

## CONFERENCE PROGRAMME

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(i) = invited

Monday, 24 September 2018

### OPENING

#### PLENARY SESSION 1AP.1

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

#### Chairpersons:

Nicholas Ekins-Daukes  
UNSW Australia, Australia  
Erwin Kessels (i)  
Eindhoven University of Technology, Netherlands

- 1AP.1.1 Hybrid III-V/SiGe Solar Cells Grown on Si Substrates through Aggressive Buffer Layers**  
P. Caño Fernández, L. Cifuentes & I. Rey-Stolle  
UPM, Madrid, Spain  
H. Nguyen, A. Morgan & A.D. Johnson  
IQE, Cardiff, United Kingdom
- 1AP.1.2 High-Efficiency Monolithic Perovskite/Silicon Tandem Solar Cells**  
F. Sahli, J. Werner, M. Bräunigner, R. Monnard, T.-J. Yang, P. Fiala, F. Fu, M. Boccard, Q. Jeangros & C. Ballif  
EPFL, Neuchâtel, Switzerland  
B.A. Kamino, B. Paviet-Salomon, L. Barraud, L. Ding, J.J. Diaz Leon, D. Sacchetto, G. Cattaneo, A. Walter, S.-J. Moon, M. Despeisse, B. Niesen & S. Nicolay  
CSEM, Neuchâtel, Switzerland
- 1AP.1.3 Electronic Ratchets as Necessary Stepping Stones for New PV Concepts**  
A. Delamarre, Z. Jehl Li Kao, Y. Okada & M. Sugiyama  
University of Tokyo, Japan  
D. Suchet  
LPICM, Palaiseau, France  
N. Cavassilas  
IM2NP - CNRS, Marseille, France  
J.-F. Guillemoles  
CNRS, Palaiseau, France
- 1AP.1.4 Invited Presentation**

### Opening Addresses

### Moderated Panel Discussion

### Becquerel Prize Ceremony

## ORAL PRESENTATIONS 1AO.1

13:30 - 15:00 Fundamental Studies

#### Chairpersons:

Lenneke H. Slooff  
ECN part of TNO, Netherlands  
Louise Hirst (i)  
University of Cambridge, United Kingdom

- 1AO.1.1 Analysis for Non-Radiative Recombination in Quantum Dot Solar Cells and Materials**  
M. Yamaguchi, K.-H. Lee, K. Araki & N. Kojima  
Toyota Technological Institute, Nagoya, Japan  
L. Zhu & H. Akiyama  
University of Tokyo, Kashiwa, Japan  
Y. Kanemitsu  
Kyoto University, Japan
- 1AO.1.2 Control of Hot Carriers in Type-II Quantum Well Solar Cell Absorbers**  
H. Esmailpour, V.R. Whiteside, S. Vijayaragunathan, B. Wang, T.D. Mishima, M.B. Santos & I.R. Sellers  
University of Oklahoma, Norman, United States  
H. Piyathilaka & A.D. Bristow  
West Virginia University, Morgantown, United States  
K.P. Roberts  
University of Tulsa, United States
- 1AO.1.3 The Use and Abuse of Woc as a Figure of Merit**  
N. Ekins-Daukes & A. Pusch  
UNSW Australia, Sydney, Australia
- 1AO.1.4 Luminescent Coupling in Multi-Junction Photovoltaic Devices Studied by Transient Voltage Measurements**  
T. Tayagaki  
AIST, Tsukuba, Japan  
S.K. Reichmuth, H. Helmers & G. Siefert  
Fraunhofer ISE, Freiburg, Germany
- 1AO.1.5 The Electronic Structure and Passivation Mechanism of CZTS Grain Boundaries Revealed by Comparative Study with CIGS Using Scanning Probe Microscopy**  
G. Chen, K. Zhou, Y. Feng, H. Luo, G. Zhong, W. Li & C. Yang  
CAS, Shenzhen, China
- 1AO.1.6 Transition Metal Oxides as Passivated Hole-Contacts Layer for Silicon Wafer PERC Solar Cells: Intrinsic and Extrinsic Defects in MoO<sub>3</sub> from First-Principles Calculations**  
M.A. Hossain, S.N. Rashkeev, V. Erkkara Madhavan, N. Tabet & A.A. Abdallah  
HBKU, Doha, Qatar  
T. Zhang, C.-Y. Lee & B. Hoex  
UNSW Australia, Sydney, Australia



## ORAL PRESENTATIONS 2AO.4

13:30 - 15:00 Characterisation and Modelling of Silicon Cells

## Chairpersons:

Rolf Brendel (i)  
ISFH, Germany

Invited

- 2AO.4.1 Opto-Electrical Modelling of Periodic Nanostructures, Integrated into Two-Side Contacted Silicon Heterojunction Devices**  
A. Razzaq, V. Depauw, M. Filipic, I. Gordon, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium
- 2AO.4.2 Optical Investigation of High-Efficiency Silicon-Based Solar Cells with Multi-Scale Interface Textures Enabled by Coupled Modelling Approach**  
B. Lipovsek, Z. Lokar, J. Krc & M. Topic  
University of Ljubljana, Slovenia  
A. Razzaq, V. Depauw, I. Gordon & J. Poortmans  
imec, Leuven, Belgium
- 2AO.4.3 Synergistic Efficiency Gain Analyses for the Photovoltaic Community: An Easy to Use SEGA Simulation Tool for Silicon Solar Cells**  
C.N. Kruse, K. Bothe, B. Lim, T. Dullweber & R. Brendel  
ISFH, Emmerthal, Germany
- 2AO.4.4 IV-Measurements of Bifacial Solar Cells in an Inline Solar Simulator with Double-Side Illumination**  
A. Krieg, N. Wöhrle, J.M. Greulich, M. Rauer & S. Rein  
Fraunhofer ISE, Freiburg, Germany  
K. Ramspeck & D. Dzafic  
h.a.l.m. elektronik, Frankfurt am Main, Germany
- 2AO.4.5 Characterization of Heterojunction Rib-Si Solar Cells by EL and DLIT Imaging**  
M. Konagai, R. Kondo & Y. Ichikawa  
Tokyo City University, Japan  
Y. Ishikawa  
NAIST, Ikoma, Japan
- 2AO.4.6 Characterization of the Reverse Breakdown Inhomogeneity of ZEBRA IBC Solar Cells**  
S. Groß, M. Werner & C. Hagendorf  
Fraunhofer CSP, Halle, Germany

## ORAL PRESENTATIONS 6AO.7

13:30 - 15:00 BIPV Products, Approaches and Technical Issues

## Chairpersons:

Francesco Frontini (i)  
SUPSI, Switzerland

Invited

- 6AO.7.1 A Simulation Approach for View Factor Calculation Usable for Bifacial and Building Integrated PV Systems Based on Ray Casting**  
F. Fatih Sönmez, H. Ziar, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands

- 6AO.7.2 PV Quality Issues Applying Building Integrated Photo Voltaic (BIPV) on Façade and Roof When Deep Renovating a 50 Years Old Apartment Building**  
A. Andersson  
RISE Research Institute of Sweden, Boras, Sweden  
D.-E. Archer  
Emulsionen, Göteborg, Sweden  
Z. Norwood  
Chalmers University of Technology, Göteborg, Sweden
- 6AO.7.3 CONIPHER: A Photovoltaic Cladding Element for Façade Renovation. Experimental Determination of Thermal Resistances and Electrical Production**  
J. Rudy, P. Thony & P. Messaoudi  
CEA, Le Bourget du Lac, France  
E. Schmitt  
Vicat, L'Isle-d'Abeau, France  
O. Bizzini  
ARaymond, Saint-Egrève, France
- 6AO.7.4 Versatile and Lightweight Transparent Composite Technology for BIPV and Other PV-Integrated Applications**  
J.M. Vega de Seoane, M. Machado, E. Román Medina, A. Astigarraga Erleaga, I. Arrizabalaga, N. Yurrita, O. Zubillaga, I. Aizpurua, G. Imbuluzeta, A. Sanz Martínez & P. Cano  
TECNALIA R&I, San Sebastián, Spain
- 6AO.7.5 Mosaic Module Concept for Cost-Efficient and Aesthetic BIPV Modules**  
M. Mittag, H.R. Wilson, T. Fellmeth, M. Heinrich & U. Eitner  
Fraunhofer ISE, Freiburg, Germany
- 6AO.7.6 Measurement of Solar Heat Gain Coefficient for Semi-Transparent Building Integrated Photovoltaics in Tropics**  
V. Shabunko & T. Reindl  
SERIS, Singapore, Singapore

## VISUAL PRESENTATIONS 2AV.1

13:30 - 15:00 Feedstock, Crystallisation, Wafering, Defect Engineering

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

## ORAL PRESENTATIONS 1AO.2

15:15 - 16:45 Advanced Material Combinations for n-Terminal Multijunctions

## Chairpersons:

Andreas W. Bett  
Fraunhofer ISE, Germany  
Antonio Martí Vega  
UPM, Spain

- 1AO.2.1 Nearly 30% High Efficiency Low Concentration InGaP/GaAs/Si 3-Junction Solar Cells Using Smart Stack Technology**  
K. Makita, H. Mizuno, R. Oshima, T. Tayagaki, T. Aihara, H. Takato & T. Sugaya  
AIST, Tsukuba, Japan  
M. Baba & N. Yamada  
Nagaoka University of Technology, Japan  
T. Nakamoto  
Tokyo City University, Japan



- 1AO.2.2 Exploring New Convergencies between PV Technologies for High Efficiency Tandem Solar Cells: Wide Band Gap Epitaxial CIGS Top Cells on Silicon Bottom Cells with III-V Intermediate Layers**  
D. Lincot  
CNRS, Palaiseau, France
- 1AO.2.3 Performance Optimization of a Four-Terminal Cu<sub>2</sub>O/c-Si Tandem Heterojunction Solar Cell**  
O. Nordseth & S.E. Foss  
IFE, Kjeller, Norway  
R. Kumar, K. Bergum, E. Monakhov & B.G. Svensson  
University of Oslo, Norway  
F. Dragan, D. Craciunescu & L. Fara  
University Politehnica of Bucharest, Romania  
I. Chilbon  
INOE-2000, Magurele, Romania
- 1AO.2.4 Three-Terminal Tandem Solar Cells Combining Bottom Interdigitated Back Contact and Top Heterojunction Subcells: A New Architecture for High Power Conversion Efficiency**  
J.-P. Kleider, W. El-Huni, Z. Djebbour & A. Migan Dubois  
CNRS, Gif-sur-Yvette, France
- 1AO.2.5 Optimization of Transport and Buffer Layers for Tandem Perovskite/Silicon Solar Cells**  
E. La Manna, F. Matteocci, E. Calabrò & A. Di Carlo  
University of Rome, Italy  
L. Serenelli, L. Martini, F. Menchini, M. Izzi & M. Tucci  
ENEA, Rome, Italy
- 1AO.2.6 Screening Selective Contact Material Combinations for Novel Crystalline Si Cell Structures**  
R. Brendel, C. Kruse, A. Merkle & R. Peibst  
ISFH, Emmerthal, Germany

**ORAL PRESENTATIONS 2AO.5**

15:15 - 16:45 **Characterisation and Modelling of Materials and Surfaces for Silicon Photovoltaics**

**Chairpersons:**

Francesca Ferrazza  
eni spa, Italy  
Jozef Szlufcik  
imec, Belgium

- 2AO.5.1 Evaluations of Oxidized Silicon Surfaces with Laser Terahertz Emission Microscope (LTEM) and Corona Charging**  
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

- 2AO.5.2 A Novel Experimental Method for the Thermal Characterization of PV Module Materials and Entire Module Stacks**  
I. El-Chami  
KU Leuven, Belgium  
H. Oprins & V. Cherman  
imec, Heverlee, Belgium  
I.T. Horvath, H. Goverde, J. Govaerts, T. Borgers & E. Voroshazi  
imec, Genk, Belgium  
J. Poortmans  
imec, Leuven, Belgium
- 2AO.5.3 A High Speed Infrared Probe to Measure Surface Concentration and Other Critical Properties of Doped Layers for Silicon Solar Cells Process Control**  
J. Wong, H. Ghoddami, S. McDonald & G. Deans  
Aurora Solar Technologies, North Vancouver, Canada  
D. Ananthanarayanan  
SERIS, Singapore, Singapore
- 2AO.5.4 Prediction of Local Temperature Dependent Efficiency of Silicon Solar Cells**  
R. Eberle, A. Fell, F. Schindler & M.C. Schubert  
Fraunhofer ISE, Freiburg, Germany
- 2AO.5.5 Challenges for the Quantification of Metal Induced Recombination Losses Using Calibrated Photoluminescence Imaging**  
D. Herrmann, S. Lohmüller, H. Höffler & A. Wolf  
Fraunhofer ISE, Freiburg, Germany
- 2AO.5.6 Influence of Emitter Layers on LeTID Kinetics in mc-Silicon**  
A. Otaegi & J.C. Jimeno  
UPV/EHU, Bilbao, Spain  
D. Skorka, A. Schmid, A. Zuschlag & G. Hahn  
University of Konstanz, Germany

