from bricks and ingots through module test. We have revolutionized industrial cell and module testing by incorporating patented methodology and analysis techniques to provide unprecedented accuracy and process-control information.

INNOVATIVE DEPOSITION EQUIPMENT – PVD & PECVD

... for new cell formats

We invite you to talk to our specialists during EU PVSEC 2019 at our booth about new cell formats and take a closer look at our production machines:

GENERIS PVD

- Inline sputtering for ITO on heterojunction solar cells
- Single sided deposition of doped a-Si layers for TOPCon and comparable cell structures

GENERIS PECVD

- Inline plasma enhanced chemical vapor deposition
- Dielectric layers for PERC
- Doped polycrystalline layers for TOPCon and comparable cell structures



SOLARC Innovative Solarprodukte GmbH E9

Glogauer Str. 21
10999 Berlin
Germany



phone: +49-30 319 85 54 00
e-mail: info@solarc.de
web: www.solarc.de

SOLARC is your industrial partner for the development and manufacturing of innovative solar power systems, customised solar modules, solar charge controllers, DC/DC converters, GPS Tracking systems as well as motor and lighting controls systems.

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Solargis s.r.o. C1

Mytna 48
81107 Bratislava
Slovakia



phone: +421-2 4319 1708
e-mail: contact@solargis.com
web: www.solargis.com

Our mission is to provide solar and weather information that help professionals anywhere in the world to build and operate successful solar projects. Our data, online apps and consultancy services are tailored to significantly reduce risk and enable companies to make world-class solar project decisions. With over 19 years of experience, Solargis has evolved to become a choice of the majority of solar market leaders in over 100 countries worldwide.

SolarSwissConnect E6

c/o FSRM
Ruelle Du Peyrou 4
Case postale 2353
2001 Neuchatel
Switzerland



phone: +41-32 720 09 00
e-mail: info@solarswissconnect.ch
web: www.solarswissconnect.ch

SolarSwissConnect is the Switzerland association of equipment manufacturers, products manufacturers and scientific & testing institutes of photovoltaic field.

SOLARUNITED E1

P.O. Box 1610
63406 Hanau
Germany



phone: +49-618 198 280 42
e-mail: ekus@ipvea.com
web: www.solar-united.org

SOLARUNITED - THE GLOBAL SOLAR BUSINESS & TECHNOLOGY ASSOCIATION

Focusing on Quality, Reliability, Innovation, and PV Technology.

Formally known as IPVEA - today, we are known as SOLARUNITED, and we serve the interests of PV equipment manufacturers, module producers, project developers, financiers, consultants, service providers – the complete value chain and more!

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e-mail: contact@solean.fr
web: www.solean.fr

Solean is a new & innovative equipment manufacturer providing disruptive „Lean solar solutions“.

We offer highly innovative, modular, 100% robotic assembly units for the manufacture of photovoltaic (pV) solar panels of all shapes and sizes.

Our assembly units have been engineered to the most extreme requirements. Solean delivers the ideal machine to facilitate and accelerate the production of photovoltaic solar panels globally.

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France

phone: +33-4 765 185 34
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TENNERDIS: THE CLUSTER FOR THE ENERGY TRANSITION

Tenerdis supports the emergence and growth of strategic solutions for the energy transition. We assist our 230 members; aiming developing their activities within the six sectors:

1. CARBON-FREE MOBILITY
2. ENERGY EFFICIENCY FOR BUILDINGS AND INDUSTRY
3. MULTI-ENERGY MICROGRIDS
4. EMBEDDED INTELLIGENCE AND CYBERSECURITY FOR ENERGY SYSTEMS
5. ENERGY CONVERSION AND STORAGE
6. RENEWABLE ENERGY PRODUCTION AND INTEGRATION INTO THE CARBON-FREE ENERGY MIX

Tenerdis is based in Grenoble, in the Auvergne-Rhône-Alpes region. It has been awarded by a Gold Cluster Management Excellence certification.

University of Ljubljana, LPVO

C5

Trzaska cesta 25
1000 Ljubljana
Slovenia

University of Ljubljana



phone: +386 1 4768 470
e-mail: Marko.Topic@fe.uni-lj.si
web: <http://slo-pv.fe.uni-lj.si/>

The University of Ljubljana is the largest and the oldest in Slovenia. The Laboratory of Photovoltaics and Optoelectronics (LPVO) within its Faculty of Electrical Engineering is central R&D&I group for photovoltaics in Slovenia. In the fields of photovoltaics, optoelectronics and electronics we offer:

- Turnkey monitoring solutions for solar cells and PV modules
- Prototype development
- Characterisation
- Modelling and simulations
- PV system planning
- PV system components testing



Come & see us at
36th EU PVSEC 2019
Booth D2

**PERC, HJT,
IBC, HBC,
TOPCon and
Perovskite
Layers**

INNOVATIVE WET PROCESSING EQUIPMENT – BATCH & INLINE

... for new cell formats

We invite you to talk to our specialists during EU PVSEC 2019 at our booth about new cell formats and take a closer look at our wet processing machines:

LINEX

Inline Wet Process
Equipment for
→ cleaning, alkaline &
acidic etching, single side
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→ advanced cleaning and
ozone applications for
high-efficiency cell lines

SINGULUS

VON ARDENNE GmbH

E5

Am Hahnweg 8
01328 Dresden
Germany



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e-mail: office@vonardenne.biz
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VON ARDENNE develops and manufactures industrial equipment for vacuum coatings on materials such as glass, wafers, metal, and polymer films. Furthermore, we are the leading provider of coating systems for thin-film and crystalline photovoltaics.

