Conference Programme

Monday, 09 September 2019

OPENING

PLENARY SESSION 1AP.1

08:30 - 10:00 Routes to High Efficiency in Photovoltaics

Chairpersons:
Seth Hubbard
Rochester Institute of Technology, United States
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. Nivelle
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

Becquerel Prize Ceremony

10:00 Opening Addresses

Moderated Panel Discussion

ORAL PRESENTATIONS 1AO.1

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

Chairpersons:
Louise Hirst
University of Cambridge, United Kingdom
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, Korea South
J.H. Noh
Korea University, Seoul, Korea South
N.J. Jeon
KRICT, Daejeon, Korea South

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
National Cheng Kung University, Tainan, Taiwan
P. Yu & A. Lin
NCTU, Hsinchu, 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 & M.C. Schubert
Fraunhofer ISE, Freiburg, Germany
G. Coletti
ECN, Petten, 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. Søndenå, 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 **Hydrogenation in Multicrystalline Silicon: The Dependence of Dielectric Films and the Impact of Firing Conditions**
H.C. Sio, S.P. Phang, H.T. Nguyen & D. Macdonald
ANU, Canberra, Australia

2AO.4.6 **Light-Induced Degradation in Boron-Doped Cz Silicon PERC: Excessive Enhancement by Dark Annealing**
F. Fertig, R. Lantzsch, F. Kersten, F. Frühauf, J. Lindroos, C. Taubitz, M. Schütze & J.W. Müller
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

Monday, 09 September 2019

ORAL PRESENTATIONS 3AO.7

13:30 - 15:00 Progress in CIGS Modules

Chairpersons:
Alessandro Romeo
University of Verona, Italy
Susanne Siebentritt *(i)*
University of Luxembourg, Luxembourg

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
EDF R&D - IPVF, Palaiseau, France
R. Würz & F. Kessler
ZSW, Stuttgart, Germany
D. Cammilleri
IPVF, Palaiseau, France
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, Korea South

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, Netherlands
G. Torres Sevilla & Y.E. Romanyuk
EMPA, Dubendorf, Switzerland

ORAL PRESENTATIONS 1AO.2

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

Chairpersons:
Jean-Francois Guillemoles
CNRS, France

Invited

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, 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

Monday, 09 September 2019

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
Thomas Dalibor
Avancis, Germany

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, Netherlands
D. Flandre & J. Lontchi
UCL, Louvain-la-Neuve, Belgium
M. Kovacic & J. Krc
University of Ljubljana, Slovenia
L. Gouillart, 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, Netherlands
Z. Vroon
TNO, Geleen, Netherlands

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

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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 *Invited*

3AO.8.6 **Improving the Efficiency of Kesterite Cu2ZnSnS4 Solar Cells by Controlling the Heterojunction Interface Chemistry**
K. Sun, J. Huang, C. Yan, H. Sun, M.A. Green & X. Hao
UNSW Australia, Sydney, Australia

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:
Invited

James Patrick Connolly
CNRS, 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 FIms 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 **Student Award Finalist Presentation: Oxygen-Enhanced Upconversion of Near Infrared Light**
E. M. Gholizadeh & T.W. Schmidt
UNSW Australia, Sydney, Australia

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

Invited

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. Stuchlík, 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, Korea South
M. Shin
Korea Aerospace University, Goyang, Korea South

Monday, 09 September 2019

ORAL PRESENTATIONS 3AO.9

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

Chairpersons:
Alex Redinger *(i)*
University of Luxembourg, Luxembourg
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, Germany
J. Keutgen & O. Cojocaru-Mirédin
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'.

Tuesday, 10 September 2019

ORAL PRESENTATIONS 2BO.1

08:30 - 10:00 **PERX Silicon Solar Cells**

Chairpersons:
Invited

Ralf Preu
Fraunhofer ISE, Germany

2BO.1.1 **Optimization of Rear Al Fire-Through Contacts for Bifacial p-Type PERC with AlOx/SiNx Rear Passivation**
D. Ourinson, T. Javaid, 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, Netherlands
B.W.H. van de Loo & P.R. Venema
Tempress, Vaassen, 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, 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
Sinogreenergy, 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

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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:
Invited

Richard King
Arizona State University, United States

1BO.9.1 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

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
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, Netherlands

ORAL PRESENTATIONS 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. Christoefl
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

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4BO.13.6 Development of Inhomogeneities in Multi-Crystalline Silicon PV Modules over Two Years of Real Operating Conditions
M. Bokalic, K. Brecl & M. Topic
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 Invited Plenary Presentation

2BP.1.2 The Versatility of Passivating Carrier-Selective Silicon Thin Films for Diverse High-Efficiency Heterojunction-Based Solar Cells
A. Descoeudres, 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. Steinhauser, 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 in Jolywood
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:
Invited

Jean-Paul Kleider
CNRS, 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. Steinhauser & 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. Descoeudres, 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, Petten, 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

Invited

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. Rüther
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. Berenguier & 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 Ga0.37In0.63P**
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 *Invited*

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, Korea South

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, Netherlands
Qi Wang *(i)*
Jinko Solar, China

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, 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

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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, Korea South

ORAL PRESENTATIONS 5BO.7

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

Chairpersons:
Invited

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, 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'.

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ORAL PRESENTATIONS 2BO.4

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

Chairpersons:
Joachim John
imec, Belgium
Jörg Müller *(i)*
Hanwha Q CELLS, Germany

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, 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, Petten, 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, Netherlands

Invited

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. Grandidier, 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

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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'.

Wednesday, 11 September 2019

ORAL PRESENTATIONS 4CO.1

08:30 - 10:00 Imaging Techniques and Characterisation

Chairpersons:
Yoshihiro Hishikawa
AIST, Japan

Invited

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

Wednesday, 11 September 2019

ORAL PRESENTATIONS 3CO.5

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

Chairpersons:
Invited

Christopher Case
Oxford PV Ltd, 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. Hirotani, 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 **Impact of the Material Design on Stability of Perovskite Photovoltaics**
A.F. Akbulatov, L.A. Frolova & O. Yamilova
RAS, Chernogolovka, Russia
K.J. Stevenson & P. Troshin
Skoltech, Moscow, Russia

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, Netherlands
E. Hoek & P.C.P. Bronsveld
ECN part of TNO, Petten, Netherlands

2CO.9.3 **Field-Effect Passivation Enhancement by Introducing Nanopyramid Gratings for Light Management in Homojunction Silicon Solar Cells**
A. Razzaq, 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