**ORAL PRESENTATIONS 6AO.8**

15:15 - 16:45 **Optimisation of Formal-Visual and Efficiency Aspects of BIPV Applications and Components**

**Chairpersons:**

Wiep Folkerts  
SEAC, Netherlands  
Gabriele C. Eder  
OFI, Austria

- 6AO.8.1 Outdoor Characterization of Colored and Textured Prototype PV Façade Elements**  
C. Tzikas, R.M.E. Valckenborg, M.N. van den Donker & W. Folkerts  
SEAC, Eindhoven, Netherlands  
A. Bognar, D. Duque Lozano, R. Loonen & J.L.M. Hensen  
Eindhoven University of Technology, Netherlands
- 6AO.8.2 BIPV Meets Customizable Glass: A Dialogue between Energy Efficiency and Aesthetics**  
E. Saretta, P. Bonomo & F. Frontini  
SUPSI, Canobbio, Switzerland



**6AO.8.3 Experimental Analysis of Different Cell and Module Technologies in a BIPV Façade Test Set Up**

J. Lehmann, J. Goncalves, G.H. Yordanov, K. Baert & D. Saelens  
 KU Leuven, Heverlee, Belgium  
 A.S.H. van der Heide & H. Goverde  
 EnergyVille, Genk, Belgium

**6AO.8.4 Dutch Solar Design BIPV: Optimizing Power Output and Aesthetic Performance in Architectural Design**

L.H. Slooff, J.A.M. van Roosmalen & L.A.G. Okeel  
 ECN, Petten, Netherlands  
 T. Minderhoud & G. Gijzen  
 UNStudio, Amsterdam, Netherlands  
 L.C. Polinder & F. Goethals  
 Design Innovation Group, Utrecht, Netherlands  
 T. Sepers  
 TS Visuals, Oudkarspel, Netherlands

**6AO.8.5 Towards Maximum Efficiency of Colorful Photovoltaics**

J. Halme & P. Mäkinen  
 Aalto University, Finland

**6AO.8.6 Decorated Building Integrated Photovoltaic Modules: Power Loss, Color Appearance and Cost Analysis**

C. Kutter, M. Mittag, M. Heinrich, C. Ferrara, B. Bläsi, T. Kuhn, T. Kroyer & O. Höhn  
 Fraunhofer ISE, Freiburg, Germany

**VISUAL PRESENTATIONS 2AV.2**

15:15 - 16:45 **Homojunction Solar Cells**

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

**ORAL PRESENTATIONS 1AO.3**

17:00 - 18:30 **Advanced Materials for Solar Cells**

**Chairpersons:**

Jozef (Jef) Poortmans  
 imec, Belgium  
 Marin Rusu (i)  
 HZB, Germany

**1AO.3.1 Simple Yet Efficient Chemically Deposited Ag Rear Side Metallization on ITO for High-Efficiency c-Si Solar Cells**

H. Nagel, M. Glatthaar & S.W. Glunz  
 Fraunhofer ISE, Freiburg, Germany  
 D. Sontag  
 Meyer Burger, Hohenstein-Ernstthal, Germany

**1AO.3.2 2d Materials and Nanoabsorbers for PV: New Potential Applications and Other Advantages**

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

**1AO.3.3 Perovskite Photovoltaics: The Role of Graphene and Related 2D Materials for Stability and Scalability**

A. Agresti, S. Pescetelli, A.L. Palma & A. Di Carlo  
 University of Rome, Italy  
 L. Najafi, A.E. Del Rio Castillo, S. Bellani & F. Bonaccorso  
 Italian Institute of Technology, Genoa, Italy

**1AO.3.4 Inorganic Cesium Carbonate Electron Transport Layer for High Efficiency Perovskite Solar Cells**

M.I. Hossain, N. Tabet & A. Belaidi  
 QEERI, Doha, Qatar  
 I. Zimmermann & M.K. Nazeeruddin  
 EPFL, Lausanne, Switzerland

**1AO.3.5 Whisperonic Solar Cells**

C. Sudakar, T.K. Das & P. Ilaiyaraja  
 IIT Madras, Chennai, India

**1AO.3.6 Towards Cost-Effective Novel Ultrathin Crystalline Silicon Wafer Production by Ultra-Fast Laser Deep Subsurface Processes Followed by Selective Etching: From Slice Production to Solar Cell Fabrication**

M. Zolfaghari Borra, H. Nasser, T. Colakoglu, I. Pavlov, R. Turan & A. Bek  
 METU, Ankara, Turkey  
 A. Turnali, P. Deminskyi, O. Tokel & F.O. Ilday  
 Bilkent University, Ankara, Turkey

**ORAL PRESENTATIONS 2AO.6**

17:00 - 18:30 **Industrial Processes for c-Si Solar Cells / Thin Film Silicon Cells**

**Chairpersons:**

Derk L. Bätzner  
 Meyer Burger Research, Switzerland  
 Paola Delli Veneri  
 ENEA, Italy

**2AO.6.1 Improved Inline Texturing & Edge-Isolation for Diamond-Wire-Sawed Multi-Crystalline Material (DWS-mc) with an Electrochemical Approach**

B. Straub, B. Burgenmeister, J. Burschik, C. Schmitt & H. Kühnlein  
 RENA, Freiburg, Germany

**2AO.6.2 Introduction of Smart Technologies in PV Production Equipment**

M. Zimmer, L. Mohr, B. Broese, T. Krick & J. Rentsch  
 Fraunhofer ISE, Freiburg, Germany  
 B. Mandlmeier, L. Papp, M. Menschick & R. Kogler  
 Singulus Technologies, Fürstenfeldbruck, Germany  
 A. Strauch  
 camLine, Dresden, Germany  
 T. Will & V. Meckelin  
 MIB, Breisach am Rhein, Germany  
 P. Mutz & D. Korner  
 SICK, Waldkirch, Germany  
 M. Kremer  
 Jumo, Fulda, Germany



- 2AO.6.3 Fabrication of APCVD PSG Emitter-Based Industrial PERC Solar Cells Reaching 21% Conversion Efficiencies**  
B. Kafle, P. Saint-Cast, U. Belledin, S. Lohmüller, A. Wolf & M. Hofmann  
Fraunhofer ISE, Freiburg, Germany  
H. Zunft & H. Knauss  
Gebr. Schmid, Freudenstadt, Germany  
P. Palinginis, C. Kusterer, R. Köhler & T. Zehl  
SolarWorld Industries, Freiberg, Germany
- 2AO.6.4 Bulk Contacts and Laser-Based Fabrication Steps for n-Type Silicon Thin-Film Solar Modules**  
S. Garud, S. Kühnapfel, O. Franke, N. Kersten, S. Severin, S. Gall & B. Rech  
HZB, Berlin, Germany
- 2AO.6.5 Flexible Transparent a-Si:H Solar Cells on Polyimide Substrates**  
J.W. Lim & G. Kim  
ETRI, Daejeon, Korea South  
M. Shin  
Korea Aerospace University, Goyang-City, Korea South  
J.-D. Kwon  
KIMS, Changwon, Korea South
- 2AO.6.6 Optimization of Inline Processes for the Production of Freestanding Epitaxially Grown Thin Films for Solar Cells**  
A. Ivanov, R. Sorgenfrei, E. Gust, P. Barth, S. Kühnhold-Pospischil, S. Riepe & S. Janz  
Fraunhofer ISE, Freiburg, Germany  
K. Van Nieuwenhuysen  
imec, Leuven, Belgium

**ORAL PRESENTATIONS 6AO.9**

**17:00 - 18:30 Overview of Innovative Application of Photovoltaics in Built Environment and Infrastructures**

**Chairpersons:**

Tjerk Reijenga (*i*)  
BEAR-iD, Netherlands

*Invited*

- 6AO.9.1 An Overview of Floating PV Worldwide**  
M.M. de Jong, K. Sinapis & W. Folkerts  
SEAC, Eindhoven, Netherlands
- 6AO.9.2 System Integration of Thin Film PV Modules in Road Restraint Systems**  
K. Sewalt  
TNO, Delft, Netherlands  
D. Roosen-Melsen  
TNO, Eindhoven, Netherlands
- 6AO.9.3 Application of Semi-Transparent Photovoltaics in Transportation Infrastructure for Energy Savings and Solar Electricity Production: Towards Novel Net-Zero Energy Tunnel Design**  
D. Sun & A.K. Athienitis  
Concordia University, Montreal, Canada  
K. D'Avignon  
ETS, Montreal, Canada

- 6AO.9.4 Performance Analysis of Vertically Mounted Bifacial PV Modules on Green Roof System**  
T. Baumann, F. Carigiet, R. Knecht, M. Klenk, H. Nussbaumer & F.P. Baumgartner  
ZHAW, Winterthur, Switzerland  
A. Dreisiebner  
Solarspar, Sissach, Switzerland
- 6AO.9.5 Solar Hybrid Energy Powering Quadcopter**  
C.-F. Lin, H. Lan, W.-S. Liao, J.-Y. Lin & H.-J. Syu  
NTU, Taipei, Taiwan  
T.-J. Lin & C.-H. Chiu  
Jianguo High School, Taipei, Taiwan
- 6AO.9.6 Solutions for a Fully Integrated > 1000 Wp Solar Electric Vehicle Body**  
B.K. Newman & L.A.G. Okel  
ECN, Petten, Netherlands  
A. van der Ham, S. Regondi, J. Steenbeek & J. Maar  
Lightyear, Helmond, Netherlands

**VISUAL PRESENTATIONS 2AV.3**

**17:00 - 18:30 Heterojunction Solar Cells**

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



Tuesday, 25 September 2018

**ORAL PRESENTATIONS 2BO.1**

**08:30 - 10:00 New Materials and Processes for Silicon Photovoltaics**

**Chairpersons:**

*Invited*

Chung-Wen Lan  
NTU, Taiwan

**2BO.1.1 A Proposal of Improved CZ Growth Technique of Monocrystalline Silicon for PV Cells**

T. Fukuda, K. Tanahashi, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan  
Y. Horioka  
Frontier Technology, Koriyama, Japan  
K. Fujiwara  
Tohoku University, Sendai, Japan

**2BO.1.2 Approaching 22% Solar Cell Efficiency with Mono-Like Silicon**

M.M. Kivambe, B. Aissa, A.A. Abdallah, A. Belaidi & N. Tabet  
QEERI, Doha, Qatar  
J. Haschke, M. Boccard, J. Cattin & C. Ballif  
EPFL, Neuchâtel, Switzerland  
J. Horzel, F. Debrot & M. Despeisse  
CSEM, Neuchâtel, Switzerland

**2BO.1.3 Development of High Performance Multicrystalline Silicon with Controlled Seeding**

A. Hess, P. Krenckel, T. Trötschler, T. Fehrenbach & S. Riepe  
Fraunhofer ISE, Freiburg, Germany

**2BO.1.4 Multicrystalline Informatics to Realize Ideal Crystalline Silicon for Solar Cells**

N. Usami, Y. Hayama, T. Muramatsu, K. Tajima, S. Kamibeppu, K. Kutsukake, T. Matsumoto & H. Kudo  
Nagoya University, Japan

**2BO.1.5 Metal Contamination in the Diamond Wire Sawing Process of Silicon and Influence on the Solar Cell Efficiency**

L. Lottspeich & T. Kaden  
Fraunhofer THM, Freiberg, Germany

**2BO.1.6 Diamond Wire Wafering: A Model-Based Evaluation of Different Control Strategies**

D. Treyer, S. Gaulocher & S. Niederberger  
FHNW, Windisch, Switzerland  
H. Rafael & G. Frech  
Meyer Burger, Gwatt, Switzerland  
A. Ams  
Freiberg University of Technology, Germany