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WCRE - World Council for Renewable Energy

G3

Belgium

web: www.wcre.de



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WIP Renewable Energies**D3**

Sylvensteinstr. 2
81369 Munich
Germany



phone: +49-89 720 12 735
e-mail: wip@wip-munich.de
web: www.wip-munich.de

WIP is a renewable energy consultancy with a long history of managing research and innovation projects and organizing leading conferences and events in the sector.

The current energy infrastructure worldwide must be transformed with the objective to reduce fossil energy related conflicts, mitigate climate change, and avoid other negative impacts of nuclear and fossil energy systems.

Our mission is to contribute to this goal by facilitating research, innovation and market integration of renewable energy systems through collaborative efforts across all sectors of society.

WIP Renewable Energies has over 37 years of experience in leading international collaborative projects aiming to bring innovative renewable energy technologies and services closer to the market.

WIP Renewable Energies has over 30 years of experience in event organization. This includes the conception, pre-financing, preparation, organisation and management of high level and large-scale international scientific conferences, workshops, seminars in the field of Renewable Energies.

Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)**A1**

Meitnerstr. 1
70563 Stuttgart
Germany



phone: +49-711 78 700
e-mail: info@zsw-bw.de
web: www.zsw-bw.de

The ZSW is one of the leading institutes for applied research in the field of photovoltaics, renewable fuels, battery technology, fuel cells and energy systems analysis with 260 employees at its locations in Stuttgart and Ulm, a solar testing facility at Widderstall, Germany, and a wind power field test site in complex mountainous terrain near Geislingen/Steige.

**FACILITATING THE TRANSITION TO
A SUSTAINABLE ENERGY FUTURE****WIP RENEWABLE
ENERGIES**

- **PROJECT MANAGEMENT & IMPLEMENTATION**
- **RESEARCH, CONSULTANCY, COMMUNICATION AND EXPLOITATION SERVICES**
- **EVENT ORGANIZATION**

WE PROVIDE EXPERTISE IN THE FOLLOWING THEMATIC AREAS:

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• Wind energy • Hydropower • Other technologies

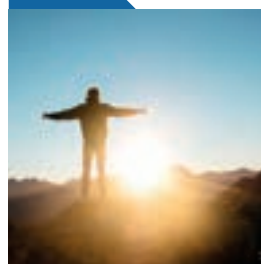
Energy System Integration

Energy storage and grid integration
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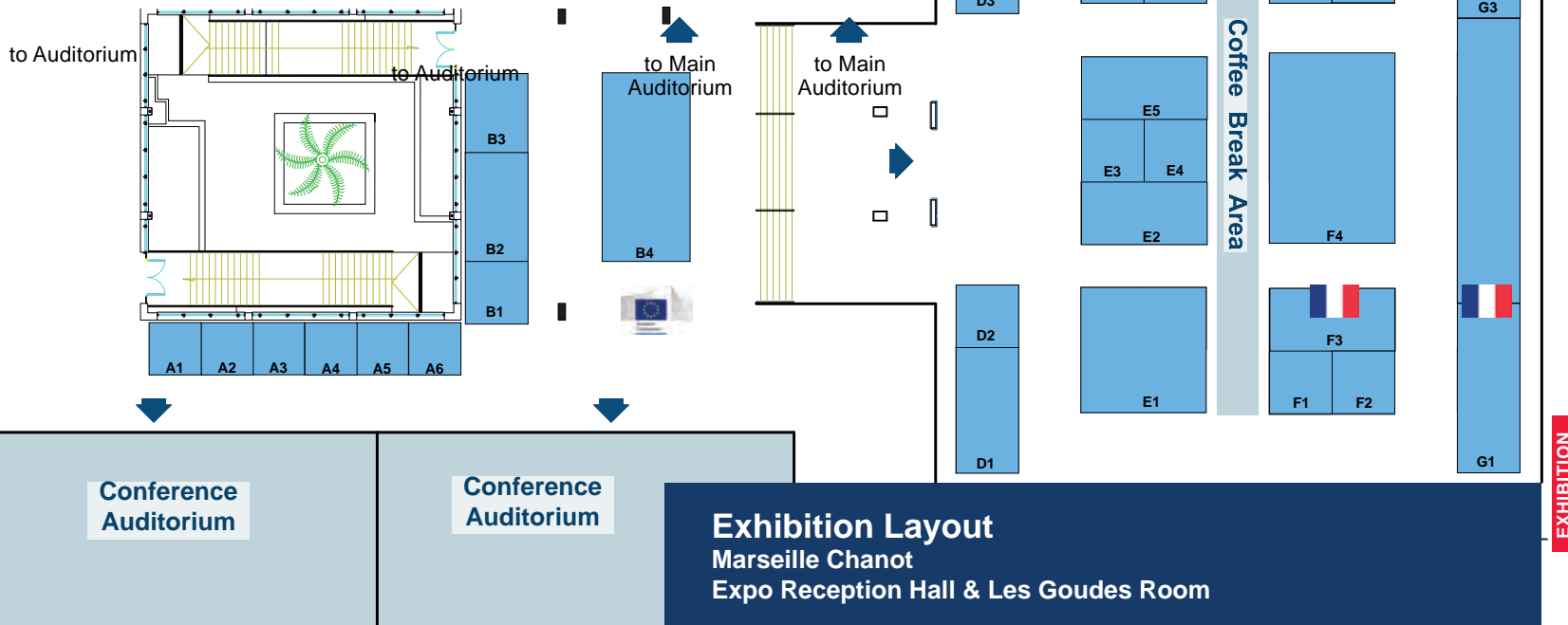
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Exhibition Layout with Exhibitors by stand number