Wednesday, 11 September 2019

ORAL PRESENTATIONS 5CO.13

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

Chairpersons:
Franck Al-Shakarchi
CEATECH-INES, France

Invited

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 *Invited*

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. Seitl & 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 *Invited*

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 **Invited Plenary Presentation**

VISUAL PRESENTATIONS 2CV.2

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

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, Netherlands
B. Van Aken
ECN, Petten, Netherlands

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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, 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 & 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. Lemaitre & S. Berson
CEA, Le Bourget du Lac, France

3CO.6.5 **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

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/Solliance, Eindhoven, Netherlands
C. Burgess & M. Creatore
Eindhoven University of Technology, Netherlands
T. Aernouts
IMEC-Solliance, 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. Champliaud & 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, 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, Netherlands
S. Senkader
Norwegian Crystals, Oslo, Norway
F. Versluis, I. Claassen & A. Molinari
Uniresearch, Delft, 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. Descoeudres, 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

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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:
Invited

Francesco Dolci
European Commission JRC, 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, Netherlands
J. Lauret
ELESTOR, Arnhem, Netherlands
R. van de Kar
Gemeente Noordoostpolder, Emmeloord, Netherlands
S. Tuinstra
Bij ZON, Spanbroek, Netherlands
P. Puttkammer
Witteveen+Bos, Deventer, 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 **Economic Analysis of Residential PV Storage Systems with Power-to-Heat Coupling for Control Reserve Provision**
G. Angenendt, S. Zurmühlen & D.U. Sauer
RWTH Aachen University, Germany

5CO.14.6 **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
SOLAÏS, Sophia Antipolis, France

ORAL PRESENTATIONS 4CO.3

15:15 - 16:45 Interconnects and Soldering

Chairpersons:
Tony Sample
European Commission JRC, Italy

Invited

4CO.3.1 **Stress-Free Interconnection for Shingled Structure Module**
H.S. Cho, J.I. Lee, S. Park, H.-E. Song & M.G. Kang
KIER, Daejeon, Korea South
D.-Y. Shin
Pukyong National University, Busan, Korea South

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. Descoeudres, J. Geissbühler, J. Champliaud, N. Badel, E. Muliqi, M. Despeisse & C. Ballif
CSEM, Neuchâtel, Switzerland
D. Lachenal, P. Papet & B. Strahm
Meyer Burger Research, Hauterive, Switzerland
N.E. Voicu & I.J. Bennett
DSM Innovation, Geleen, 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

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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, 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, Korea South

3CO.7.3 **Power Performance and Thermal Operation of Organic Photovoltaic Modules in Real Operating Conditions**
G. Bardizza, E. Salis & E.D. Dunlop
European Commission JRC, Ispra, Italy
C.A. Toledo Arias
UPCT, Cartagena, Spain

3CO.7.4 **Energy Yield Modelling of Perovskite-Based Tandem Photovoltaics**
M. Langenhorst, R. Schmager & U.W. Paetzold
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany
J. Lehr, U. Lemmer & B.S. Richards
Karlsruhe Institute of Technology, 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
Matthieu Despeisse
CSEM, Switzerland

2CO.11.1 **Design and Characterization of High-Efficiency Silicon Heterojunction Solar Cells**
M. Boccard, L. Antognini, J. Cattin, J. Dréon, 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. Nowottnick
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 in Now Ready for Market**
D. Muñoz & C. Roux
CEA, Grenoble, France

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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, Netherlands

6CO.15.3 **Impact of Behavior on Using Photovoltaics to Charge Electric Vehicles: Systematic Analysis**
N. Pflugradt & U. Muntwyler
BUAS, Burgdorf, Switzerland

6CO.15.4 **From Solitary Pro-Sumers to Energy Community: Quantitative Assesment 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, 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

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

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. Topic
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, Netherlands
N. Voicu
DSM Advanced Solar, Geleen, Netherlands
A. Faes, J. Levrat, J. Champliaud & 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

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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. Bräuninger, 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 Pervoskite/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 Aples, 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, Petten, Netherlands
F. Di Giacomo, M. Najafi, D. Zhang, R.A.J.M. Andriessen & S.C. Veenstra
ECN, Eindhoven, Netherlands
T. Aernouts
imec, Genk, Belgium
J. Hüpkes
Forschungszentrum Jülich, Germany
C. Burgess & M. Creatore
Eindhoven University of Technology, 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 Topic
University of Ljubljana, Slovenia
Karsten Bothe *(i)*
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, 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, 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, Hauterive, Switzerland
W. Duan, A. Lambertz & K. Ding
Forschungszentrum Jülich, Germany
A. Fejfar
Czech Academy of Sciences, Prague, Czech Republic

Wednesday, 11 September 2019

ORAL PRESENTATIONS 6CO.16

17:00 - 18:30 PV Systems Optimization

Chairpersons:
Franz P. Baumgartner
ZHAW, Switzerland

Invited

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. Grottke
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, A. Lluna Arriaga, 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'.

Thursday, 12 September 2019

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 *(i)*
Band Gap, Germany
Laurent Torcheux
EDF R&D, France

5DP.2.1 **Invited Keynote Presentation**

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, Netherlands

Thursday, 12 September 2019

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 Protogeropoulos
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, Korea South
A. Benlarabi
IRESEN, Rabat, Morocco
J.-H. Choi
KTL, Seoul, Korea South
M. Ebert & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
B. Figgis
QEERI, Doha, Qatar
K.S. Kim
KIER, Yuseong-gu, Korea South
T. Reindl
SERIS, Singapore, Singapore
R. Rüther
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, Nikosia, Cyprus
G. Yang
Technical University of Denmark, Kongens Lyngby, Denmark

Thursday, 12 September 2019

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, Korea South
R. Bründlinger, R. Ablinger, C. Messner, C. Seitl & Z. Miletic
AIT, Vienna, Austria
J. Hashimoto & K. Otani
AIST, Fukushima, Japan
I. Vidaurrazaga 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. Rüther
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, 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

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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, 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
Mines ParisTech, Sophia Antipolis, France
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 **Intrahour Solar PV Production Forecasting: A Benchmark of Independent Methods Based Irradiance Measurements, All-Sky Imager or Satellite Data**
P. Aillaud, L. Huet, M. Turpin, O. Liandrat, H.S. de Lavoreille & S. Cros
Reuniwatt, Sainte-Clotilde, France

ORAL PRESENTATIONS 2DO.5

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

Chairpersons:
Peter Fath
RCT-Solutions, Germany
Derk L. Bätzner
Meyer Burger Research, Switzerland