**ORAL PRESENTATIONS 6BO.5**

**08:30 - 10:00 Soiling in PV**

**Chairpersons:**

*Invited*

Benjamin Figgis  
QEERI, Qatar

**6BO.5.1 Evaluation of Soiling Rates for PV Modules Installed at Different Tilt Angles in Dubai, UAE**

A. Elnosh, J.J. John, A. Alnuaimi, J. Quadir, M. Stefancich & P. Banda  
DEWA, Dubai, United Arab Emirates

**6BO.5.2 Investigating the Technical Effectiveness of Different Photovoltaic Cleaning Methods in Dust-Intensive Climates**

F.G. Alzubi, A. Alkandary & A.T. Al-Asfour  
KISR, Safat, Kuwait

**6BO.5.3 Business Cases for Anti-Soiling Coatings in The Netherlands**

C. Tzikas & W. Folkerts  
SEAC, Eindhoven, Netherlands  
M. Cappa & G.P.J. Verbong  
Eindhoven University of Technology, Netherlands  
M.N. van den Donker  
ECN, Eindhoven, Netherlands  
P.M. Sommeling  
ECN, Petten, Netherlands

**6BO.5.4 Mars Soiling Sensor™**

M. Gostein, K. Miller & B. Stueve  
Atonometrics, Austin, United States

**6BO.5.5 Electrodynamic Cleaning of PV Module**

A. Faes, M. Despeisse, J. Champliaud, J. Levrat, N. Badel, J. Geissbühler, B. El Roustom & C. Ballif  
CSEM, Neuchâtel, Switzerland  
D. Petri, N. Wyrsh & A. Hessler-Wyser  
EPFL, Neuchâtel, Switzerland  
G. McKarris & G.-O. Gétaz  
CleanFizz, Geneva, Switzerland

**6BO.5.6 Predicting Future Soiling Losses Using Environmental Data**

L. Micheli & M.G. Deceglie  
NREL, Golden, United States



**ORAL PRESENTATIONS 5BO.9****08:30 - 10:00 Bifacial PV Modules****Chairpersons:**

Tom Betts (*i*)  
Loughborough University, United Kingdom  
Roland Einhaus (*i*)  
Apollon Solar, France

- 5BO.9.1 Special Introductory Presentation: Type Approval and Safety Considerations for Bifacial PV Modules: Requirements for IEC 61215 and IEC 61730**  
B. Jaeckel  
UL International, Neu-Isenburg, Germany  
G. Volberg  
TÜV Rheinland, Cologne, Germany  
C. Monokroussos  
TÜV Rheinland, Shanghai, China  
G. Mülhöfer  
Fraunhofer ISE, Freiburg, Germany  
A. Roth  
VDE Renewables, Offenbach, Germany
- 5BO.9.2 Design Study of a Double-Side Illumination Solar Simulator for Bifacial Silicon PV Modules Characterisation Based on Low-Cost LED Bias Light**  
J. Lopez-Garcia, D. Shaw & T. Sample  
European Commission JRC, Ispra, Italy
- 5BO.9.3 Comparison of Layouts for Shingled Bifacial PV-Modules in Terms of Power Output, Cell to Module Factor and Bifaciality**  
A. Mondon, N. Klasen, M. Mittag, C. Hilger, M. Heinrich, U. Eitner & H. Wirth  
Fraunhofer ISE, Freiburg, Germany
- 5BO.9.4 Rear Face Spectral Irradiance at 1-Sun and Application to Bifacial Module Power Rating**  
C. Monokroussos, X.Y. Zhang, E. Lee, Y.H. Wang & C. Zou  
TÜV Rheinland, Shanghai, China  
J. Bonilla Castro, M. Schweiger & W. Herrmann  
TÜV Rheinland Energy, Cologne, Germany
- 5BO.9.5 Impact of Using Spectrally Resolved Ground Albedo Data for Performance Simulations of Bifacial Modules**  
M.R. Vogt, T. Gewohn, K. Bothe & R. Brendel  
ISFH, Emmerthal, Germany  
C. Schinke  
Leibniz University of Hannover, Germany

**VISUAL PRESENTATIONS 6BV.1****08:30 - 10:00 Solar Resource and Forecasting / Building, Infrastructure, Landscape and other Applications of PV / Grid and Energy System Integration****PLENARY SESSION 2BP.1****10:30 - 12:10 Silicon Photovoltaics****Chairpersons:**

Stefan W. Glunz  
Fraunhofer ISE, Germany  
Wim C. Sinke (*i*)  
ECN part of TNO, Netherlands

- 2BP.1.1 Learning from the Past to Look Beyond the Roadmap of PERC Si Solar Cell Mass Production**  
P.P. Altermatt, Y. Yang, Y. Chen, D. Chen, X. Zhang, G. Xu & Z. Feng  
Trina Solar Energy, Changzhou, China
- 2BP.1.2 Inline Characterization of Diamond Wire Sawn Multicrystalline Silicon Wafers**  
N. Bergmann, T. Hammer, K. Krieg, N. Wöhrle, S. Al-Hajjawi & J. Haunschild  
Fraunhofer ISE, Freiburg, Germany  
O. Anspach  
PV Crystalox Solar, Erfurt, Germany  
H. Schremmer  
Hennecke Systems, Zülpich, Germany
- 2BP.1.3 Overview of Cell Fabrication Options for Thin (< 50 µm) Kerfless Epitaxial Silicon Foils: Recent Progress and Challenges**  
H. Sivaramakrishnan Radhakrishnan, J. Cho, M. Xu, T. Bearda, V. Depauw, K. Van Nieuwenhuysen, I. Gordon, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
E. Neubauer & Z. Kovacova  
RHP-Technology, Seibersdorf, Austria  
T. Kaden  
Fraunhofer THM, Freiberg, Germany  
J. Röth  
Anhalt University of Applied Sciences, Köthen, Germany

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





**2BP.1.4 Status of the EU H2020 Disc Project: European Collaboration in Research and Development of High Efficient Double Side Contacted Cells with Innovative Carrier-Selective Contacts**

B. Min, T. Wietler, S. Bordihn & R. Peibst  
 ISFH, Emmerthal, Germany  
 T. Desrues, P. Carroy & J. Jourdan  
 CEA, Le Bourget du Lac, France  
 M. Hermle, F. Feldmann & J. Bartsch  
 Fraunhofer ISE, Freiburg, Germany  
 C. Allebé, L. Ding, J. Horzel & A. Lachowicz  
 CSEM, Neuchâtel, Switzerland  
 A. Ingenito & F.-J. Haug  
 EPFL, Neuchâtel, Switzerland  
 E. Schneiderlöchner, V. Linss & K. Lüdemann  
 VON ARDENNE, Dresden, Germany  
 A. Campa, M. Bokalic & M. Topic  
 University of Ljubljana, Slovenia  
 M. Zwegers  
 Meco Equipment Engineers, Drunen, Netherlands  
 B. Hartlin  
 ERM, London, United Kingdom  
 B. Field  
 ERM, Paris, France  
 B. Bénédicte  
 Meyer Burger, Thun, Switzerland  
 Z. Adam  
 EcoSolifer Modulgyarto, Budapest, Hungary  
 J. Penaud & S. Filonovich  
 TOTAL, Paris la Defense, France  
 E. Marcon, J. Chupin & F. Tamini  
 Ayming, Brussels, Belgium

**2BP.1.5 Silicon Solar Cells by "DESIJN"**

A. Cuevas, D. Yan, S.P. Phang, Y. Wan & D. Macdonald  
 ANU, Canberra, Australia

**ORAL PRESENTATIONS 2BO.2**

**13:30 - 15:00 Defect Engineering in Silicon**

**Chairpersons:**

Markus Rinio  
 University of Karlstad, Sweden

*Invited*

**2BO.2.1 Minority Carrier Trapping in Czochralski Silicon: Influence of Thermal Donors and the Doping Density**

M. Siriwardhana, D. Macdonald & F.E. Rougieux  
 ANU, Canberra, Australia  
 F.D. Heinz  
 Fraunhofer ISE, Freiburg, Germany

**2BO.2.2 Influence of Oxygen Concentration at Top Position of Cz Ingot on the p-Type PERC Efficiency**

S. Baik, Y. Hahn, A. Jeong, J.M. Kang & W. Nam  
 Woongjin Energy, Daejeon, Korea South

**2BO.2.3 Kinetics of the Degradation and Regeneration of p-Type Multicrystalline Silicon under Dark Anneal**

C. Vargas Castrillon, D. Payne, C. Chan & Z. Hameiri  
 UNSW Australia, Sydney, Australia  
 G. Coletti  
 ECN, Petten, Netherlands

**2BO.2.4 Elimination of Light-Induced Degradation by Black Silicon**

T.P. Pasanen, C. Modanese, V. Vähänissi, H.S. Laine & H. Savin  
 Aalto University, Espoo, Finland  
 F. Wolny, A. Oehlke, C. Kusterer & M. Wagner  
 SolarWorld Industries, Bonn, Germany

**2BO.2.5 Bulk Lifetime Improvement by Applying n-Type Poly-Si Passivating Contacts**

J. Liu, M.K. Stodolny, P.C.P. Bronsveld & I.G. Romijn  
 ECN, Petten, Netherlands

**2BO.2.6 Defects in Epitaxially Grown Silicon Wafers Causing Lifetime Patterns**

M. Drießen, P. Beu, F. Heinz, T. Fehrenbach, E. Gust, F. Schindler & S. Janz  
 Fraunhofer ISE, Freiburg, Germany

**ORAL PRESENTATIONS 6BO.6**

**13:30 - 15:00 Advanced Inspection and Failure Detection in PV Systems**

**Chairpersons:**

Peter Lechner  
 ZSW, Germany  
 Dezso Sera (i)  
 Aalborg University, Denmark

**6BO.6.1 Photoluminescence Outdoor Measurement System (PLOMS)**

M. Koch & B. Bucher  
 HSR, Rapperswil, Switzerland

**6BO.6.2 DUBIO: A Fully Automatic IR Inspecting System for Large PV Plants**

M. Colaprico, M.F. de Ruvo & F. Marino  
 APIS, Bari, Italy  
 S. Vergura  
 Polytechnic University of Bari, Italy  
 G. Leotta  
 ENEL Green Power, Catania, Italy  
 M.L.T. Lo Trovato & F. Bizzarri  
 ENEL Green Power, Rome, Italy

**6BO.6.3 Solar Module Inspection Drone**

N. Treutner, S. Stübing, S. Hellwig & B. Meffert  
 HU Berlin, Germany  
 M. Menz & J. Killat  
 greateyes, Berlin, Germany

**6BO.6.4 Better Fault Detection and Diagnosis with Artificial Intelligence: Methods, Examples and Business Cases**

A. Woyte, B. Sarr, K. de Brabandere, M. Richter & W. Coppys  
 3E, Brussels, Belgium





- 6BO.6.5 Advanced Diagnostic Approach of Failures for Grid-Connected PV Systems**  
A. Livera, M. Theristis, G. Makrides & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
J. Sutterlueti  
Gantner Instruments, Schruns, Austria
- 6BO.6.6 Performance Analysis of Pre-cracked PV-Modules at Cyclic Loading Conditions**  
C. Buerhop-Lutz, T. Winkler, T. Patel, J. Hauch & C. Camus  
ZAE Bayern, Erlangen, Germany  
C.J. Brabec  
FAU, Erlangen, Germany

**ORAL PRESENTATIONS 5BO.10**

**13:30 - 15:00 PV Module Characterisation and Calibration for Mono and Bifacial Modules**

**Chairpersons:**

Stefan Winter  
PTB, Germany  
Yoshihiro Hishikawa (i)  
AIST, Japan

- 5BO.10.1 Towards IEC 60904-1-2: Assessing the Requirements for Irradiance on the Non-Illuminated Side of Bifacial PV Modules with Single Light Source Testing**  
T.S. Liang, M. Pravettoni, J.P. Singh, Y. Wang & Y.S. Khoo  
SERIS, Singapore, Singapore
- 5BO.10.2 Characterization of Bifacial PV Mini-Modules Using Front- and Double-Side Illumination**  
S. Dittmann, S. Krause & J. Bagdahn  
Anhalt University of Applied Sciences, Köthen, Germany  
H. Park, S.-Y. Oh & W.K. Kim  
Yeungnam University, Gyeongsan, Korea South  
S. Esefelder & T. Brammer  
Wavelabs Solar Metrology Systems, Leipzig, Germany  
B.S. Kim & S. Chang  
LG Electronics, Gumi, Korea South
- 5BO.10.3 Hot-Spot Endurance Test - Modifications for Bifacial Photovoltaic Modules**  
D. Philipp, H. Manuel & G. Mülhófer  
Fraunhofer ISE, Freiburg, Germany