Exhibition Area

Reception Hall & Les Goudes Room



List of Exhibitors, alphabetical

A1	ZSW Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg	C5	University of Ljubljana, Faculty of Electrical Engineering	E5	VON ARDENNE GmbH	F4, G2	PHOTOWATT
A2	Engineered Materials Systems, Inc.	D2	SINGULUS TECHNOLOGIES	E6	CSEM SA	F4, G2	Pôle de Compétitivité DERBI
A5	exateq GmbH	D3	EUREC	E6	SolarSwissConnect	F4, G2	SOLEAN
A6	GenSun	D3	IEA PVPS International Energy Agency Photovoltaic Power Systems Programme	E7	Newport Spectra-Physics	F4, G2	Tenerddis
B1	h.a.l.m. elektronik	D3	WIP Renewable Energies	E8	Wiley	F5	Fraunhofer Institute for Solar Energy Systems ISE
B3	Bentham Instruments Ltd.	E1	InnoLas Solutions GmbH	E9	SOLARC Innovative Solarprodukte GmbH	F6	CNRS - Centre National de la Recherche Scientifique
B4	European Commission JRC	E1	Jonas & Redmann Group GmbH	F1	H2020 Projects (NextBase, DISC, AMPERE)	F7	FME (Dutch PV Sector)
C1	Solargis s.r.o.	E1	SOLARUNITED	F2	Abet Technologies, Inc.	G3	ETA - Florence Renewable Energies
C2	pv magazine group GmbH & Co.KG	E10	Ivy Battery Tech Ltd	F3	Sinton Instruments	G3	WCRE - World Council for Renewable Energy
C3	Tempress Systems BV	E11	Semilab Co. Ltd.	F4, G2	ECM Greentech	G4	GGEIC - Global Green Energy Industry Council
C4	GIORDANO Industries	E2	RENA Technologies GmbH	F4, G2	INES - CEA LITEN		
		E3	Atotech Deutschland GmbH	F4, G2	Institut Photovoltaïque d'Ile de France		
		E4	G2V Optics Inc.	F4, G2	Ion Beam Services		



GENERAL INFORMATION

For more information please refer to
www.photovoltic-conference.com/participation

VENUE OF EU PVSEC 2019

Marseille Chanot Convention and Exhibition Centre
 114 Rond-Point du Prado
 13008 Marseille
 France

www.marseille-chanot.com

For detailed Information please visit
www.photovoltaic-conference.com/participation

FIRST FLOOR



GROUND FLOOR



INFORMATION

INFORMATION

ACCESS**EU PVSEC Conference**

Upon arrival at Marseille Chanot Convention and Exhibition Centre, Conference participants should proceed to the Conference Registration Desk at the Registration Area, 1st floor to check in and pick up their badge.

Opening hours of the Conference Registration Desk:

Sun	08 Sept 2019	16:00 – 18:00
Mon	09 Sept 2019	07:30 – 19:00
Tue – Thu	10 - 12 Sept 2019	08:00 – 19:00
Fri	13 Sept 2019	08:00 – 09:30

Conference Badge

Your personalised Conference badge authorises you to visit:

- all EU PVSEC 2019 Conference sessions on day/s registered
- all EU PVSEC 2019 Parallel Events on day/s registered
- the Exhibition (09 - 12 September 2019)

Kindly note, that your badge is not transferable to another person. We ask for your understanding that your personalised admission might be controlled by our staff. In case of loss or find a badge, please inform our staff immediately. Kindly note that lost badges cannot be replaced.

EU PVSEC Exhibition

The Exhibition is open to all Conference Delegates.

Opening hours are from:

Mon	09 Sept 2019	13:00 – 20:00
Tue – Wed	10 - 11 Sept 2019	09:00 – 18:00
Thu	12 Sept 2019	09:00 – 16:00

EU PVSEC Parallel Events

All EU PVSEC 2019 Parallel Events are open to Conference Delegates on day/s registered.