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

Thursday, 12 September 2019

2DO.5.2 **The Influnce of Diffusion Condtion 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. Gensowski, 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
BFH - Bern University of Applied Sciences, 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 Dobbelsteen, O. Isabella & M. Zeman
Delft University of Technology, 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, 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, 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, Netherlands

Thursday, 12 September 2019

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. Boublil & 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, Netherlands
H. Lok, L.S. Bosma & T. Jansma
Hanze University, Groningen, 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, Netherlands

ORAL PRESENTATIONS 2DO.6

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

Chairpersons:
Invited

Ivan Gordon
imec, Belgium

2DO.6.1 **Student Award Finalist Presentation: Generalised LeTID Modelling Using Temperature and Injection-Level Dependencies**
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, 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-Veettill & 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
Eric Scotto *(i)*
Akuo Energy, France

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, 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**
V. Godefroy & A.-L. Gorge
Sun'R, 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

Friday, 13 September 2019

ORAL PRESENTATIONS 2EO.1

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

Chairpersons:
Invited

Invited

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 Heterojuntion 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, Hauterive, Switzerland

2EO.1.4 **Large Area TOPC on Cells Realized by a PECVD Tube Process**
F. Feldmann, T. Fellmeth, B. Steinhauser, 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, 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 Electrolitic Water Treatment for Industrial Application**
S. Shimura
IFSP, São Paulo, Brazil
R. de Paula Diver
UNICAMP, Campinas, Brazil

Friday, 13 September 2019

ORAL PRESENTATIONS 7EO.3

08:30 - 10:00 Economic and Market Analisys

Chairpersons:
Invited

Invited

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

PLENARY SESSION 6EP.1 / 7EP.2

10:30 - 12:10 PV Impacting Society

Chairpersons:
Francesco Frontini
SUPSI, Switzerland
Stefan Nowak *(i)*
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

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 **Invited Plenary Presentation**

7EP.2.3 **Mass-Scale Solar Hydrogen: How PV is Set to Become the New Oil**
T. Lepercq
Solairestream, Paris, France

Visual Presentations

Monday, 09 September 2019

VISUAL PRESENTATIONS 4AV.1

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

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
Shinsung E&G, Jeungpyeong-gun, Korea South

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 Photovoltics 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. Topic
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

Monday, 09 September 2019

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.1.35 **Adhesion Force Degradation in Degraded Single Junction Amorphous Silicon Module**
E.L. Meyer & G. Osayemwenre
University of Fort Hare, Alice, South Africa

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. Martinez-Sacristan, M.A. González-Rebollo & J. Jiménez-López
University of Valladolid, Spain
S. Gallardo-Saavedra, V. Alonso-Gómez, L. Hernández-Callejo & J.I. Morales-Aragonés
University of Valladolid, Soria, 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, 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

Monday, 09 September 2019

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.1.43 **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

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, 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
Fraunhofer CSP, Halle (Saale), Germany
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, 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, 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, Korea South

4AV.1.53 **Performance Research of Hotspot Free p-Multi Crystalline and n–Type Bifacial Silicon Module**
J. Ni, T. Feng, Y. Li, H. Liu, F. Wang, C. Ma, J. Shi & D. Song
Yingli Green Energy, Baoding, China
Z. Huang
Alphasolar, Suzhou, China

4AV.1.54 **Reliability and Durability Infulence of Different Backsheet for PV Modules in High Humiduty Enviroment**
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 **Perfromance Degradation of Solar Modules for Solar Roadways**
J.H. Kim
DGIST, Daegu, Korea South
F. Khan
KFUPM, Dhahran, Saudi Arabia

4AV.1.57 **Hecaro(TM) for Shingled Cell Modules: Low Silver Content ECA Enabling Exceptional Long-Term Reliability**
D. Holzmann, T. Wegner, D. Ries, M. Deckelmann, M. König & I. Luck
Heraeus, Hanau, Germany

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

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, Korea South
G.-G. Kim
Chungbuk Technopark, Jincheon, Korea South
C.-S. Won
Floating PV Team, Gyeonggi-Do, Korea South
O. Kwon & H. Jo
K-water, Daejeon, Korea South
H.J. Go
Koenergy, Gyeongsangnam-Do, Korea South

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

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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, Korea South
C.-S. Won
Scotra, Pyeongtaek, Korea South
Y.K. Kwon
Korea Testing Laboratory, Ansan, Korea South
C.Y. Cho
Sun engineering, Daejeon, Korea South
H. Jo & O. Kwon
K-water, Daejeon, Korea South
H.J. Go
Koenergy, Jinju, Korea South

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. Yang & H. Wang
Xi'an Jiaotong University, China

4AV.2.9 **Statistical El-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. Ouberri, 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, 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, M. Field, 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
University of Valladolid, Soria, Spain
A. Moreton-Fernandez, M.M. Jiménez-Martín, O. Martinez-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

Monday, 09 September 2019

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
Firenze, 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.2.34 **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. Seitl
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.2.40 **Aiming at Resolving Limitation of Indian Standard (IS): 2911-1-2 Regarding Calculation of Lateral Load Capacity for Short Rigid Piles of Solar Module Mounting Structure**
S. Chatterjee
RGM International, Kolkata, India
S. Mukherjee
KEC International, Mumbai, India

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. Poulopoulos & 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.2.52 **An Universal Recycling Technology for Thin Film and Silicon Based Photovoltaic Modules as an Example for Circular Economy**
W. Palitzsch, A. Killenberg & I. Röver
Loser 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, Korea South

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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

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

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, Korea South

3BV.1.5 Space-Charge Limited Current in CdTe Thin Film Solar Cell
Q. Li, X. Li, R. Yang & D. Wang
USTC, Hefei, China

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, 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

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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. Topic
University of Ljubljana, Slovenia
W.-C. Chen & M. Edoff
Uppsala University, Sweden
P.J. Bolt & J. van Deelen
TNO, Eindhoven, 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, Korea South

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, Korea South

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, Netherlands
E. Haverkamp
ReRa Solutions, Nijmegen, 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

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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?Se1-?)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, 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 MgxZn1-xO 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, Korea South

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. Siepchen
CTF Solar, Dresden, Germany
O. Zywitzki, T. Modes, D. Hirsch, T. Kopte & C. Metzner
Fraunhofer FEP, Dresden, Germany
S. Peng
CTIEC, Shanghai, China

3BV.1.46 **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, Korea South
S.H. Jung & H.K. Kang
KANC, Suwon, Korea South

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. Butkuté, 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. Tummalieh & 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 Husseini, 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. Xinyi
State Key Lab of Space Powersources, Shanghai, China