- 5BO.10.4 Interlaboratory Comparison of Methodologies for Measuring the Angle of Incidence Dependence of Solar Cells**  
N. Riedel, A.A. Santamaria Lancia, M. Amdemeskel, S. Thorsteinsson, P.B. Poulsen, A. Thorseth, C. Dam-Hansen & G.A. dos Reis Benatto  
Technical University of Denmark, Roskilde, Denmark  
F. Plag & I. Kröger  
PTB, Braunschweig, Germany  
L.H. Slooff, M.J. Jansen, A.J. Carr & P. Manshanden  
ECN, Petten, Netherlands  
M. Bliss & T.R. Betts  
Loughborough University, United Kingdom  
I. Petrina Jauregui & M. Ezquer Mayo  
CENER, Sarriguren-Navarra, Spain  
J.L. Balenzategui  
CIEMAT, Madrid, Spain  
R. Roldán  
SUPSI, Canobbio, Switzerland  
U. Kråling & G. Baarah  
Fraunhofer ISE, Freiburg, Germany  
B. Iandolo & R.S. Davidsen  
Technical University of Denmark, Kongens Lyngby, Denmark
- 5BO.10.5 Quantitative Evaluation of PV Device Linearity with the Two-Lamp Method**  
H. Müllejjans & E. Salis  
European Commission JRC, Ispra, Italy
- 5BO.10.6 Practical Assessment of Power Rating Uncertainties for Industrial Silicon Modules**  
H.W. Wilterdink, A.L. Blum, C.L. Sainsbury & R.A. Sinton  
Sinton Instruments, Boulder, United States

**VISUAL PRESENTATIONS 3BV.2**

**13:30 - 15:00 CI(G)S, CdTe and Related Thin Film Solar Cells and Modules**

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

**ORAL PRESENTATIONS 2BO.3**

**15:15 - 16:45 PERX and Selective Phosphorous Emitters**

**Chairpersons:**

Thorsten Dullweber  
ISFH, Germany  
Marko Topic  
University of Ljubljana, Slovenia

- 2BO.3.1 Large Area Monofacial Screen-Printed Rear-Emitter nPERT Cells Approaching 23% Efficiency**  
L. Tous, J. Chen, P. Choulal, S. Singh, M. Aleman, I. Kuzma-Filipek, J. John, F. Duerinckx & J. Szlufcik  
imec, Leuven, Belgium
- 2BO.3.2 LID-Free PERC+ Solar Cells with Stable Efficiencies Up to 22.1%**  
B. Lim, A. Merkle, R. Peibst & T. Dullweber  
ISFH, Emmerthal, Germany  
Y. Wang & R. Zhou  
LONGi Clean Energy, Xi'an, China



- 2BO.3.3 Change of the Bulk Carrier Lifetime of High Quality Silicon Wafers during PERC Solar Cell Processing**  
M. Müller, F. Wolny, G. Fischer, A. Krause & H. Neuhaus  
SolarWorld Innovations, Freiberg, Germany
- 2BO.3.4 Selective Emitter Using APCVD PSG Layers as Doping Source**  
P. Saint-Cast, U. Belledin, E. Lohmüller, B. Kafle, J. Weber, A. Wolf & M. Hofmann  
Fraunhofer ISE, Freiburg, Germany  
S. Seren  
SCHMID Group, Freudenstadt, Germany
- 2BO.3.5 Non Mass Separation Type Ion Implantation System for Bifacial PERT Cell Fabrication**  
K. Nakamura  
Meiji University, Kawasaki, Japan  
K. Muramatsu  
Namics, Niigata, Japan  
N. Yamaguchi  
ULVAC, Susono, Japan  
Y. Ohshita  
Toyota Technological Institute, Nagoya, Japan
- 2BO.3.6 Laser-Doped Selective Emitter - Process Development and Speed-Up**  
J. Weber, S. Gutscher, S. Lohmüller, E. Lohmüller & A.A. Brand  
Fraunhofer ISE, Freiburg, Germany

**ORAL PRESENTATIONS 6BO.7**

**15:15 - 16:45 Operation, Maintenance and Performance Optimisation of PV Systems**

**Chairpersons:**

Fabrizio Bonemazzi (*i*)  
ENEL, Italy  
George Elias Georghiou  
University of Cyprus, Cyprus

- 6BO.7.1 Optimum Condition for Accurate Measurement of Photovoltaic Array Temperature**  
K. Okumoto, K. Miyamura & K. Nishioka  
University of Miyazaki, Japan
- 6BO.7.2 PV System Performance Evaluation by Clustering Production Data to Normal and Non-Normal Operation.**  
O. Tsafarakis & W.G.J.H.M. van Sark  
Utrecht University, Netherlands  
K. Sinapis  
SEAC, Eindhoven, Netherlands
- 6BO.7.3 Understanding the Time Evolution of the PVGIS Performance Model Parameters and the Temperature Coefficients**  
P. Ingenhoven, G. Belluardo, S. Lindig & D. Moser  
EURAC, Bolzano, Italy
- 6BO.7.4 Automated Module Failure Identification and Proposal of Repowering in Operating Solar Plants for Continuous Optimum Operation**  
H.-J. Rodríguez San Segundo, A. Calo López & C. de Vicente Suso  
The South Oracle, Sevilla, Spain
- 6BO.7.5 How to Maximize the kWh/kWp Ratio: Simulations of Single-Axis Tracking in Bifacial Systems**  
G.J.M. Janssen, A.R. Burgers, A.J. Carr, B.B. Van Aken & I.G. Romijn  
ECN, Petten, Netherlands

- 6BO.7.6 Operation, Performance and Maintenance of First Utility-Scale Solar Photovoltaic Plant in Kuwait Oil Kuwait for the Operation of Electric Submersible Pumps**  
R.A. Sherif, A. Al-Qudaihi, H. Alsaqabi, A. Najaf, E. Safar & R. Al-Ajmi  
Kuwait Oil Company, Ahmadi, Kuwait

**ORAL PRESENTATIONS 5BO.11**

**15:15 - 16:45 Imaging Techniques for PV Modules**

**Chairpersons:**

Ralph Gottschalg (*i*)  
Fraunhofer CSP, Germany  
Eszter (Esther) Voroshazi  
imec, Belgium

- 5BO.11.1 1st International Round Robin on EL Imaging: Automated Camera Calibration and Image Normalization**  
K.G. Bedrich, J. Chai, Y. Wang, A.G. Aberle, R. Gottschalg & Y. S. Khoo  
SERIS, Singapore, Singapore
- 5BO.11.2 Electroluminescence Power Loss Prediction of Photovoltaic Modules**  
T. Kropp, M. Schubert & J.H. Werner  
University of Stuttgart, Germany
- 5BO.11.3 Performance and Electroluminescence Analysis on Reliability and Lifetime of Thin-Film Photovoltaics (PEARL TF-PV)**  
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
- 5BO.11.4 A Photovoltaic Module Diagnostic Setup for Lock-in-Thermography and Lock-in Electroluminescence Imaging**  
H.R. Parikh, S.V. Spataru & D. Sera  
Aalborg University, Denmark  
C. Mantel, S. Forchhammer, G.A. dos Reis Benatto, N. Riedel, S. Thorsteinsson & P.B. Poulsen  
Technical University of Denmark, Roskilde, Denmark  
M. Larsen, H. Voss & M. Messerschmidt  
Sky-Watch, Nordjylland, Denmark  
K.H.B. Frederiksen  
Kenergy, Horsens, Denmark  
J. Vedde  
SiCon, Birkerød, Denmark



- 5BO.11.5 A Novel Method for PV: Spatially Resolved Magnetic Field Mapping for Defect Analysis**  
D. Lausch, M. Patzold, C.-M. Lin, J. Fröbel & K. Kaufmann  
Fraunhofer CSP, Halle (Saale), Germany
- 5BO.11.6 Utilising Digital Light Processing and Compressed Sensing for Photo-Current Mapping of Encapsulated Photovoltaic Modules**  
G. Koutsourakis  
NPL, Teddington, United Kingdom  
M. Bliss, T.R. Betts & R. Gottschalg  
CREST, Loughborough, United Kingdom

**VISUAL PRESENTATIONS 3BV.3**

15:15 - 16:45 Perovskite, Organic and Dye-Sensitised Devices

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

**ORAL PRESENTATIONS 2BO.4**

17:00 - 18:30 Silicon Surface Passivation

**Chairpersons:**

Jan Schmidt  
ISFH, Germany  
Barbara Terheiden  
University of Konstanz, Germany

- 2BO.4.1 SiO<sub>2</sub> Passivation Layers – From the Past to the Future**  
S.W. Glunz & F. Feldmann  
Fraunhofer ISE, Freiburg, Germany
- 2BO.4.2 Development of 4 nm-Thin PECVD Aluminium Oxide Using Plasma Analysis and Its Application to PERC Solar Cells and Modules**  
M. Hofmann, D. Wagenmann, C. Teßmann, P. Saint-Cast, D. Eberlein & A. Kraft  
Fraunhofer ISE, Freiburg, Germany  
T. Dippell, F. May, M. Dörr & B. Cord  
Singulus Technologies, Kahl am Main, Germany  
T. Schütte & P. Neiß  
Plasus, Mering, Germany  
L. Eichhorn & M. Klick  
Plasmetrex, Berlin, Germany  
U. Richter  
SENTECH, Berlin, Germany  
M. Siemers  
Fraunhofer IST, Braunschweig, Germany  
P. Wiedemuth  
TRUMPF Hüttinger, Freiburg, Germany
- 2BO.4.3 Efficient Silicon Nitride SiN<sub>x</sub>:H Antireflective and Passivation Layers Deposited by Atmospheric Pressure PECVD for Low Cost PERC Solar Cells**  
J.-F. Lelièvre, P. Brunet & F. Massines  
CNRS, Perpignan, France  
B. Kafle & P. Saint-Cast  
Fraunhofer ISE, Freiburg, Germany

- 2BO.4.4 Well Passivating and Highly Temperature Stable Aluminum Oxide Deposited by Atmospheric Pressure Chemical Vapor Deposition for PERC and PERT Solar Cell Concepts**  
J. Engelhardt, B. Gapp, F. Mutter, G. Hahn & B. Terheiden  
University of Konstanz, Germany
- 2BO.4.5 Potential-Induced Degradation Leads to the Destruction of the Si/SiN<sub>x</sub> Interface**  
X. Jia, C. Zhou & W. Wang  
CAS, Beijing, China
- 2BO.4.6 Evidence of Rear Surface Related Degradation in Cz-Si PERC-Type Solar Cells**  
A. Herguth, C. Derricks & D. Sperber  
University of Konstanz, Germany

**ORAL PRESENTATIONS 6BO.8**

17:00 - 18:30 Performance Analysis and Evaluation of PV Systems

**Chairpersons:**

Alessandro Virtuani  
O'Sole, Italy  
Christian Camus  
ZAE Bayern, Germany

- 6BO.8.1 Introducing 'PEARL-PV': Performance and Reliability of Photovoltaic Systems: Evaluations of Large-Scale Monitoring Data**  
A.H.M.E. Reinders  
University of Twente, Enschede, Netherlands  
D. Moser  
EURAC, 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  
A. Scognamiglio  
ENEA, Portici, Italy  
J. Leloux  
UPM, Madrid, Spain
- 6BO.8.2 Fully Automated Photovoltaic System Modelling for Low Cost Energy Management Applications Based on Power Measurement Data**  
B. Hanke, M. Bottega, D. Peters, N. Maitanova, J.-S. Telle, K. von Maydell & C. Agert  
DLR, Oldenburg, Germany  
M. Grottko  
Hammer Real, Munich, Germany
- 6BO.8.3 A More Accurate Machine Learning PV System Performance Analyser by Using Fuzzy Logic**  
S. Rodrigues  
University of Lisbon, Funchal, Portugal  
J.P. Carvalho & H. Geirinhas Ramos  
University of Lisbon, Portugal  
F. Morgado-Dias  
University of Madeira, Funchal, Portugal



- 6BO.8.4 Remote I-V Curve Measurement for Photovoltaic Monitoring and Fault Detection**  
S. Sarikh, M. Raoufi & A. Bennouna  
Cadi Ayyad University, Marrakech, Morocco  
A. Benlarabi & B. Ikken  
IRESEN, Rabat, Morocco
- 6BO.8.5 Outdoor Performance of Various PV Module Technologies at Different Locations**  
H. Goverde, A.S.H. van der Heide, J. Govaerts, E. Voroshazi & J. Poortmans  
imec, Leuven, Belgium  
K. Spiliotis, J. Lehmann, G.H. Yordanov & K. Baert  
KU Leuven, Heverlee, Belgium  
B. Aldalali  
Kuwait University, Safat, Kuwait
- 6BO.8.6 Simulation of Bifacial PV Modules in Nordic Conditions for Low and High Albedo**  
E. Molin & E. Wäckelgård  
Dalarna University, Falun, Sweden  
B. Stridh  
Mälardalen University, Västerås, Sweden  
A. Molin  
PPAM Solkraft, Ljungsbros, Sweden