For further information about the EU PVSEC Parallel Events see page 240.

Find here a general overview of the EU PVSEC 2019 ticketing categories and registration benefits:

EU PVSEC 2019 Registration Benefits

Registration Category	Conference	Exhibition	Parallel Events	Information Material	Proceedings	EU PVSEC Dinner	Networking Lunch	Welcome Reception
Full Conference Week	✓	✓	✓	✓	✓			✓
* One Day Admission	✓*	✓	✓*	✓	✓			✓
* Two Days Admission	✓*	✓	✓*	✓	✓			✓
Students	✓	✓	✓	✓	✓			✓
Networking Lunch (from Mon - Thu)							✓	
EU PVSEC Dinner (Wednesday)						✓		
Exhibition Visitors		✓						

* on registered day/s only

CONFERENCE PROCEEDINGS

The EU PVSEC 2019 Proceedings contain all scientific papers presented at the EU PVSEC 2019 and submitted for publication.

They constitute a comprehensive source of state-of-the-art information and vital point of reference for researchers, technologists, decision-makers, entrepreneurs and all involved in the global PV sector.

The EU PVSEC 2019 Proceedings include full presented papers, slides presentations and poster presentations (if available).

A digital identifier (DOI code) has been assigned to each paper to ensure unequivocal and permanent identification and citation capability of the online publication. This identification system is administered by the German National Library of Science and Technology.

Conference participants will have immediate and free access to the EU PVSEC 2019 Proceedings right after publication. All EU PVSEC Proceedings are published under a full free access policy and are searchable online (and citable online). This underlines our commitment to prioritising quick and open access to high quality scientific results and allows the entire PV community to easily access this comprehensive database for PV research and technology, renowned for the high standard of its scientific contributions.

The EU PVSEC Proceedings are available on www.eupvsec-proceedings.com.

Authors are requested to submit their manuscript for publication in the Conference Proceedings (see page 334).

COOPERATION WITH 'PROGRESS IN PHOTOVOLTAICS'

In 2019, *Progress in Photovoltaics* once again proudly partners with the EU PVSEC. Through the partnership, selected research papers from the event will be peer reviewed and published on the website and in a digital special issue in *Progress in Photovoltaics*, the high impact, international journal for the latest research in photovoltaic technology in addition to the EU PVSEC 2019 Conference Proceedings.



PRIZES & AWARDS

European Becquerel Prize for Outstanding Merits in Photovoltaics

The European Becquerel Prize for Outstanding Merits in Photovoltaics will be awarded during the Conference. This prize was established by the European Commission in 1989 to mark the 150th anniversary of Alexandre-Edmond Becquerel's discovery of the photovoltaic effect in 1839, which laid the foundation of both, photovoltaics and photography. The Becquerel Prize will be awarded on Monday, 09 September 2019 during the Opening Ceremony in Auditorium 1.

The Becquerel Prize 2019 is awarded to

Dr. Pierre Verlinden

Consultant, Non-Executive Director to PV companies, Visiting Professor at Sun Yat-sen University (Guangzhou).

He receives the award in honour of his scientific and technological merits in the development of high-efficiency photovoltaics. The decision of the Becquerel Committee is based on the outstanding work of Dr. Verlinden on the design of high-efficiency solar cells, modules and systems including back contact and rear side passivated silicon solar cells.



Throughout his career, Dr. Verlinden has pioneered the development of advanced solar cell structures, not limiting his work to just scientific progress but focusing on feasible implementation for industrial mass production. This combination of deep scientific understanding and his contributions to the global PV industry makes his work unique for the progress of photovoltaics over the last 40 years. He has been very active in the global photovoltaic scientific community, serving on numerous scientific boards. Committed to education and teaching for decades, Dr. Verlinden has passed on his great passion and deep knowledge of photovoltaics to generations of young scientists as well as manufacturing engineers.

Award Ceremony

The prize will be awarded at the Opening of this years' European Photovoltaic Solar Energy Conference and Exhibition, on Monday morning, 09 September 2019.

Awards for Outstanding Visual Presentations

This award is one of the highlights of the Closing Session: The most outstanding Visual Presentations of each session will be awarded.

A jury of experts judges the quality of the contents reported and the quality of the presentation.

New this year!: Aiming to increase the visibility of poster awards winners and as a recognition to the quality of their presentation, the winners will have the opportunity to perform a 5 minutes presentation to the poster area audience during the closing visual session on Thursday 12 September from 17:00 to 18:30. Winning posters will be moved to the "winners wall" in the poster area and it is there where the presentations will take place.

Same as in previous years, the awards will be delivered as part of the Conference Closing on Friday, 13 September 2019. The winners will be invited on stage and the winning posters will be projected in the Auditorium.

EU PVSEC 2019 Student Awards

Following the success of previous years, to encourage high-quality work among young researchers and to engage themselves in the scientific examination of the multifaceted issues and questions in the photovoltaic sector, the EU PVSEC Student Awards will be delivered in recognition of the most remarkable and outstanding research work in the field of PV on the occasion of the EU PVSEC 2019. The award is meant to honour students with extraordinary achievements in their scientific activities.