Tuesday, 10 September 2019

3BV.1.55 **Multijuction 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

VISUAL PRESENTATIONS 3BV.2

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

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.2.4 **Synthesis and Investigation of the Properties of Perovskites with Noncontact Methods**
V.P. Kostylyov, A.V. Sachenko, V.M. Vlasiuk, I.O. Sokolovskyi, S.D. Kobylianska, P.V. Torchyniuk, O.I. V'yunov & A.G. Belous
NAS ISP, Kyiv, Ukraine

3BV.2.5 **The Effect of Structural Dimensionality on Carrier Mobility in Lead-Halide Perovskites**
N.T.P. Hartono, S. Sun, J. Yoo, M. Bawendi, T. Buonassisi & J.-P. Correa-Baena
MIT, Cambridge, United States
M. Gélvez-Rueda & F. Grozema
Delft University of Technology, Netherlands
P. Pierone, M. Erodici & M.J. Sher
Wesleyan University, Middletown, United States
F. Wei
A*STAR, Singapore, Singapore

3BV.2.6 **Reduced Dimensional Perovskites: In-Situ Investigation of Film Formation and Morphological Studies Affecting the Device Performance**
R. Munir, A. Merdasa, K. Hirselandt, O. Shargaieva, J. Dagar & E. Unger
HZB, Berlin, Germany

3BV.2.7 **Optically Uniform Thin Films of Mesoporous TiO2 for Perovskite Solar Cell Applications**
A. Hernandez Granados, A.N. Corpus Mendoza, P.M. Moreno-Romero, C.A. Rodríguez-Castañeda, J.E. Pascoe-Sussoni, O.A. Castelo-González & H. Hu
UNAM, Temixco, Mexico
E.C. Menchaca-Campos
UAEM, Cuernavaca, Mexico
J. Escorcia-García
CONACYT-CINVESTAV, Ramos Arizpe, Mexico

3BV.2.8 **Fabrication of Smooth, Mirror-Like and PbI2-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-Diaz & 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-Diaz, 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-Diaz
ULL, La Laguna, Spain

3BV.2.18 **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

3BV.2.19 **Wet (CBD, Spin-Coating) and Dry (ALD, CVD) Deposition of Tunable Metal Hybrid Perovskites MASnxPb1-x(IxBr1-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, Dubendorf, Switzerland
D. Martineau & T. Meyer
Solaronix, Aubonne, Switzerland

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3BV.2.21 **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

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.2.35 **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.2.38 **Hybrid Materials Based on ZnO and Conductive Polymers Generated in Situ by PEP as Photoanodes in Solid-State Dye Sensitized Solar Cells**
M.-P. Santoni, M. Jouini, A. Délices, C.-Z. Dong & S. Bellynck
Paris Diderot University, 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.2.40 **Great Stability Enhancement of Anchored Dyes on Mesoporous Metal Oxide Electrodes Upon Crosslinking for DSSCs and DSPECs**
Y. Bentounsi, S. Diring, Y. Pellegrin, E. Blart & F. Odobel
CNRS, Nantes, France

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.2.48 **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/Solliance, Eindhoven, Netherlands
T. Aernouts
Imec/Solliance, Genk, Belgium

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
CNRS, Gif sur Yvette, France
C. Renard, G. Hallais, L. Vincent & D. Bouchier
C2N, Palaiseau, France
J.P. Connolly
CNRS, Gif sur Yvette, Spain
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. Patriarche & M. Tchernycheva
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, Korea South

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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

VISUAL PRESENTATIONS 1BV.3

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

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.3.3 **C-AFM and KPFM Characterization of poly-Si/SiOx/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

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.3.6 **Optimal Transparent Matrix Materials for Luminescent Solar Concentrators**
M.R. Kulish, V.P. Kostylyov, A.V. Sachenko & I.O. Sokolovskyi
NAS ISP, Kyiv, Ukraine
A.I. Shkrebtii / Chkrebtii
University of Ontario, Oshawa, Canada

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.3.12 **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, Korea South

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

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1BV.3.21 **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

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.3.24 **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, Korea South
M.J. Yun, S.I. Cha & D.Y. Lee
KERI, Changwon, Korea South

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, Netherlands

1BV.3.26 **Vertically Aligned Heterojunction Sb2S3 Solar Cells**
Y. Zeng, K. Sun, J. Huang, M.A. Green & X. Hao
UNSW Australia, Sydney, Australia
H. Deng & H. Song
HUST, Wuhan, China

1BV.3.27 **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

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, Korea South

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
IIEST 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.3.43 **Synthesis of Silicon Nanoparticles from the Padma River Sand of Bangladesh and Their Application in Thin-Film Solar Cell**
M.A. Kuddus & A.B.M. Ismail
University of Rajshahi, Bangladesh

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

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1BV.3.46 **Synthesis and Characterization of Cu2NiSnS4 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

VISUAL PRESENTATIONS 6BV.4

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

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. Heinstein, 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, 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-OOE, Wels, Austria
G.C. Eder
OFI, Vienna, Austria
K.A. Berger & G. Újvári
AIT, Vienna, Austria
D. Moor
Ertex Solar, Amstetten, Austria
S. Boddaert
CSTB, Sophia Antipolis, France
R.M.E. Valckenborg & J. van den Brand
SEAC, Eindhoven, 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 Martinez & M. Machado
Tecnalia, San Sebastián, Spain
J.T. Kim
Kongju National University, Cheonan, Korea South
A. Masolin & M. Ritzen
ZUYD, Heerlen, 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, Korea South
C.-S. Won
Scotra, Pyeongtaek, Korea South
S.C. Woo
Woodo Energy, Busan, Korea South
S.H. Lee
KETEP, Seoul, Korea South
H.J. Go
Koenergy, Jinju, Korea South
H. Jo & O. Kwon
K-water, Daejeon, Korea South

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

Tuesday, 10 September 2019

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, Netherlands
D.-J. Bles
Plastica Plaat, Waalwijk, 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. Jomâa
SINTEF, Oslo, Norway

6BV.4.15 **Development of a Photovoltaic Powered Poultry Egg Incubator**
W.I. Okonkwo & O. Onyekwere
University of Nigeria, Nsukka, Nigeria

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.4.19 **Bifacial PV Cylindrical Modules Track Mounted over Areas of Massive Leached Pristine White Salt Crust Canopies, Designed to Anthropogenically Control World Albedo Irradiation or Absorption of Light Energy**
D. Bloch
Salt Archive, Telaviv, Israel

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, Korea South

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, Netherlands
A. De Vries
Celstar, Brussels, Belgium
W.G.J.H.M. van Sark
Utrecht University, 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. Neugebohrn, 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.4.31 **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