**ORAL PRESENTATIONS 5BO.12**

**17:00 - 18:30 Durability and Reliability of PV Modules**

**Chairpersons:**

Michael Köhl (i)  
Fraunhofer ISE, Germany  
Tony Sample (i)  
European Commission JRC, Italy

- 5BO.12.1 Field Analysis and Degradation of Modules and Components in Distributed PV Applications**  
H. Hu & O. Fu  
DuPont, Shanghai, China  
W.J. Gambogi, K. Roy-Choudhury, T. Felder, S. MacMaster & T.-J. Trout  
DuPont, Wilmington, United States  
L. Garreau-Iles  
DuPont, Geneva, Switzerland
- 5BO.12.2 Trend Analysis of PV Module Failure Occurrence in Different Climate Zones**  
M. Halwachs, K.A. Berger, M. Schwark & R. Ebner  
AIT, Vienna, Austria  
L. Maul & S. Dimitriadis  
UAS Technikum Vienna, Austria  
L. Neumaier, N. Vollert, W. Mühleisen & C. Hirschl  
CTR, Villach, Austria  
Y. Voronko  
OFI, Vienna, Austria  
A. Omazic  
PCCL, Leoben, Austria
- 5BO.12.3 Degradation of Photovoltaic Performance due to Outdoor Exposure at AIST Kyushu Center in Japan**  
S. Choi, R. Sato, Y. Chiba & A. Masuda  
AIST, Tosu, Japan  
T. Ishii  
CRIEPI, Yokosuka-shi, Japan

- 5BO.12.4 Climate-Specific Damage Accumulation of Solder Bonds in Silicon Photovoltaic Modules**  
M. Owen-Bellini  
NREL, Golden, United States  
J. Zhu & T.R. Betts  
Loughborough University, United Kingdom  
R. Gottschalg  
Fraunhofer CSP, Halle (Saale), Germany
- 5BO.12.5 Evaluation of Technology-Dependent Maximum Power Point Current and Voltage Degradation in a Temperate Climate**  
S. Lindig, P. Ingenhoven, G. Belluardo & D. Moser  
EURAC, Bolzano, Italy  
M. Topic  
University of Ljubljana, Slovenia
- 5BO.12.6 Delamination of CIGS Thin Film Photovoltaic Module in Desert Climate**  
A.A. Abdallah, A. Abotaleb & M. Buffière  
QEERI, Doha, Qatar  
S. Großer & C. Hagendorf  
Fraunhofer CSP, Halle (Saale), Germany

**VISUAL PRESENTATIONS 4BV.4**

**17:00 - 18:30 III-V-Based Devices for Terrestrial and Space Applications**

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



Wednesday, 26 September 2018

**ORAL PRESENTATIONS 1CO.1**

**08:30 - 10:00 Advanced Material Development and Analysis for High Performance PV Modules**

**Chairpersons:**

Rasit Turan  
METU, Turkey  
Ulrich Eitner (i)  
Fraunhofer ISE, Germany

- 1CO.1.1 Analysis of Grain-Size Distribution and Yield Strength of Interconnector Ribbons and Wires at Different Stretching Condition Using Color Etching**  
J. Walter, J. Stegmaier, A. Kraft & U. Eitner  
Fraunhofer ISE, Freiburg, Germany
- 1CO.1.2 Electrically Conductive Adhesives for Cell Interconnection in Shingled Module Technology: Impact of Material Properties on Minimodule Performance**  
M. Estruga, L. Theunissen, A. Ardizzone, B. Willems & A. Henckens  
Henkel, Westerlo, Belgium
- 1CO.1.3 Progress in Encapsulant-Integrated Multi-Wire Interconnection**  
J. Govaerts  
imec, Genk, Belgium  
T. Borgers, P. Nivelte, A.S.H. van der Heide, E. Voroshazi, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
R. Van Dyck, I. El -Chami, I. Isaa & T. Hoogewijs  
KULeuven, Belgium
- 1CO.1.4 DSM Innovative Endurance Backsheet Outdoor Validation in Hot and Humid Climate**  
M. Mrcarica, P. Tummers, K. Van Durme, I. Goudswaard & A. Hoek  
DSM, Geleen, Netherlands  
P. Pathak  
DSM, Pune, India
- 1CO.1.5 Optically Engineered Bifacial Modules for Maximum Power for All Cell Types**  
A.J. Carr, B.K. Newman, M.J.H. Kloos & A. Gutjahr  
ECN, Petten, Netherlands  
I.J. Bennett & J. Gaury  
DSM Innovation, Geleen, Netherlands
- 1CO.1.6 Novel Light-Trapping Structures in Module Non-Active Area for Boosting Efficiency and CTM Ratio**  
M. Falsini  
Firenze, Italy

**ORAL PRESENTATIONS 4CO.5**

**08:30 - 10:00 III-V-Based Devices for Terrestrial and Space Applications**

**Chairpersons:**

Giovanni Flamand  
imec, Belgium  
Carla Signorini  
European Space Agency, Netherlands

- 4CO.5.1 The Potential and Design Principle for Next-Generation Spectrum-Splitting Photovoltaics: Targeting 50% Efficiency through Built-In Filters and Generalization of Concept**  
D. Lan & M.A. Green  
UNSW Australia, Sydney, Australia
- 4CO.5.2 HVPE vs. MOCVD: A Comparison of GaAs/Si Tandem Device Performance**  
K. VanSant  
Colorado School of Mines, Golden, United States  
M. Schnabel, J. Simon, J.F. Geisz, A. Ptak, M. Young, H. Schulte-Huxel & A. Tamboli  
NREL, Golden, United States  
M. Rienäcker, R. Niepelt, S. Kajari-Schröder, R. Brendel & R. Peibst  
ISFH, Emmerthal, Germany
- 4CO.5.3 Broadband Antireflection Coating Using Intermediate Alumina and Titania Compounds**  
J. Buencuerpo, S. Christensen & J.F. Geisz  
NREL, Golden, United States
- 4CO.5.4 Effects of Irradiation on Triple and Single Junction InGaP/GaAs/Ge Solar Cells**  
C. Baur  
ESA, Noordwijk, Netherlands  
R. Campesato, M. Casale & E. Greco  
CESI, Milan, Italy  
M. Gervasi, P.G. Rancoita, D. Rozza & M. Tacconi  
INFN, Milan, Italy  
E. Gombia & A. Kingma  
CNR, Parma, Italy
- 4CO.5.5 Progress towards High Efficiency Thin-Film III-V Quantum Dot Solar Cells for Space**  
T. Aho, A. Tukiainen, J. Lyytikäinen, E. Halonen, T. Niemi & M. Guina  
Tampere University of Technology, Finland  
F. Elsehrawy, A. Khalili & F. Cappelluti  
Polytechnic University of Turin, Italy
- 4CO.5.6 Invited Presentation**



## ORAL PRESENTATIONS 2CO.9

08:30 - 10:00 Industrial Production of Silicon Solar Cells

## Chairpersons:

Peter Fath  
RCT-Solutions, Germany  
Stefan Peters (i)  
Hanwha Q CELLS, Germany

- 2CO.9.1 Development of p-Cz PERC Solar Cells Approaching 23% Efficiency for Gigawatt-Level Production**  
B.G. Lee, I. Höger, T. Ballmann, M. Kauert, S. Laube, M. Neuber, S. Geißler, T. Rudolph, K. Duncker, R. Lantzsch, M. Bartsch, F. Fertig, M. Schaper & J.W. Müller  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany
- 2CO.9.2 Industrially Feasible PERC Cells on Diamond Wire Sawing Multi-Crystalline Silicon Wafers Textured by RIE towards 21.31% Efficiency**  
Q. Ye, W. Wei, W. Wang, J. Dong, S. Yuan, J. Sheng & C. Zhang  
GCL, Suzhou, China
- 2CO.9.3 Effective Lightly Doped Emitter Manufacturing Approach for Nanotextured Black Silicon Solar Cells**  
C.-J. Hung, S.P. Su & P.S. Huang  
Motech Industries, Taoyuan, Taiwan
- 2CO.9.4 Production Compatible Remedy Against LeTID in High-Performance Multicrystalline Silicon Solar Cells**  
D. Bredemeier, D.C. Walter & J. Schmidt  
ISFH, Emmerthal, Germany  
T. Pernau & O. Romer  
centrotherm international, Blaubeuren, Germany
- 2CO.9.5 Less is More: Compact, Cost-Effective, High Performance Wet Chemical Process for HJT Solar Cell Manufacturing**  
V. Breus, A. Wissen, A. Waltinger & M. König  
Meyer Burger, Hohenstein-Ernstthal, Germany  
D.L. Bätzner & R. Kramer  
Meyer Burger Research, Haurerive, Switzerland
- 2CO.9.6 Bifacial Shingle pSPEER Solar Cells for Shingle Modules**  
P. Balozian, N. Wöhrle, E. Lohmüller, T. Fellmeth & R. Preu  
Fraunhofer ISE, Freiburg, Germany

## VISUAL PRESENTATIONS 5CV.1

08:30 - 10:00 PV Module Design, Manufacture, Performance and Reliability

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

## PLENARY SESSION 3CP.1 / 4CP.2

10:30 - 12:00 Progress in Thin Film PV / Progress in Concentrating PV

## Chairpersons:

Ayodhya Nath Tiwari  
EMPA, Switzerland  
Roberta Campesato (i)  
CESI, Italy

- 3CP.1.1 Keynote Presentation: Characterization and New Concepts Applied to Cu(In,Ga)Se<sub>2</sub> Solar Cells: Advancements through EU Project Sharc25**  
W. Witte, P. Jackson, D. Hariskos, F. Kessler & M. Powalla  
ZSW, Stuttgart, Germany  
S. Buecheler, R. Carron, E. Avancini, B. Bissig, T. Weiss, J. Löckinger & A. Tiwari  
EMPA, Dubendorf, Switzerland  
S. Siebentritt, F. Werner & M. Wolter  
University of Luxembourg, Belvaux, Luxembourg  
P. Pareige, S. Duguay, E. Cadel, C. Castro & A. Vialta-Clemente  
INSA Rouen, Saint Etienne du Rouvray, France  
R. Menozzi, G. Sozzi & S. Di Napoli  
University of Parma, Italy  
E. Bourgeois, G. Degutis & R. Gehlhaar  
imec, Leuven, Belgium  
M. Bär, R. Wilks, T. Kunze, E. Handick & J. Bombsch  
HZB, Berlin, Germany  
S. Sadewasser & N. Nicoara  
INL, Braga, Portugal  
M. Puska, M. Malitckaya, H.-P. Komsa & V. Havu  
Aalto University, Finland  
P. Reinhard  
Flisom, Dubendorf, Switzerland  
B. Dimmler & R. Wächter  
NICE Solar Energy, Schwäbisch Hall, Germany
- 3CP.1.2 CIGS Productive Technology above 18%**  
P. Kratzert, S. Weeke, M. Zimmer, S. ten Haaf, S. Hartnauer, S. Jander, R. Hunger & M. Vogl  
Solibro, Bitterfeld-Wolfen, Germany  
O. Lundberg, E. Wallin, V. Gusak & L. Stolt  
Solibro Research, Uppsala, Sweden
- 3CP.1.3 Large Area (>140 cm<sup>2</sup>) Perovskite Solar Modules Made by Sheet to Sheet and Roll to Roll Fabrication with 14.5% Efficiency**  
F. Di Giacomo, H. Fledderus, H. Gorter, G. Kirchner, I. de Vries, I. Dogan, V. Zardetto, F. Biascioli, F. Isabelli, H. Lifka, Y. Galagan, P. Groen & R.A.J.M. Andriessen  
Holst Centre - TNO, Eindhoven, Netherlands  
T. Aernouts & Y. Kuang  
imec, Leuven, Belgium  
W. Verhees, M. Najafi, D. Zhang & S.C. Veenstra  
ECN, Eindhoven, Netherlands