Among the applications received, the EU PVSEC Scientific Committee, made up of more than 230 leading research and industry experts, selected 14 international students who submitted abstracts to one of the seven topics of EU PVSEC's conference programme. Finalists presentations will be evaluated by the Student Awards Committee during the week and the 6 EU PVSEC Student Award Winners will be presented during the Closing Session on Friday, 13 September 2019.

Take the chance to attend the presentation of their outstanding work in the following sessions:

Monday, 09 September 2019

Dennis Bredemeier

ISFH, Emmerthal, Germany

2AO.4.4 *Impact of Silicon Nitride Film Properties on Hydrogen In-Diffusion into Crystalline Silicon*

Andres Calcabrini

Delft University of Technology, The Netherlands

1AO.2.1 *The Ultimate Potential of Reconfigurable Modules for Increasing the Energy Yield of Partially Shaded Urban Photovoltaics Systems*

Nasim Rezaei

Delft University of Technology, The Netherlands

3AO.8.2 *Submicron CIGS Solar Cells: Feasibly towards the Absorption Limit*

Tuesday, 10 September 2019

Achala Satharasinghe

Nottingham Trent University, United Kingdom

1BO.9.2 *Wearable and Washable Photovoltaic Fabrics*

Aline Kirsten Vidal de Oliveira

UFSC, Florianópolis, Brazil

5BO.6.4 *Automatic Fault Detection of Photovoltaic Array by Convolutional Neural Networks during Aerial Infrared Thermography*

Klemens Ilse

Fraunhofer CSP, Halle (Saale), Germany

4BO.11.5 *Physics of Soiling and Dust Adhesion - Lessons Learnt from Laboratory Soiling Tests*

Wednesday, 11 September 2019

Adrien Bercegol

IPVF, Palaiseau, France

3CO.5.2 *Multidimensional Luminescence Imaging of Electron/Hole Transport in Triple Cation Perovskite*

Elise Bruhat

CEA, Le Bourget du Lac, France

2CO.9.1 *Fired Hydrogenated AZO Layers: A New Passivation Approach for High Temperature Passivated Contact Solar Cells*

Laurie-Lou Senaud

CSEM, Neuchâtel, Switzerland

2CO.10.2 *Bottom-Up vs Top-Down Approaches for Identifying and Mitigating the Transport Losses in High-Efficiency Silicon Heterojunction Solar Cells*

Cyril Leon

GeePs, Gif sur Yvette, France

3CO.8.3 *Capacitance-Voltage Characterization Technique Adapted to Tandem Solar Cell*

Dominik Amstad

University of Applied Sciences, Rapperswil, Switzerland

5CV.4.6 *Fault Inspection of CIGS PV Plant Using Aerial Infrared Thermography*

Thursday, 12 September 2019**Kathlen Schneider**

UFSC, Florianópolis, Brazil

7DO.7.1 *Shared Solar Cooperatives in Brazil: Context, Overcoming Barriers and Lessons to Be Drawn from Previous European Countries Experiences*

Sara Mirbagheri Golroodbari

Utrecht University, The Netherlands

5DO.6.3 *Simulation of Performance Differences between Off-Shore and Land-Based Photovoltaic Systems*

Moonyong Kim

UNSW Australia, Sydney, Australia

2DO.6.1 *Generalised LeTID Modelling Using Temperature and Injection-Level Dependencies*

Above programme may be subject to adaptation.

**NETWORKING****Coffee Breaks (for Conference Delegates)**

Coffee Breaks are included in the Conference fee. They will be served during the Conference breaks in the Exhibition Area, 1st floor.

Catering / Restaurants

A special dedicated Networking Lunch could be booked prior to the event. Tickets are not available on-site. The Networking Lunch will be served in a dedicated networking area in exclusive ambiance, directly in the Marseille Chanot Convention and Exhibition Centre. For those who did not include Networking Lunch tickets in their registration, there is a wide range of cafés and restaurants around Marseille Chanot Convention and Exhibition Centre.

Welcome Reception

On Monday, 09 September, there will be a Welcome Reception for all Conference participants and Exhibitors, from 18:30 in the Exhibition Area, 1st floor. Come and meet your colleagues of the PV community and celebrate the EU PVSEC 2019 as a major networking platform for the global PV Solar sector.

EU PVSEC Dinner

The EU PVSEC 2019 Conference Dinner takes place on Wednesday evening, 11 September 2019.

The EU PVSEC Dinner will be a most captivating social event of the EU PVSEC week:

- Meet professionals from the PV world
- Enjoy excellent Cuisine
- Relax and network in pleasant ambiance
- Wednesday, 11 September 2019 from 19:30 – 23:00
- Free Bus Shuttle starting at 18:45 at the Marseille Chanot Convention and Exhibition Centre and going back at 22:00.

Networking Lunch

A networking lunch will be available for interested delegates from Monday to Thursday, 09 – 12 September in a dedicated networking area in exclusive ambiance, directly in the Marseille Chanot Convention and Exhibition Centre, Room Endoume 3, 1st floor.