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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.4.33 **Efficiency Enhancement of PV under Desert Conditions by Day- and Night-Time Thermal Control**
M.N. Reda, B. Heithorst, M. Spinnler & T. Sattelmayer
TUM, Garching, Germany
H. Al-Kayiem
Petronas University of Technology, Perak, Malaysia

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

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VISUAL PRESENTATIONS 6CV.1

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

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. Wyrsch
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. Hatziargyriou
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

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6CV.1.10 **Development of a Photovoltaic Driven Thermodynamic Chiller - Application to Solar Air Conditioning and Cooling Storage**
P. Esparcieux & O. Baup
Atisys Concept, Toulon, France
C. Marvillet
CNAM, Paris, France
C. Weber
Neotherm, Le Bourget-u-ac, France
D. Mugnier
Tecsol, Perpignan, France

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, Bogota, 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. Topic
University of Ljubljana, Slovenia

VISUAL PRESENTATIONS 2CV.2

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

2CV.2.1 **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

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. Søndenå
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

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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. Søndenå
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. Søndenå
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, Korea South

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, Wettenberg, 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, Korea South

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. Köpge, 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, Korea South
D.-W. Kang
Chung-Ang University, Seoul, Korea South
M. Shin
Korea Aerospace University, Goyang, Korea South

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, Korea South

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, Korea South

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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.2.39 **Influence of the Removable Recombination Mechanisms on the Photoconversion Parameters of High-Efficiency Silicon Solar Cells**
A.V. Sachenko, V.P. Kostylyov & I.O. Sokolovskyi
NAS ISP, Kyiv, Ukraine
M. Evstigneev
Memorial University of Newfoundland, St. John's, Canada

2CV.2.40 **Toward the Optimizing the Textured Silicon-Based Solar Cells**
A.V. Sachenko, V.P. Kostylyov, V.M. Vlasiuk & I.O. Sokolovskyi
NAS ISP, Kyiv, Ukraine
M. Evstigneev
Memorial University of Newfoundland, St. John's, Canada

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, Korea South

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
Nagoya Institute of Technology, Koriyama, Japan

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, Bhilai, 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.2.48 **The Influence of Parameters Extraction Approaches on Silicon-Based Photovoltaic Cell Performances**
Y. Chaibi & M. Salhi
Moulay Ismail University, Meknes, Morocco

2CV.2.49 **Improving the Analysis of Contact Recombination by Photoluminescence Imaging**
P. Manshanden
ECN part of TNO, Petten, 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
Fraunhofer CSP, Halle (Saale), Germany
G. Köhler, H.-P. Sperlich, T. Große & H. Mehlich
Meyer Burger, Hohenstein-Ernstthal, Germany

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
IMEP-LAHC, Grenoble, France

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
Meiji University, Kawasaki, Japan

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
Anhalt University of Applied Sciences, Köthen, Germany
J. Hirsch
Fraunhofer CSP, Halle (Saale), Germany

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
Fraunhofer ISE, Freiburg, Germany

2CV.2.57 **Opto-Electronic Properties of Dislocations in Cast-Mono Silicon for Solar Cells**
D. Ory, N. Paul & V. Le-Guen
EDF R&D, Palaiseau, France
T. Bidaud & S. Collin
CNRS, Palaiseau, France
L. Lombez
IPVF, Palaiseau, France

2CV.2.58 **Porous Silicon Low Dielectric Constant Thin Films and Its Application in Solar Cell**
K. Rahmoun
University of Tlemcen, Algeria

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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
KIER, Daejeon, Korea South

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
AMOLF, Amsterdam, Netherlands
T.H. Fung & M. Abbott
UNSW Australia, Sydney, Australia
D. Payne
Macquarie University, Sydney, Australia

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
KOPEL, Kyoto, Japan

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
Risen Energy, Changzhou, China
Y. Ren & L. Zhu
Fusion New Material, Changzhou, China

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
E-TON Solar Tech, Tainan, Taiwan
J.-Y. Hung
New E Materials, Kaohsiung, Taiwan
Z.-P. Yang
National Chiao Tung University, Tainan, Taiwan
I.-S. Yu
National Dong Hwa University, Hualien, Taiwan

2CV.2.74 **The AMPERE Project Key Exploitable Result: A Bifacial Heterojunction Cell and Module Industrial Automated Manufacturing Plant in Europe**
C. Colletti, C. Gerardi & D. Iuvara
ENEL Green Power, Catania, Italy
F. Bizzarri
ENEL Green Power, Rome, Italy
B. Strahm
Meyer Burger Research, Hauterive, Switzerland
A. Richter
Meyer Burger Technology, Gwatt, Switzerland
J.-F. Lerat & D. Muñoz
CEA, Le Bourget du Lac, France
M. Izzi
ENEA, Rome, Italy
J. Levrat & C. Ballif
CSEM, Neuchâtel, Switzerland
O. Nielsen
NorSun, Oslo, Norway
B. Hartlin
ERM, London, United Kingdom
B. Melzer
Jonas & Redmann, Berlin, Germany
M. Tallián
SEMILAB, Budapest, Hungary
S. Lombardo
CNR, Catania, Italy
M. Balucani
RISE Technology, Ostia, Italy
J. Rentsch
Fraunhofer ISE, Freiburg, Germany

2CV.2.75 **23% Efficient Industrial Bifacial n-Type Crystalline Silicon Solar Cells with Electron-Selective Polysilicon Passivating Contacts**
Z. Ma, Z. Ma, W. Gu, X. Qian, J. Sheng, C. Zhang & W. Wang
GCL System Integration Technology, Suzhou, China

2CV.2.76 **Inverted Pyramid Texturing of Monocrystalline Silicon Wafer**
A. Sutejo, H.P. Hsu & C.-W. Lan
NTU, Taipei, Taiwan

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
Korea University, Seoul, Korea South

2CV.2.78 **Simultaneous Front-Side Texturing and Rear-Side Polishing of Monocrystalline Silicon Wafer by Spray-Etching with HF-HCl-Cl2 Mixtures**
K. Halbfaß, 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.2.80 **Industrial Production of MCCE Textured Solar Cells with 19.3% Efficiency**
H. Wang, Z. Xu, 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

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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
UNSW Australia, Sydney, Australia
S. Zou, X.-S. Wang & G. Xing
Canadian Solar, Suzhou, China

2CV.2.83 **Process Optimization for Inline Black Silicon Based Solar Cell Production Line**
M.C. Raval
RCT Solutions, Constance, Germany
S. Gok, T. Eren, M. Comak & M. Ender
BereketEnerji, Pamukkale, Turkey
I. Melnyk, A. Teppe, S. Madugula, W. Jooss & P. Fath
RCT-Solutions, Constance, Germany
B. Hu & J. Zhou
RCT Automation Equipment, Suzhou, China