- 4CP.2.1 Final Results of CPVMatch - Concentrating Photovoltaic Modules Using Advanced Technologies and Cells for Highest Efficiencies**  
 G. Siefer, D. Lackner, O. Höhn, S.P. Philipps, M. Wiesenfarth & A.W. Bett  
 Fraunhofer ISE, Freiburg, Germany  
 B. Schineller  
 AIXTRON, Herzogenrath, Germany  
 R. Parmesani  
 ASSE, Trieste, Italy  
 T. Kubera  
 AZUR SPACE, Heilbronn, Germany  
 P. Voarino  
 CEA, Le Bourget du Lac, France  
 J. Payet  
 CYCLECO, Ambérieu-en-Bugey, France  
 I. Antón Hernández  
 UPM, Madrid, Spain  
 G. Abagnale, N. Armani, M. Cornelli, A. Minuto, G. Timò & F. Trespidi  
 RSE, Milan, Italy  
 R. Alonso & E. Román Medina  
 TECNALIA, San Sebastián, Spain

**ORAL PRESENTATIONS 1CO.2**

13:30 - 15:00 Novel Approaches for Special PV Applications

**Chairpersons:**

Jan-Willem Schüttauf (*i*)  
 CSEM, Switzerland  
 Ignacio Rey-Stolle (*i*)  
 UPM, Spain

- 1CO.2.1 Glued Solar Cells - A Sophisticated Technology for PV Modules**  
 W. Mühleisen, L. Neumaier & C. Hirschl  
 CTR, Villach, Austria  
 J. Scheurer & B. Stoesser  
 Polytec PT, Karlsbad, Germany  
 W. Pranger & A. Schütz  
 Ulbrich of Austria, Müllendorf, Austria  
 F. Vollmaier  
 PVP Photovoltaik, Wies, Austria  
 T. Fischer & R. Lorenz  
 Teamtechnik, Freiberg, Germany  
 M. Schwark & R. Ebner  
 AIT, Vienna, Austria
- 1CO.2.2 Wet Chemical Texturization of Glass Substrate Using AZO as Sacrificial Layer for Improved Light Management in Thin Film Silicon Solar Cells**  
 S. Bose, G. Das, A. Kole, S. Mukhopadhyay & A.K. Barua  
 IEST Shibpur, Howrah, India  
 S. Mandal  
 IIT Delhi, New Delhi, India
- 1CO.2.3 Design of Coloured Bragg Reflectors with Heating Prevention Capability for BIPV Modules**  
 J.C. Ortiz Lizcano, P. Seoane da Silva, O. Isabella & M. Zeman  
 Delft University of Technology, Netherlands

- 1CO.2.4 Research on New Materials for Building Integrated Photovoltaic Applications: AiSoVol Project**  
 O. González, R. Castelo, A. Alvarez, P. Hernández, E. Llarena, C. Montes, D. Molina, A. Pío, L. Ocaña, C. Quinto, M. Friend & M. Cendagorta  
 ITER, Granadilla de Abona, Spain  
 A. Linares  
 AIET, Granadilla de Abona, Spain  
 A.B. Cueli  
 CENER, Sarriguren-Navarra, Spain
- 1CO.2.5 High-Efficiency GaAs Based Laser Power Converters: A Direct Optical Fiber Coupling**  
 J. Garnier Le Pallec, A. Takrouni, K. Thomas, E. Pelucchi & B. Corbett  
 Tyndall National Institute, Cork, Ireland  
 D. O'Mahony  
 Cork Institute of Technology, Ireland  
 P. Doguet  
 Synergia Medical, Mont-Saint-Guibert, Belgium
- 1CO.2.6 Spatial Light Modulator Based Laser Microfabrication of Volume Optics Inside Solar Modules**  
 B. Lamprecht, V. Satzinger, G. Peharz & F.P. Wenzl  
 Joanneum Research, Weiz, Austria  
 V. Schmidt  
 Rebeat Innovation, Weiz, Austria

**ORAL PRESENTATIONS 3CO.6**

13:30 - 15:00 CIGS Devices and Processing

**Chairpersons:**

Wiltraud Wischmann  
 ZSW, Germany  
 Bernhard Dimmler  
 NICE Solar Energy, Germany

- 3CO.6.1 Special Introductory Presentation: Sputtered-ZnOS Buffer Layers in CIGS Modules at 18% Efficiency**  
 P. Eraerds, M. Algasinger, R. Lechner, T. Dalibor & J. Palm  
 Avancis, Munich, Germany
- 3CO.6.2 Recent Advances in High Efficiency CIGS Solar Cells on Polymer Substrates: New Results on Ga Grading and Alkali Fluorides**  
 F. Donsanti, M. Balestrieri, V. Achard, T. Hildebrandt, L. Lombez, S. Béchu, M. Jubault & N. Naghavi  
 IPVF, Palaiseau, France  
 M. Bouttemy & A. Etcheberry  
 UVSQ, Versailles, France  
 D. Lincot  
 CNRS, Palaiseau, France
- 3CO.6.3 The Optimization of CIGS Absorbers Obtained from Atmospheric Selenium-Sulphur Annealing of Electrodeposited Precursors on a 30x30 cm<sup>2</sup> Pilot Line**  
 M. Theelen, A. Hovestad, M. Simor, M. Van der Vleuten, H.L.A.H. Steijvers & H. Linden  
 TNO, Eindhoven, Netherlands  
 K. van der Werf, D. Zhang & M. Dörenkämper  
 ECN, Eindhoven, Netherlands  
 W. Luk, W.T.J. Lee & S. Yang  
 ADPV, Hong Kong, China





**3CO.6.4 Characterization of High Performance Cu(In,Ga)Se<sub>2</sub> Bottom Cells in Thin Film Solar Tandem Applications**  
H. Elanzeery, F.-S. Babbe, M. Melchiorre, F. Werner & S. Siebentritt  
University of Luxembourg, Belvaux, Luxembourg

**3CO.6.5 Narrow Bandgap Cl(G)S for Tandem Application**  
T. Feuer, T. Moser, T.P. Weiss, E. Avancini, S. Buecheler & A.N. Tiwari  
EMPA, Dubendorf, Switzerland

#### ORAL PRESENTATIONS 2CO.10

**13:30 - 15:00 Poly-Si Based Passivating Contacts**

#### Chairpersons:

Giso Hahn  
University of Konstanz, Germany  
Arthur W. Weeber  
ECN part of TNO, Netherlands

**2CO.10.1 Intrinsic Poly-Crystalline Silicon Region in between the p+ and n+ POLO Contacts of an 26.1%-Efficient IBC Solar Cell**  
C. Klamt, M. Rienäcker, F. Haase, N. Folchert, R. Brendel & R. Peibst  
ISFH, Emmerthal, Germany  
V. Krausse & J. Krügener  
Leibniz University of Hannover, Germany

**2CO.10.2 Highly Passivating and Blister-Free PECVD Poly-Silicon for Large Area Silicon Solar Cells**  
A. Morisset, R. Cabal, B. Grange & S. Dubois  
CEA, Le Bourget du Lac, France  
C. Marchat  
IPVF, Palaiseau, France  
J. Alvarez, M.E. Gueunier-Farret & J.-P. Kleider  
CNRS, Gif-sur-Yvette, France

**2CO.10.3 Novel Schemes of p+poly-Si Hydrogenation Implemented in Industrial 6" Bifacial Front-and-Rear Passivating Contacts Solar Cells**  
M.K. Stodolny, J. Anker, C.J.J. Tool, A.A. Mewe, P. Manshanden & I.G. Romijn  
ECN, Petten, Netherlands  
M. Lenes  
Tempress, Vaassen, Netherlands

**2CO.10.4 LPCVD Polysilicon-Based Passivating Contacts for Plated Bifacial n-Type PERT Solar Cells**  
M. Recamán Payo, R. Russell, S. Singh, V. Depauw, I. Kuzma-Filipek, Y. Li, M. Firat, L. Tous, J. John, F. Duerinckx, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
J.R.M. Luchies & M. Lenes  
Tempress, Vaassen, Netherlands

**2CO.10.5 Electron Beam Evaporation of Silicon for Polysilicon/SiO<sub>2</sub> Passivated Contacts**  
J. Lossen, J. Hoß & S. Eisert  
ISC Konstanz, Germany  
D. Amkreutz & M. Muske  
HZB, Berlin, Germany  
G. Andrá  
IPHT, Jena, Germany

**2CO.10.6 High-Thermal Budget c-Si Heterojunction Solar Cells with Poly-SiO<sub>x</sub> Carrier-Selective Passivating Contacts**  
G. Yang, P.Q. Guo, R. Santbergen, G. Limodio, A.W. Weeber, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands

#### VISUAL PRESENTATIONS 6CV.2

**13:30 - 15:00 Design and Installation of PV Systems**

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

#### ORAL PRESENTATIONS 6CO.3

**15:15 - 16:45 Modelling for PV Systems**

#### Chairpersons:

Adriano Sabene (I)  
ENEL Green Power, Italy  
Kari Lappalainen  
Tampere University of Technology, Finland

**6CO.3.1 Simplified Method for Partial Shading Losses Calculation for Series Connected PV Modules with Experimental Validation**  
M. Dallapiccola, P. Inghoven & D. Moser  
EURAC, Bolzano, Italy  
J.S. Stein  
Sandia National Laboratories, Albuquerque, United States

**6CO.3.2 A Lower TC: In the Future Maybe Not Always the Best Idea?**  
J. Govaerts, I. Horvath & H. Goverde  
imec, Genk, Belgium  
B. Aldalali  
Kuwait University, Khaldiya, Kuwait  
J. Poortmans  
imec, Leuven, Belgium

**6CO.3.3 From BIPV Module to System: A Modelica-Developed Framework for Building Energy Simulations Including BIPVs**  
K. Spiliotis, J. Goncalves, K. Baert, J. Driesen & D. Saelens  
KU Leuven, Belgium

**6CO.3.4 Predicting Yields of Bifacial PV Power Plants – What Accuracy Is Possible?**  
M. Chioldetti  
EDF, Moret-Loing-Orvanne, France  
J. Kang & C. Reise  
Fraunhofer ISE, Freiburg, Germany  
A. Lindsay  
EDF, Los Altos, United States

**6CO.3.5 Mitigating Snow on Rooftop PV Systems for Higher Energy Yield and Safer Roofs**  
B.B. Aarseth  
University of Oslo, Kjeller, Norway  
M.B. Øgaard, J. Zhu, J.A. Tsanakas, J.H. Krogh Selj & E.S. Marstein  
IFE, Kjeller, Norway  
T. Strömberg  
Innos, Etterstad, Norway



- 6CO.3.6 Load Flow Simulation of a Low-Voltage PV-Battery Based DC Micro-Grid to Supply Small Isolated Communities**  
 P. Ferreira Torres, M. Barros Galhardo, W. Negrao-Macedo & J. Tavares Pinho  
 UFPA, Belém, Brazil  
 J. de Arimatéia Alves Vieira Filho, V. Lima Chaar Junior & L. Ferreira de Araújo  
 UFPA, Belem, Brazil  
 S. Williamson  
 University of Bristol, United Kingdom

**ORAL PRESENTATIONS 3CO.7**

15:15 - 16:45 CIGS Characterisation

**Chairpersons:**

Alex Redinger (i)  
 University of Luxembourg, Luxembourg  
 Thomas Dalibor  
 Avancis, Germany

- 3CO.7.1 Discrimination of Trapping and Front Surface Recombination for Double Graded Cu(In,Ga)Se<sub>2</sub>**  
 T.P. Weiss, R. Carron, J. Löckinger, E. Avancini, S. Buecheler & A.N. Tiwari  
 EMPA, Dubendorf, Switzerland
- 3CO.7.2 Defects, Buffer Layer, or Artefact – What Do We See in Capacitance Measurements of Thin-Film Solar Cells?**  
 F. Werner, F.-S. Babbe, J. Burkhart, H. Elanzeery & S. Siebentritt  
 University of Luxembourg, Belvaux, Luxembourg
- 3CO.7.3 Reduced Recombination in a Surface-Sulfurized Cu(InGa)Se<sub>2</sub> Thin-Film Solar Cell**  
 S. Kim, J. Nishinaga, H. Tampo, H. Shibata & S. Niki  
 AIST, Tsukuba, Japan
- 3CO.7.4 Impact of Chalcogen Atmosphere during KF-Post Deposition Treatment on Cu(In,Ga)Se<sub>2</sub>/CdS Interface Formation and PV Performance**  
 S. Harel, T. Lepetit, L. Arzel & N. Barreau  
 University of Nantes, France  
 P. Zabierowski  
 Warsaw University of Technology, Poland
- 3CO.7.5 Service Life Prediction for CIGS Modules Regarding Potential-Induced Degradation**  
 P. Lechner, J. Schnepf & S. Hummel  
 ZSW, Stuttgart, Germany