This avoids queueing up in lunch periods and provides a networking environment. The networking lunch will be served in buffet style, and is convenient for both meat lovers and vegetarians. Tickets can be bought online prior to the event, may become subject to availability and need to be paid in advance. Tickets will not be sold on-site. Access to the networking lunch will be granted upon presentation of a lunch voucher which you will receive at the registration desk on-site along with your registration documents. Lost tickets will not be replaced.

SERVICES

EU PVSEC Programme Online / App

We recommend using the EU PVSEC Programme Online Tool / App in order to most successfully schedule your EU PVSEC week.

The EU PVSEC Programme Online provides a quick and detailed general synopsis of all events, sessions and presentations, speaker's CV and photos of the EU PVSEC 2019. It provides targeted search e.g. by speakers, organisations, topics, product categories, keywords, time and location.

Create your personal, clearly laid out agenda. See at a glance where and when your chosen presentations / sessions take place and get detailed information about the respective topics. You may save and modify your agenda at any time.

Please use the online version at www.eupvsec-planner.com, or the mobile version at mobile.eupvsec-planner.com.

The mobile version is web-based and can be used by all kinds of smartphones. All you need is your smartphone's browser and internet connection.

More information about the EU PVSEC App can be found at www.photovoltaic-conference.com.

INSTRUCTIONS FOR AUTHORS AND PRESENTERS

Plenary / Oral Presentations

Speakers of Plenary and Oral presentations hand in their presentation/s at the **Presenters' Desk (Room Escalette, 1st floor) at least 2 hours prior to the start of their presentation**. A technician will control the correct functionality and transfer the presentation to the respective auditorium. Further details regarding Plenary/Oral Presentations can be found in the Notes for Authors available on the EU PVSEC website.

Opening hours of Presenters' Desk (Room Escalette, 1st floor):

Sun	08 Sept 2019	16:00 – 18:00
Mon	09 Sept 2019	07:30 – 19:00
Tue – Thu	10 - 12 Sept 2019	08:00 – 19:00
Fri	13 Sept 2019	08:00 – 12:00

Speakers and Chairpersons of Plenary and Oral sessions meet **15 minutes prior to the start of their session** in the respective auditorium in order to be briefed and to become acquainted with audio-visual aids.

Visual Presentations

Authors of all Visual Presentations are requested to bring their posters with them and to set them up on the allotted boards during registration hours on Sunday (08 September), or the latest by Monday morning (09 September) and to take them down on Thursday (12 September) after the last Session at 18:30. All Visual presentations should be presented through the full 4 days from Monday to Thursday in the Poster Area. Authors of posters are requested to be in situ at their posters at the session time indicated in the Programme Brochure, in order to present their paper to the audience and to create a Q&A session. Please find all detailed guidelines in the Notes for Authors of Visual Presentations.

Submission of papers for publication in the EU PVSEC Conference Proceedings

In order to be published in the EU PVSEC 2019 Proceedings, corresponding authors of each presentation have to submit the original paper online between 02 - 12 September 2019 in his/her user area.

Only corresponding authors of each submission may upload final manuscripts. This means that the corresponding author is the only author from each paper that is able to complete the submission (as is the case for abstract submission). If the manuscript is not made available during this period, your paper cannot be published in the Conference Proceedings.

The document must be submitted in both Microsoft Word and Adobe Acrobat PDF formats.

To upload the paper, corresponding authors have just to follow the step-by-step procedures provided in the user area and complete the mandatory electronic Copyright Transfer Agreement as one of the steps of the online submission. The Copyright Transfer Agreement is compulsory and can only be carried out electronically. During the submission of your paper, you will be taken automatically to the EU PVSEC electronic copyright form. Your paper submission will not be complete and therefore cannot be published without the electronic copyright submission.

The Instructions for Preparation of Papers are available for download on the EU PVSEC website.

You can find computers and technical support for the online submission of final manuscripts on site.

Opening hours of the "Authors' Area" (Room Escalette, 1st floor) are:

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PLENARY SESSIONS	Page
1AP.1 Routes to High Efficiency in Photovoltaics	6
2BP.1 Silicon PV Highlights	32
3CP.1 Perovskite, Organic, CIGS and III-V Multi-Junction Devices	49
4DP.1 Measurement, Reliability and Sustainability	68
5DP.2 PV Systems and Storage	68
6EP.1 / 7EP.2 PV Impacting Society	90

ORAL SESSIONS	Page
1 New Materials and Concepts for Photovoltaic Devices	
1AO.1 Energy Conversion Mechanisms and Materials Characterisation	12
1AO.2 Conversion Efficiency Limits and Materials Characterisation	16
1AO.3 Light Management and Spectral Conversion	20
1BO.9 Novel Concepts for PV Modules	29
1BO.10 Novel Concepts for Materials and Solar Cells	35