2CV.2.84 **The Post-Etching Processing of Black Silicon's Surface to the Properties of mc-Si Solar Cells**
R. Jia, X. Dai, Z. Ji & K. Tao
CAS, Beijing, China
Y. Zhu & L. Tang
Jiangsu Rongma New Energy, Siyang, China
C. Zhao
Zhongkexin Electrical Equipment, Beijing, China

2CV.2.85 **Investigation of Laser Damage for Selective Emitter Silicon Solar Cells**
H. Li, D. Xu, W. Yang, Q. Ma & Y. Wang
Dongfang Huansheng Photovoltaic, Yixing, China

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
Fraunhofer ISE, Freiburg, Germany
T. Nagel
Freiburg Seminar, Germany

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
Fraunhofer ISE, Freiburg, Germany

2CV.2.88 **Multivariate Statistical Modelling to Correlate PECVD Layer Properties with Plasma Chemistry during Silicon Nitride Deposition**
L. Rachdi & M. Hofmann
Fraunhofer ISE, Freiburg, Germany

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
CEA, Le Bourget du Lac, France
J. Yang & S. Tran
SEMCO Technologies, Montpellier, France

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
Singulus Technologies, Kahl am Main, Germany

2CV.2.91 **Development of Nanostructured FTO Films as Transparent and Diffuse Electrodes and Their Integration in Silicon Solar Cells**
S. Lakhdar Chaouche, D. Bellet & C. Jimenez
Grenoble INP, France
A. Fave
INSA Lyon, Villeurbanne, France
S. Daniele
University of Lyon 1, Villeurbanne, France

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
Fraunhofer FEP, Dresden, Germany

2CV.2.93 **FolMet-Connect: Progress of Al-Foil Based Metallization Technology for PERC Cells**
J. Paschen, A.A. Brand, T. Fellmeth & J. Nekarda
Fraunhofer ISE, Freiburg, Germany

2CV.2.94 **Plated Front Side Metallization on Transparent Conducting Oxide Utilizing Low-Cost APCVD SiO2 Insulating Layer**
E. Issa, H. Nagel, M. Glatthaar & S.W. Glunz
Fraunhofer ISE, Freiburg, Germany

2CV.2.95 **A Solution for In-Situ Spatially-Resolved Intensity Measurements in Belt Furnaces**
A. Herguth, C. Derricks & G. Hahn
University of Konstanz, Constance, Germany

2CV.2.96 **Photoluminescence Imaging for Inline Detection of Organic Residues on Silicon Wafers**
B. Ahrens & S. Schweizer
University of Applied Sciences, Soest, Germany
P.-T. Miclea, S. Wahl & C. Hagendorf
Fraunhofer CSP, Halle (Saale), Germany
R. Schäfer
S & I Spectroscopy & Imaging, Warstein, Germany

2CV.2.97 **Contacting New Solar Cell Metallization Layouts and Contact Quality Surveillance in Production**
K. Ramspeck, S. Schenk, M. Alt, P. Waleska, S. Zimmermann & M. Meixner
h.a.l.m. elektronik, Frankfurt, Germany

2CV.2.98 **Sorting Criteria for Bifacial PERC Cells for Improved Module Classification**
N. Wöhrle, A. Krieg, T. Fellmeth, A. Alapont Sabater, A. Schmid & S. Rein
Fraunhofer ISE, Freiburg, Germany
K. Ramspeck
h.a.l.m. elektronik, Frankfurt am Main, Germany

2CV.2.99 **Industry 4.0 PV Factory of the Future: Installing a Test-Bed in a Solar Research Facility**
S. Sasidharan, R. Harney & R. Marczak
ISC Konstanz, Germany

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**
S. Roder, V. Arya, A. Brand & J. Nekarda
Fraunhofer ISE, Freiburg, Germany
D. Pysch & N. Bay
RENA, Freiburg, Germany
K. Krauß
Rehm Thermal Systems, Blaueuren, Germany

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2CV.2.101 **Comparing Cz-Si PERC Solar Cells from Various Manufacturers Regarding BO-Related Light-Induced Degradation and Regeneration**
D.C. Walter, L. Helmich & J. Schmidt
ISFH, Emmerthal, Germany
O. Romer & T. Pernau
centrotherm international, Blaubeuren, Germany

2CV.2.102 **Micro- and Macrotextured Foils for Solar Cells Application**
O. Sergeev, H. Meddeb & M. Vehse
DLR, Oldenburg, Germany
R. Warmers, G. Jenke & R. Schlegel
SAUERESSIG, Vreden, Germany
S. Brüning
Schepers, Vreden, Germany
P. Veldhuizen & R. van Erven
Morphotonics, Veldhoven, 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**

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. Zaaiman
European Commission JRC, Ispra, Italy
G. Jüngst
INTA, Torrejon de Ardoz, Spain
M. Halwachs & M. Rennhofer
AIT, Vienna, Austria
A.A. Santamaria Lancia
Technical University of Denmark, Roskilde, Denmark
E.J. Haverkamp & D. Van der Woude
Radboud University, Nijmegen, 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.3.4 **A New Method for Estimating the UV Spectrum by ANN**
F.-E. Dahr & A. Bah
ENSET, Rabat, Morocco
A. Ghennioui
IRESEN, Rabat, Morocco

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, 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. Piazzi & C. Lanzetta
I-EM, Livorno, Italy

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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, Korea South
A. Benlarabi
IRESEN, Rabat, Morocco
J.-H. Choi
KTL, Seoul, Korea South
M. Ebert & R. Gottschalg
Fraunhofer CSP, Halle (Saale), Germany
B.W. Figgis
QEERI, Doha, Qatar
K.S. Kim
KIER, Yuseong-gu, Korea South
T. Reindl
SERIS, Singapore, Singapore
R. Rüther
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. Flottemesch
Constellation Energy, Baltimore, United States

5CV.3.18 **Fast Physical Radiative Transfer Code to Compute Solar Radiation Effectively Collected by a Photovoltaïc 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.3.20 **Short-Term Power Prediction Research for Wind Farm and Solar Plant Clusters Based on Machine Learning Method**
Z. Chen & C. Yang
CMA, Wuhan, China

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, Korea South

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, Korea South

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.3.37 **Photovoltaic (PV) Winter Electricity in the Swiss Energy Strategy 2050**
U. Muntwyler, T. Schott & E. Schüpbach
BUAS, Burgdorf, Switzerland