**ORAL PRESENTATIONS 2CO.11**

15:15 - 16:45 Transparent Passivating Layers for Silicon Cells

**Chairpersons:**

Joachim John (i)  
 imec, Belgium

*Invited*

- 2CO.11.1 Nanocrystalline n-Type Silicon Front Surface Field Layers: From Research to Industry Applications in Silicon Heterojunction Solar Cells**  
 A.B. Morales-Vilches, L. Mazzarella, L. Korte, R. Schlatmann & B. Stannowski  
 HZB, Berlin, Germany  
 D. Decker & D. Sontag  
 Meyer Burger, Hohenstein-Ernstthal, Germany
- 2CO.11.2 SiCx- and SiOx-Based Passivating Contacts for High-Efficiency Silicon Solar Cells**  
 F.-J. Haug, J. Stuckelberger, G. Nogay, P. Wyss, M. Lehmann, L. Gnocchi, A. Ingenito & C. Ballif  
 EPFL, Neuchâtel, Switzerland  
 C. Allebé, J. Horzel & M. Despeisse  
 CSEM, Neuchâtel, Switzerland
- 2CO.11.3 Passivating Contacts for Silicon Solar Cells Made of Al<sub>2</sub>O<sub>3</sub> and TiO<sub>x</sub> Nanolayer Systems**  
 M. Grube, D. Tröger, M. Materano & T. Mikolajick  
 NaMLab, Dresden, Germany  
 M. Knaut, J. Reif & J.W. Bartha  
 Technical University of Dresden, Germany
- 2CO.11.4 Implementation of Full-Area-Deposited Electron-Selective TiO<sub>x</sub> Layers into Silicon Solar Cells**  
 V. Titova & J. Schmidt  
 ISFH, Emmerthal, Germany
- 2CO.11.5 Electron-Selective Contact Using i-a-Si:H/TiO<sub>x</sub> and Yb for Silicon Heterojunction Solar Cells**  
 J. Cho, M. Recamán Payo, M. Debucquoy, H. Sivaramakrishnan Radhakrishnan, I. Gordon, J. Szlufcik & J. Poortmans  
 imec, Leuven, Belgium
- 2CO.11.6 Transparent Passivating Contacts for Front Side Application**  
 J. Stuckelberger, G. Nogay, P. Wyss, L. Gnocchi, M.J. Lehmann, L. Antognini, F.-J. Haug, A. Ingenito & C. Ballif  
 EPFL, Neuchâtel, Switzerland  
 J.J. Diaz Leon, L. Ding, J. Horzel, C. Allebé, S. Nicolay & M. Despeisse  
 CSEM, Neuchâtel, Switzerland

**VISUAL PRESENTATIONS 5CV.3**

15:15 - 16:45 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'.



## ORAL PRESENTATIONS 6CO.4

17:00 - 18:30 Design and Calculations

## Chairpersons:

Christer Nyman (*i*)  
Soleco, Finland

*Invited*

- 6CO.4.1 Open Source Tool for a Better Design of BIPV+ Battery System: An Applied Example**  
M. Lovati, J. Adami & D. Moser  
Eurac Research, Bolzano, Italy
- 6CO.4.2 Size of a Basic Simulation Unit in PV System Partial Shading Studies**  
K. Lappalainen & S. Valkealahti  
Tampere University of Technology, Finland
- 6CO.4.3 Special Presentation: Economic Validation of Large Power PV Irrigation Systems**  
R.H. Almeida, I.A. Barata Carrêlo, C. Lorenzo Navaro & L. Narvarte Fernández  
UPM, Madrid, Spain
- 6CO.4.4 Design of Hybrid-Minigrids in South African Rural Areas under Consideration of Social and Cultural Aspects**  
M. Kühnel, B. Hanke & K. von Maydell  
DLR, Oldenburg, Germany  
Y. Baranova  
DEULA-Nienburg, Germany  
O. Weigel & S. Maebe  
GIZ, Hamburg, Germany  
I.W. Stuermer  
MU-Niedersachsen, Hannover, Germany  
A. McMaster  
DEDEAT, East London, South Africa
- 6CO.4.5 Comparison of Vertically Mounted PV on Land and on Water**  
A.J. Carr & B.B. Van Aken  
ECN, Petten, Netherlands  
H. Lok, L.S. Bosma & T. Jansma  
Hanze University, Groningen, Netherlands  
W. Vermeulen  
Tempress, Vaassen, Netherlands  
S. Eggink & R. Kreiter  
Sunfloat, Bennekom, Netherlands  
W. Otto  
MARIN, Wageningen, Netherlands

## ORAL PRESENTATIONS 3CO.8

17:00 - 18:30 CdTe and CZTS

## Chairpersons:

*Invited*

Susanne Siebentritt  
University of Luxembourg, Luxembourg

- 3CO.8.1 Increased Efficiency with CdSeTe Layer in Front of CdTe**  
J.R. Sites, T. Song & A. Huss  
Colorado State University, Fort Collins, United States  
M. Lingg  
EMPA, Dübendorf, Switzerland
- 3CO.8.2 Introduction of Copper by Wet Deposition in CdTe Solar Cells**  
E. Artegiani, D. Menossi, M. Leoncini, M. Cavallini & A. Romeo  
University of Verona, Italy
- 3CO.8.3 In-Line MOCVD of Al Doped ZnS: A Path to High Performance CdTe Solar Cells**  
A.J. Clayton, P.J. Siderfin, S. Jones, G. Kartopu, O. Oklobia, A.C. Teloecken, D.A. Lamb & S.J.C. Irvine  
Swansea University, St. Asaph, United Kingdom
- 3CO.8.4 Towards Cd-Free R2R CZTSSe-Monograin-Membrane PV-Module Production**  
P. Santos Ortiz, S. Lopez, S. Edinger, M. Ursprung, L. Plessing, C. Waldauf & D. Meissner  
Crystalsol, Vienna, Austria  
J. Mangalam, T. Rath, P. Poelt & G. Trimmel  
Graz University of Technology, Austria  
C. Neubauer  
Tallinn University of Technology, Estonia
- 3CO.8.5 SWInG – Development of Thin Film Solar Cells Based on Wide Band Gap Kesterite Absorbers**  
B. Vermang, G. Brammertz, S. Sahayaraj, S. Ranjbar, M. Aniket, S. Garud & M. Meuris  
imec, Leuven, Belgium  
T. Schnabel & E. Ahlswede  
ZSW, Stuttgart, Germany  
L. Choubrac, S. Harel, C. Cardinaud, L. Arzel & N. Barreau  
CNRS, Paris, France  
J. van Deelen & P.J. Bolt  
TNO/Solliance, Eindhoven, Netherlands  
P. Bras, Y. Ren & E. Jaremalm  
Midsummer, Järfälla, Sweden  
S. Khelifi, S. Yang & J. Lauwaert  
Ghent University, Gent, Belgium  
X. Kozina, E. Handick, Y. Zhang, R.G. Wilks & M. Bär  
HZB, Berlin, Germany
- 3CO.8.6 Electronic Structure of CdS/Cu<sub>2</sub>ZnGeSe<sub>4</sub> Heterointerface**  
T. Nagai, H. Tampo, S. Kim, H. Shibata, K. Matsubara & S. Niki  
AIST, Tsukuba, Japan  
K. Tanigawa, Y. Iwamoto, H. Hamada, N. Ohta, T. Shimamura & N. Terada  
Kagoshima University, Japan



## ORAL PRESENTATIONS 2CO.12

17:00 - 18:30 Metallisation and Structuring

## Chairpersons:

Jörg Horzel (i)  
CSEM, Switzerland  
Florian Clement  
Fraunhofer ISE, Germany

- 2CO.12.1 Ultra-Short Laser Processing for Damage-Free Back-Contacted Silicon Hetero-Junction Solar Cells**  
A. Singh, B. Turan, S. Haas, A. Lambertz, K. Ding & U. Rau  
Forschungszentrum Jülich, Germany
- 2CO.12.2 Benefits of Pattern Transfer Printing Method for Finger Metallization on Silicon Solar Cells**  
A. Adrian, D. Rudolph & J. Lossen  
ISC Konstanz, Germany  
M. Matusovsky  
Utilight, Yavne, Israel
- 2CO.12.3 Progress on Bifacial Ni/Ag Plated nPERT Cells for Module Fabrication with SWCT**  
L. Tous, R. Russell, S. Jambaldinni, A. van der Heide, G. Doumen, F. Duerinckx, E. Voroshazi & J. Szlufcik  
imec, Leuven, Belgium  
Y. Yao & B. Bonnet-Eymard  
Meyer Burger, Gwatt, Switzerland
- 2CO.12.4 Plated Fine Line Metallization for PERC Solar Cells**  
S. Kluska, A. Lorenz, B. Grübel, A. Büchler, G. Cimiotti, F. Clement, V. Arya, A.A. Brand, J. Nekarda, J. Bartsch & M. Glatthaar  
Fraunhofer ISE, Freiburg, Germany  
S. Hörnlein & A. Mette  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany
- 2CO.12.5 Processing Routes and Costs for Copper Plating on Bifacial Heterojunction Cells**  
A. Lachowicz, J. Geissbühler, A. Faes, J. Champlaud, J. Horzel, C. Ballif & M. Despeisse  
CSEM, Neuchâtel, Switzerland  
M. Sciuto & A. Battaglia  
3SUN, Catania, Italy  
J.-F. Lerat, D. Muñoz & P.-J. Ribeyron  
INES, Le Bourget du Lac, France  
P. Papet & B. Strahm  
Meyer Burger Research, Hauterive, Switzerland
- 2CO.12.6 Novel Methods of Efficient Metallization for Silicon Heterojunction Solar Cells**  
G.K. Zhavnerko, I. Paribok & V.Y. Shiripov  
Izovac Technologies, Minsk, Belarus  
O.V. Sergeev  
DLR, Oldenburg, Germany

## VISUAL PRESENTATIONS 1CV.4

17:00 - 18:30 Fundamental Studies / New Materials and Concepts for Photovoltaic Devices

## Thursday, 27 September 2018

## PLENARY SESSION 5DP.1

08:30 - 10:00 Photovoltaic Modules and BoS Components

## Chairpersons:

Werner Herrmann  
TÜV Rheinland Energy, Germany  
Mariska De Wild-Scholten (i)  
SmartGreenScans, Netherlands

- 5DP.1.1 Invited Keynote Presentation**
- 5DP.1.2 Invited Plenary Presentation**
- 5DP.1.3 Invited Plenary Presentation**
- 5DP.1.4 Environmental Aspects of Crystalline Silicon PV Module Recycling Technologies**  
K. Komoto, S. Oyama, T. Sato & H. Uchida  
Mizuho IR Institute, Tokyo, Japan

## PLENARY SESSION 6DP.2

10:30 - 12:00 PV Systems Performance, Applications and Integration

## Chairpersons:

Franz P. Baumgartner  
ZHAW, Switzerland  
Alessandra Scognamiglio  
ENEA, Italy

- 6DP.2.1 Keynote Presentation: Visions from the Future: The Interaction between Curtailment, Spinning Reserve Settings and Generator Limits on Australian Projects with Medium to High Renewable Energy Fractions**  
B. Herteleer, G. Dickeson, L. McLeod, B. van Ree, C. Paynter & L. Frearson  
Ekistica, Alice Springs, Australia  
D. Airen, P. Maker & S. Latz  
Power and Water, Alice Springs, Australia  
A. Dobb & S. Rodgers  
ARENA, Canberra, Australia

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



**6DP.2.2 Demonstrating Novel Building Integrated Photovoltaic Technologies with the PVSITES Project**

M. Machado, R. Alonso & J.M. Vega de Seoane  
 Tecnalia, San Sebastián, Spain  
 I. Weiss & S. Challet  
 WIP - Renewable Energies, Munich, Germany  
 V.K. Nguyen & P. Alamy  
 CADCAMation, Onex, Switzerland  
 F. Noris  
 R2M Solution, Pavia, Italy  
 E. Rico  
 Onyx Solar Energy, Avila, Spain  
 T. Reijenga  
 BEAR-iD, Gouda, Netherlands  
 P. Brassier  
 Nobatek, Anglet, France  
 P. Surguy  
 Film Optics, Watchfield, United Kingdom  
 V. Francisco  
 CTCV, Coimbra, Portugal  
 J. Perrenoud  
 Filsom, Dübendorf, Switzerland  
 H. Delgado  
 CRICURSA, Barcelona, Spain  
 F. Burgun  
 CEA, Le Bourget du Lac, France  
 J.C. Esteban  
 Acciona Infraestructuras, Madrid, Spain  
 D. Déramaix  
 Format D2, Sirault, Belgium  
 A. Bogucka  
 Vilogia, Paris, France