2 Silicon Materials and Cells	
2AO.4 Defects in Crystalline Silicon	13
2AO.5 Crystallizing Silicon for Photovoltaics	17
2AO.6 Thin Silicon Solar Cells	21
2BO.1 PERX Silicon Solar Cells	27
2BO.2 Poly/Si Passivating Contacts (I)	33
2BO.3 Poly/Si Passivating Contacts (II)	36
2BO.4 Advanced Concepts for Si-based Solar Cells	39
2CO.9 TCOs and Surface Passivation	46
2CO.10 Heterojunction Solar Cells (I)	52
2CO.11 Heterojunction Solar Cells (II)	57
2CO.12 Characterisation & Simulation of Si Cells (I)	62
2DO.5 Production Processes Silicon Solar Cells	77
2DO.6 Characterisation & Simulation of Si Cells (II)	81
2EO.1 Manufacturing of Silicon Solar Cells	86

3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices	
3AO.7 Progress in CIGS Modules	14
3AO.8 New Concepts in ChalcoGenides	18
3AO.9 Buffers, Absorbers and Interfaces in CIGS Devices	22
3BO.8 III-V Cells for Space and Terrestrial Applications	40
3CO.5 Perovskite Based Photovoltaics (I)	45
3CO.6 Perovskite Based Photovoltaics (II)	51
3CO.7 Organic and Dye-Sensitised Devices / Optimization of Perovskite Silicon Tandems	56
3CO.8 Perovskite Silicon Tandem Devices	61

4 Photovoltaic Modules and BoS Components	
4BO.11 PV Module Design / Wind Load / Soiling	38
4BO.12 Induced Degradation	42
4BO.13 Module Aging and Degradation	30
4CO.1 Imaging Techniques and Characterisation	44
4CO.2 Outdoor Performance	50
4CO.3 Interconnects and Soldering	55
4CO.4 Module Materials	60
4DO.4 Inverter Design and Integration / Sustainability of PV Systems	71

5 PV Systems and Storage – Modelling, Design, Operation and Performance	
5BO.5 Performance of PV Systems	28
5BO.6 Imaging and Fault Detection in PV Systems	34
5BO.7 Soiling, Degradation and Failure Diagnosis PV Systems	37
5CO.13 Microgrids, Grid Integration and Simulation of PV Systems	47
5CO.14 Storage	53
5DO.1 Solar Resource	70
5DO.2 Forecasting	75
5DO.3 Designing Systems for Specific Environments	80

6 PV Applications and Integration	
6CO.15 Smart PV and Prosumers	58
6CO.16 PV Systems Optimization	64
6DO.8 PV for Buildings	78
6DO.9 PV Integration in Non Conventional Application	82
6EO.2 Professional Applications of PV	87

7 Finance, Markets and Policies	
7DO.7 Lessons from Around the World	73
7EO.3 Economic and Market Analyses	89

VISUAL SESSION	Page
1BV.3 Fundamental Studies / New Materials and Concepts for Cells and Modules	126
2CV.2 Feedstock, Crystallisation, Watering, Defect Engineering /Thin Film and Foil-Based Si Solar Cells /Characterisation & Simulation	139
2DV.1 Homojunction Solar Cells /Heterojunction Solar Cells	165
3BV.1 Cl(G)S, CdTe and Related Thin Film Solar Cells / III-V and Related Compound Semiconductor Based Devices	111
3BV.2 Perovskites Based Photovoltaics / Organic and Dye-Sensitised Devices / Tandems	119
4AV.1 PV Module Design, Manufacture, Performance and Reliability (I)	95
4AV.2 PV Module Design, Manufacture, Performance and Reliability/Inverters and Balance of System Components/Sustainability and Recycling	102
5CV.3 Solar Resource and Forecasting / Design and Installation of PV Systems / Storage / Concentrators and PV for Space Applications	151
5CV.4 Operation, Performance and Maintenance of PV Systems	157
6BV.4 PV on/in Buildings, Infrastructure, Landscape, Water and Nature / Professional Applications of PV	130
6CV.1 PV Driven Energy Management and System Integration	136
7DV.2 Costs, Economics, Finance and Markets / Policies and Scenarios for Renewables, Societal and Global Challenges	175