5CV.3.38 **Study of PV Systems for Self-Consumption at the UPC**
S. Silvestre & D. Fontanilles
UPC, Barcelona, Spain

5CV.3.39 **Development of Grid Interactive Mini-Grid System for Achieving Continuous Power Supply**
R. Jasthi & S. Mondal
Vikram Solar, Kolkata, India

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, Netherlands

5CV.3.42 **Comparison on Main In-Use Properties of Different Metallic Profiles Used in PV Solar Plants**
P. Verpoort, B. Corlu & J. De Strycker
ArcelorMittal, Zelzate, Belgium
C. Dieu
ArcelorMittal, Flémalle, Belgium

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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.3.50 **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

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.3.62 **Electron and Proton Irradiation of GaAs Solar Cells**
N. Gruginskie, G.J. Bauhuis, P. Mulder, E. Vlieg & J.J. Schermer
Radboud University, Nijmegen, 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. Arstamyan & 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

VISUAL PRESENTATIONS 5CV.4

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

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, Écuelles, 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, Netherlands
A. Alami Merrouni
IRESEN, Rabat, Morocco
F. Wolfertstetter & S. Wilbert
German Aerospace Center, Tabernas, Spain

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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, Netherlands
D. Moser
Eurac Research, Bolzano, Italy
W.G.J.H.M. van Sark
Utrecht University, 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, Korea South

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

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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, 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, Netherlands
A. Martin
Crystalsol, Vienna, Austria
B. Rau
HZB, Berlin, Germany
E.J. Achterberg
Solar Tester, Schinnen, Netherlands
M. Rennhofer
AIT, Vienna, Austria
M. Theelen
TNO, Eindhoven, 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. Thönnes, 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

Wednesday, 11 September 2019

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

Thursday, 12 September 2019

VISUAL PRESENTATIONS 2DV.1

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

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. Rafhay, N. Ait-Abdelkader & Y. Kalboussi
IMEP-LAHC, Grenoble, France
J. Alvarez & M.E. Gueunier-Farret
CNRS, Gif-sur-Yvette, France
C. Marchat
IPVF, Palaiseau, France
J.P. Kleider
CNRS, Gif sur Yvette, 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, Peynier, 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. Çiftpinar & 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

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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. Goaer
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. Søndenå & 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, Korea South
M.G. Kang & H.-E. Song
KIER, Daejeon, Korea South

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. Yang
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 SiOx 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**
M. Aoki & I. Sumita
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
NTU Singapore, Singapore

2DV.1.21 **Low Temperature p-n Junction Fabrication by PECVD for n-PERT Solar Cells: An Alternative to Boron Diffusion**
M. Chrostowski & E. Drahi
TOTAL, Paris, France
J. Alvarez & J.-P. Kleider
CNRS, Gif sur Yvette, France
K.-H. Kim
Cheongju University, Korea South
P. Roca i Cabarrocas
CNRS, Palaiseau, France

2DV.1.22 **PECVD Grown SiOx/Poly-Si for TOPCon Solar Cell Application**
L. Zhang, Z. Shu, C.H. Shin, C.-P. Ouyang, Y. Chae & S.H. Cho
Applied Materials, Santa Clara, United States

2DV.1.23 **Understanding of UV-ps Laser Ablation Mechanisms on Bifacial n-PERT Silicon Solar Cells and Impact on Ni/Cu Plating**
C. Molto, J.E. Lee & S. Béchu
IPVF, Palaiseau, France
J. Nekarda & V. Arya
Fraunhofer ISE, Freiburg, Germany
M. Bouttemy, A. Etcheberry & A.-M. Goncalves
UVSQ, Versailles, France
E. Drahi
TOTAL, Paris, France
P.P. Grand
EDF R&D, Palaiseau, France

2DV.1.24 **Ultra-Fine Contact Finger Achieved by Pattern Transfer Printing (PTP) Technology for Silicon Solar Cells – Recent Development**
A. Adrian, D. Rudolph & J. Lossen
ISC Konstanz, Germany
M. Matusovsky & A. Noy
Utilight, Yavne, Israel

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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
CRTSE, Algiers, Algeria
M. Kechouane
USTHB, Algiers, Algeria

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
CEA, Le Bourget du Lac, France
M. Sciuto, G. Condorelli, A. Ragonesi, A. Canino, M. Foti & C. Gerardi
ENEL Green Power, Catania, Italy

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
Kuwait University, Safat, Kuwait
H. Sivaramakrishnan Radhakrishna & I. Gordon
imec, Leuven, Belgium

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
AIST, Tsukuba, Japan

2DV.1.38 **Si-Based Heterojunction Solar Cells Passivated by a-SiOx:H Thin Film**
K. Saito
Fukushima University, Japan
T. Takamura, Y. Ichikawa & M. Konagai
Tokyo City University, Japan

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
Hanergy Thin Film Power, Chengdu, China

2DV.1.40 **Development of Transparent Conductive Oxide for Silicon Heterojunction Solar Cell**
K. Nakamura & Y. Ohshita
Toyota Technological Institute, Nagoya, Japan
K. Muramatsu
Namics, Niigita City, Japan
T. Nishihara & A. Ogura
Meiji University, Kawasaki, Japan

2DV.1.41 **Effect of Argon-Hydrogen Gas Mixture on Properties of ITO Layers and Performance of Silicon Heterojunction Solar Cells**
P. Ishmuratov, V. Yakovlev, V. Tarasov & A. Dubrovskiy
Hevel Solar, Novocheboksarsk, Russia
I. Nyapshaev, S. Abolmasov, D. Andronikov, K. Emtsev & A. Abramov
R&D Center TFTE, St. Petersburg, Russia

2DV.1.42 **Progress in In2O3-Based Transparent Conductive Oxide Films for Solar Cells**
T. Koida, Y. Ueno & H. Shibata
AIST, Tsukuba, Japan

2DV.1.43 **Overview of Deposition Methods for Heterojunction Solar Cells with High Deposition Rates**
S. Leszczynski, C. Strobel, B. Leszczynska, M. Albert & J.W. Bartha
Technical University of Dresden, Germany
F. Stahr & J. Kuske
FAP, Dresden, Germany

2DV.1.44 **DC Sputtering of TCO Layers in Neon Atmosphere and Its Application to Silicon Heterojunction Solar Cells**
S. Abolmasov, V. Verbitskiy, I. Nyapshaev, A. Abramov, D. Andronikov & E. Terukov
R&D Center TFTE, St. Petersburg, Russia
I. Shakhray
Hevel LLC, Moscow, Russia