Conference Programme Outline

Monday, 09 September	Tuesday, 10 September	Wednesday, 11 September	Thursday, 12 September	Friday, 13 September
<p>08:30</p> <p>Opening</p> <p>Scientific Opening 1AP.1 (60 min plenary) Auditorium 1</p> <p>Becquerel Prize Ceremony</p> <p>10:00</p> <p>Opening Addresses</p> <p>Moderated Panel Discussion</p> <p>11:00</p> <p>12:15</p> <p>Lunch</p> <p>1A0.1 2A0.4 3A0.7 Poster T1.1 T2.1 T3.2 Awards Auditorium 1</p> <p>1A0.2 2A0.5 3A0.8 4AV.1 T1.1 T2.1 T3.2 Auditorium 1</p> <p>15:00</p> <p>Break</p> <p>15:15</p> <p>1A0.3 2A0.6 3A0.9 4AV.2 T1.2 T2.1/4 T3.2 Auditorium 3</p> <p>16:45</p> <p>Break</p> <p>17:00</p> <p>EU PVSEC Welcome Reception</p>	<p>10:30</p> <p>Break</p> <p>2BO.1 5BO.5 1BO.9 4BO.13 3BV.1 T2.2 T5.3 T1.2 Auditor 1</p> <p>12:10</p> <p>2BP.1 (100 min plenary) Auditorium 1</p> <p>12:45</p> <p>Lunch</p> <p>2BO.2 5BO.6 1BO.10 3BV.2 T2.2/3 T5.3 T1.2 Auditor 1</p> <p>2BO.3 5BO.7 4BO.11 1BV.3 T2.2/3 T5.3 T4.1 Auditor 1</p> <p>2BO.4 3BO.8 4BO.12 6BV.4 T2.2/3 T3.4/5.5 T4.1 Auditor 1</p> <p>Break</p> <p>EU PVSEC Dinner</p>	<p>10:30</p> <p>Break</p> <p>3CP.1 (90 min plenary) Auditorium 1</p> <p>12:00</p> <p>12:45</p> <p>Lunch</p> <p>4CO.2 3CO.6 2CO.10 5CO.14 2CV.2 T4.1 Auditor 1</p> <p>4CO.3 3CO.7 2CO.11 6CO.15 5CV.3 T4.1 Auditor 1</p> <p>4CO.4 3CO.8 2CO.12 6CO.16 5CV.4 T4.1 Auditor 1</p> <p>Break</p>	<p>10:00</p> <p>4DP.1 (90 min plenary) Auditorium 1</p> <p>10:30</p> <p>Break</p> <p>12:10</p> <p>5DP.2 (100 min plenary) Auditorium 1</p> <p>12:45</p> <p>Lunch</p> <p>5DO.1 4DO.4 7DO.7 2DV.1 T4.2/3 Auditor 2</p> <p>5DO.2 2DO.5 6DO.8 7DV.2 T5.1 T2.6 T6.1 Auditor 1</p> <p>5DO.3 2DO.6 6DO.9 6DO.9 T5.2 T2.5 T6.1 Auditor 2</p> <p>Break</p>	<p>08:30</p> <p>2EO.1 6EO.2 7EO.3 T2.6 T6.2 T7.1 Auditor 1</p> <p>10:00</p> <p>Break</p> <p>12:10</p> <p>6EP.1 / 7EP.2 (joint session 100 min plenary) Auditorium 1</p> <p>13:30</p> <p>Closing Session</p> <p>Key note, Highlights of the Conference, Poster Awards, Student Awards, Farewell</p>
<p>1 New Materials and Concepts for Photovoltaic Devices</p> <p>T1.1 Fundamental Studies</p> <p>T1.2 New Materials and Concepts for Cells and Modules</p> <p>2 Silicon Materials and Cells</p> <p>T2.1 Feedstock, Crystallisation, Watering, Defect Engineering</p> <p>T2.2 Homojunction Solar Cells</p> <p>T2.3 Heterojunction Solar Cells</p> <p>T2.4 Thin Film and Foil-Based Si Solar Cells</p> <p>T2.5 Characterisation & Simulation of Si Cells</p> <p>T2.6 Manufacturing & Production of Si Cells</p> <p>3 Perovskites, other Non-Silicon-Based Photovoltaics and Multi-Junction Devices</p> <p>T3.1 Perovskites Based Photovoltaics</p> <p>T3.2 CIGS, CdTe and Related Thin Film Solar Cells</p> <p>T3.3 Organic and Dye-Sensitised Devices</p> <p>T3.4 III-V and Related Compound Semiconductor Based Devices</p> <p>T3.5 Tandems</p> <p>4 Photovoltaic Modules and BoS Components</p> <p>T4.1 PV Module Design, Manufacture, Performance and Reliability</p> <p>T4.2 Inverters and Balance of System Components</p> <p>T4.3 Sustainability and Recycling</p> <p>5 PV Systems and Storage – Modelling, Design, Operation and Performance</p> <p>T5.1 Solar Resource and Forecasting</p> <p>T5.2 Design and Installation of PV Systems</p> <p>T5.3 Operation, Performance and Maintenance of PV Systems</p> <p>T5.4 Storage</p> <p>T5.5 Concentrators and PV for Space Applications</p> <p>6 PV Applications and Integration</p> <p>T6.1 PV on/in Buildings, Infrastructure, Landscape, Water and Nature</p> <p>T6.2 Professional Applications of PV</p> <p>T6.3 PV Driven Energy Management and System Integration</p> <p>7 Finance, Markets and Policies</p> <p>T7.1 Costs, Economics, Finance and Markets</p> <p>T7.2 Policies and Scenarios for Renewables, Societal and Global Challenges</p>				

Topics / Subtopics

Session Code



Day Codes

- A** Monday, 09 Sept 2019
- B** Tuesday, 10 Sept 2019
- C** Wednesday, 11 Sept 2019
- D** Thursday, 12 Sept 2019
- E** Friday, 13 Sept 2019

Session Type

- P** Plenary Session
- O** Oral Session
- V** Visual Session

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