2DV.1.45 **17.25%-Efficient, All Room-Temperature Silicon Solar Cells**
S.-H. Kim, J.Y. Jung & J.-H. Lee
Hanyang University, Ansan, Korea South
R.B. Wehrspohn
Fraunhofer IWM, Halle (Saale), Germany

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
IIT Delhi, New Delhi, India
V.K. Komarala
IIT Delhi, New Dehli, India

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. Topic
University of Ljubljana, Slovenia

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
Fraunhofer ISE, Freiburg, Germany

2DV.1.49 **Impact of Interfacial SiOx 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
ANU, Canberra, Australia
K.R. McIntosh
PV Lighthouse, Coledale, Australia

2DV.1.50 **Hydrogen-Doped In2O3 as High Mobility TCO for Silicon Heterojunction Solar Cell Application**
M.L. Addonizio, A. Spadoni & A. Antonaia
ENEA, Portici, Italy

2DV.1.51 **Approach to Clarify the Cause of Handling Defects in SHJ Cell Production through the Interplay of Different Imaging Techniques**
A. Fischer, A. Moldovan & J. Rentsch
Fraunhofer ISE, Freiburg, Germany

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
CEA, Le Bourget du Lac, France

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
Forschungszentrum Jülich, Germany

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2DV.1.54 **Graphene Application as Non Conventional Transparent Conductive Electrode in c-Si Based Heterojunction Solar Cells**
L. Lancellotti, E. Bobeico, M. Della Noce, L.V. Mercaldo, I. Usatii & P. Delli Veneri
ENEA, Portici, Italy
G.V. Bianco, A. Sacchetti & G. Bruno
CNR - IMIP, Bari, Italy

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
METU, Ankara, Turkey

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
CEA, Le Bourget du Lac, France

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
RAS / Ioffe, St. Petersburg, Russia
I. Shakhray
Hevel Solar, Moscow, Russia

2DV.1.59 **Influence of Surface Defectivity on the Performances of Silicon Heterojunction Solar Cells**
V. Giglia, J. Veirman & R. Varache
CEA, Le Bourget du Lac, France
E. Fourmond
INSA Lyon, Villeurbanne, France

2DV.1.60 **Optoelectronic Properties of Sputtered TCOs and Their Application in Silicon Heterojunction Solar Cells**
Z. Yao, W. Duan, A. Mikosch, A. Lambertz, J. Hüpkes, M. Pomaska, K. Bittkau & K. Ding
Forschungszentrum Jülich, Germany
H. Shen
Sun Yat-sen University, Guangzhou, China

2DV.1.61 **Plating Processes for Silicon Heterojunction Cells: An Overview**
A. Lachowicz, C. Ballif & M. Despeisse
CSEM, Neuchâtel, Switzerland

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
ECN, Petten, Netherlands

2DV.1.63 **TCO Layers with High Charge Carrier Mobility as Transparent Conductive Contacts for Silicon Heterojunction Solar Cells**
P. Ishmuratov & A. Dubrovskiy
Hevel Solar, Novocheboksarsk, Russia
I. Nyapshaev, S. Abolmasov, D. Andronikov, A. Abramov, E.I. Terukov & D. Orekhov
R&D Center TFTE, St. Petersburg, Russia
I. Shakhray
Avelar Solar, Novocheboksarsk, Russia
M. Dimer, U. Graupner, M. Thumsch & E. Schneiderlöchner
VON ARDENNE, Dresden, Germany

2DV.1.64 **A Proposed Flexible p-Si/n-ZnO Heterojunction Based All Solid-State Solar Cell**
A.K. Dikshit, A. Singh & P. Chakrabarti
IIT, Varanasi, India
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**
M. Justianto, M. Höfer, T. Harig & V. Sittinger
Fraunhofer IST, Braunschweig, Germany
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. Razzaq, V. Depauw, H. Sivaramakrishnan Radhakrishna, I. Gordon, J. Szlufcik & J. Poortmans
imec, Leuven, Belgium

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
Forschungszentrum Jülich, Germany

2DV.1.68 **Interplay of Intrinsic and Doped Amorphous Silicon Layer and ITO Properties and Process Conditions on Contact Passivation in Silicon Heterojunction Cells**
T.S. Yadav & A. Kottantharayil
IIT Bombay, Mumbai, India
H. Sivaramakrishnan Radhakrishna, I. Gordon & J. Poortmans
imec, Leuven, Belgium

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
ITRI, Hsinchu, Taiwan
C.-L. Cheng
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
imec, Leuven, Belgium

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
CRTSE, Algiers, Algeria

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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**

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. Topic
University of Ljubljana, Slovenia
F. Frontini, P. Bonomo & E. Saretta
SUPSI, Canobbio, Switzerland
P. Macé
Becquerel Institute, Brussels, Belgium
P.J. Bolt
TNO, Eindhoven, 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**
P. Alonso & S. Caneva
WIP Renewable Energies, Munich, Germany
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, Netherlands

7DV.2.8 **Web Tool for Early Stages of Techno-Economical Analysis of Shared Solar Cooperatives in the Brazilian Context**
K. Schneider & R. Rüther
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.2.22 **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

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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.2.30 **The Impact of Large-Scale PV Power Stations on Climate**
C. Yang & Z. Chen
CMA, Wuhan, China

7DV.2.31 **Binomial Rate for Low Voltage Consumers in Brazil: Conditions for Successful Implementation**
R. Teixeira, R. Flora Calili & D. Louzada
PUC-Rio, Rio de Janeiro, Brazil

7DV.2.32 **Ongoing Activities in Eco-Design, Life-Cycle Assesment and Recyling as Presented during the ECO-PV Workshops**
F. Burgun & E. Gerritsen
CEA, Le Bourget du Lac, France

7DV.2.33 **SocialRES Project - Fostering Socially Innovative and Inclusive Strategies for Empowering Citizens in the Renewable Energy Market of the Future**
S. Caneva & P. Alonso
WIP Renewable Energies, Munich, Germany
I. Lizarralde
ESTIA Institute of Technology, Côte Basque, France
V. Kromrey
Bodensee-Stiftung, Radolfzell, Germany
N. Zwangerman
Adelphi, Berlin, Germany
E. Schmid
Fondazione Icons, Lodi, Italy
E. Denny
Trinity College Dublin, Ireland
S. Saludes
CARTIF, Valladolid, Spain
I. Lacoste
I-ENER, Saint-Jean-Pied-de-Port, France
R. Ruiz
ENERGETICA, Valladolid, Spain
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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7DV.2.37 **Towards Solar Energy Civilization before Climate Catastrophy**
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