**6DP.2.3 Lessons Learned After the Quality Control Analysis of a Supply of 217 MWp from a Tier-1 Manufacturer for a Project Located in Desert Conditions**

L. Pérez, J.A. Florez, E. Alvarez, M. Martínez, G. Castillo, H. Silva & A. Velasco  
 Enertis Solar, Madrid, Spain

**6DP.2.4 Infrared and Electroluminescence Imaging for PV Field Applications: An Overview of the Latest Report by IEA PVPS Task 13**

J.A. Tsanakas  
 IFE, Kjeller, Norway  
 U. Jahn & M. Herz  
 TÜV Rheinland Energy, Cologne, Germany  
 M. Köntges  
 ISFH, Emmerthal, Germany  
 D. Parlevliet  
 Murdoch University, Perth, Australia  
 M. Paggi  
 IMT School for Advanced Studies, Lucca, Italy  
 J.S. Stein  
 Sandia National Laboratories, Albuquerque, United States  
 K.A. Berger  
 ALT, Vienna, Austria  
 S. Ranta  
 Turku University of Applied Sciences, Finland  
 R. French  
 Case Western Reserve University, Cleveland, United States  
 M. Richter  
 3E, Brussels, Belgium  
 T. Tanahashi  
 AIST, Tsukuba, Japan

**ORAL PRESENTATIONS 2DO.1**

**13:30 - 15:00 Heterojunction Silicon Cells**

**Chairpersons:**

Miro Zeman (i)  
 Delft University of Technology, Netherlands  
 Delfina Muñoz  
 CEA, France

**2DO.1.1 Special Introductory Presentation: Engineering of Thin Film Silicon Materials for High Efficiency Crystalline Silicon Solar Cells**

M. Despeisse, B. Paviet-Salomon, A. Descoedres, L.-L. Senaud, C. Allebé, J. Levrat, J. Horzel, A. Lachowicz, F. Debrot, J. Champlaud, A. Faes, N. Badel, J. Geissbühler, S. Martin de Nicolás, G. Christmann, J.J. Diaz Leon, L. Ding & S. Nicolay  
 CSEM, Neuchâtel, Switzerland  
 M. Boccard & C. Ballif  
 EPFL, Neuchâtel, Switzerland

**2DO.1.2 Silicon Heterojunction Solar Cells with Open-Circuit-Voltage above 750mV**

A. Danel, S. Harrison, F. Gérenton, R. Varache & J. Veirman  
 CEA, Grenoble, France

**2DO.1.3 Selective Deposition of a-Si:H: A Proof-of-Concept Study**

M. Xu, T. Bearda, M. Hasan, H. Sivaramakrishnan Radhakrishnan, I. Gordon, J. Szlufcik & J. Poortmans  
 imec, Leuven, Belgium

**2DO.1.4 Passivation and Transport Modification Upon Light Soaking of Silicon Heterojunction Solar Cells**

J. Cattin, J. Haschke, O. Dupré, M. Boccard & C. Ballif  
 EPFL, Neuchâtel, Switzerland

**2DO.1.5 Implementation of a Novel Silicon Heterojunction IBC Process Flow Using Partial Etching of Doped a-Si:H with Efficiencies Close to 23%**

H. Sivaramakrishnan Radhakrishnan, M.D. Gius Uddin, M. Xu, J. Cho, I. Gordon, J. Szlufcik & J. Poortmans  
 imec, Leuven, Belgium



## ORAL PRESENTATIONS 3DO.4

13:30 - 15:00 **Characterisation, Stability and Outdoor Performance of Emerging PV Technologies**

## Chairpersons:

Sjoerd Veenstra  
ECN part of TNO, Netherlands  
Quentin Jeangros  
EPFL, Switzerland

- 3DO.4.1 Worldwide Standardization Activity on Emerging Photovoltaic Devices: Guidance for the Measurement of Organic, Dye Sensitized and Perovskite PV Devices**  
G. Bardizza & H. Müllejans  
European Commission JRC, Ispra, Italy  
T. Matsuyama  
University of Tokyo, Japan  
C.J. Fell  
CSIRO Energy Technology, Mayfield West, Australia
- 3DO.4.2 Outdoor Monitoring of MAPI and FMC Mini-Modules**  
V. Stoichkov  
Bangor University, United Kingdom  
J. Troughton, K. Hooper, F. de Rossi & T.M. Watson  
Swansea University, United Kingdom  
J. Kettle  
University of Bangor, United Kingdom
- 3DO.4.3 Outdoor Measurements of MPP-Tracked Perovskite Solar Cells**  
C. Ulbrich, M. Riedel, S. Pingel, S. Neubert & R. Schlattmann  
PVcomB, Berlin, Germany  
A. Abate  
HZB, Berlin, Germany  
M. Jankovec, B. Glažar & M. Topic  
University of Ljubljana, Slovenia  
C. Schultz  
University of Applied Sciences, Berlin, Germany
- 3DO.4.4 Towards Long-Term Thermally Stable Highly Efficient Perovskite Solar Cells**  
W. Song, J.P. Bastos, L. Rakocevic, W. Qiu, T. Merckx, G. Uytterhoeven, R. Gehlhaar, T. Aernouts & J. Poortmans  
imec, Heverlee, Belgium
- 3DO.4.5 Probing Photoinduced Degradation of CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub> Perovskite Films by Kelvin Probe and Photoluminescence Techniques**  
A. Peter Amalathas, L. Abelová, B. Conrad & B. Dzurak  
CTU, Prague, Czech Republic  
M. Ledinsky & J. Holovsky  
ASCR, Prague, Czech Republic
- 3DO.4.6 Development of Imaging Tools for Degradation Study of Organic Photovoltaic Cells and Modules under Illumination**  
M.-A. Llobel, M. Matheron, S. Cros & S. Berson  
CEA, Le Bourget du Lac, France  
C. Arrivé, S. Courtel, G. Rivière & M. Bertrand  
ARMOR, Nantes, France

## ORAL PRESENTATIONS 5DO.7

13:30 - 15:00 **Qualification and Testing of Glass, Encapsulation and Backsheet Materials**

## Chairpersons:

Mike Van Iseghem  
EDF R&D, France  
Hartmut Nussbaumer  
ZHAW, Switzerland

- 5DO.7.1 New Test Method for Performance Evaluation of Anti-Soiling Coatings**  
K. Ilse, M.Z. Khan, V. Naumann & C. Hagendorf  
Fraunhofer CSP, Halle (Saale), Germany  
N. Voicu  
DSM Advanced Solar, Geleen, Netherlands
- 5DO.7.2 PV Module and Solar Glass Trickling Sand Testing**  
G. Mathiak, D. Grimm, L. Falk, L. Rimmelspacher, W. Herrmann, F. Reil & J. Althaus  
TÜV Rheinland Energy, Cologne, Germany  
A. Morlier  
ISFH, Hamelin, Germany
- 5DO.7.3 Do PV Modules Optimized for Different Climatic Conditions Make Sense? Discussion by Using the Example of Backsheet and Encapsulant Films**  
G. Oreski & A. Omazic  
PCCL, Leoben, Austria  
G.C. Eder & Y. Voronko  
OFI, Vienna, Austria  
L. Neumaier & C. Hirschl  
CTR, Villach, Austria  
R. Ebner  
AIT, Vienna, Austria  
M. Edler  
ISOVOLTAIC, Lebring, Austria
- 5DO.7.4 Climate Specific Accelerated Ageing Tests & Evaluation of Ageing Induced Electrical, Physical and Chemical Changes**  
G.C. Eder & Y. Voronko  
OFI, Vienna, Austria  
S. Dimitriadis & K. Knöbl  
University of Applied Sciences Vienna, Austria  
G. Újvári & K.A. Berger  
AIT, Vienna, Austria  
L. Neumaier  
CTR, Villach, Austria
- 5DO.7.5 Backsheet Chalking: Background and Relation to Backsheet Cracking**  
P. Gebhardt, L. Pitta Bauermann & D. Philipp  
Fraunhofer ISE, Freiburg, Germany
- 5DO.7.6 Combined-Accelerated Stress Testing for Advanced Reliability Assessment of Photovoltaic Modules**  
M. Owen-Bellini, P. Hacke, M. Kempe & D.C. Miller  
NREL, Golden, United States  
S.V. Spataru  
AAU, Aalborg, Denmark  
L. Schelhas & S. Moffitt  
SLAC, Menlo Park, United States



## ORAL PRESENTATIONS 6DO.10

13:30 - 15:00 Solar Radiation

## Chairpersons:

Christos Protopogeropoulos (i)  
EEPS, Greece

*Invited*

- 6DO.10.1 Improving the Accuracy of the National Solar Radiation Database (1998-2016)**  
M. Sengupta, A. Habte, A. Lopez & Y. Xie  
NREL, Golden, United States
- 6DO.10.2 Disaggregation of Local Photovoltaic Generation from Composite Power Flows with Direct Measuring and Satellite Estimations of the Irradiance: A Comparison**  
F. Sossan, E. Scolari & M. Paolone  
EPFL, Lausanne, Switzerland
- 6DO.10.3 Solar Irradiation on Roof Surfaces: Generating Spatially Resolved Hour-by-Hour Time Series for Buildings in the Netherlands**  
N. Nortier, W.G.J.H.M. van Sark & B.B. Kausika  
Utrecht University, Netherlands  
M. Paardekooper  
Geodan, Amsterdam, Netherlands
- 6DO.10.4 Modeling Reflected Irradiance in Urban Environments – A Case Study for Simulation-Based Measurement Quality Control for an Outdoor PV Test Site**  
A. Bognar, R. Loonen & J.L.M. Hensen  
Eindhoven University of Technology, Netherlands  
R.M.E. Valckenborg  
SEAC, Eindhoven, Netherlands
- 6DO.10.5 Direct Normal Irradiance Measurements Using a Tracker-Less Sunshine Duration Measurement Concept**  
J.M. da Costa Pó & K. Hoogendijk  
EKO Instruments, Den Haag, Netherlands  
I. Chiba & A. Akiyama  
EKO Instruments, Tokyo, Japan  
W. Beuttell  
EKO Instruments, San Jose, United States
- 6DO.10.6 Radiometer Response Time and Irradiance Measurement Accuracy**  
A. Driesse  
PV Performance Labs, Freiburg, Germany

## VISUAL PRESENTATIONS 6DV.1

13:30 - 15:00 Operation, Performance and Maintenance of PV Systems

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

## ORAL PRESENTATIONS 2DO.2

15:15 - 16:45 Transparent Conductive Oxides

## Chairpersons:

Yoshio Ohshita  
Toyota Technological Institute, Japan  
David Young  
NREL, United States

- 2DO.2.1 Transparent Conductive Oxide Screening on High Temperature Passivating Contact Solar Cells for Improved Passivation and Cell Efficiency**  
J.J. Diaz Leon, L. Ding, G. Christmann, C. Allebé, M. Despeisse & S. Nicolay  
CSEM, Neuchâtel, Switzerland  
G. Nogay, J. Stuckelberger, P. Wyss, F.-J. Haug, A. Ingenito & C. Ballif  
EPFL, Neuchâtel, Switzerland
- 2DO.2.2 Optoelectronic Performance of TCOs on Silicon Heterojunction Rear Emitter Solar Cells**  
A. Cruz, S. Neubert, A.B. Morales-Vilches, D. Erfurt, F. Ruske, B. Stannowski & R. Schlatmann  
HZB, Berlin, Germany  
S. Koerner & B. Szyszka  
Berlin University of Technology, Germany
- 2DO.2.3 Zr-Doped In<sub>2</sub>O<sub>3</sub>: Combining High-Doping and High-Mobility in a Water-Free Ultra-Transparent Electrode for SHJ Solar Cells**  
M. Boccard, R. Monnard, E. Rucavado, M. Morales-Masis & C. Ballif  
EPFL, Neuchâtel, Switzerland
- 2DO.2.4 High Mobility Transparent Conductive Oxides for Silicon Heterojunction Solar Cells Deposited by Rotatable Magnetrons**  
M. Dimer, J. Löhnert, U. Graupner, M. Thumsch & E. Schneiderlöchner  
VON ARDENNE, Dresden, Germany  
A. Cruz, S. Neubert, A.B. Morales-Vilches & B. Stannowski  
HZB, Berlin, Germany
- 2DO.2.5 High Mobility IWO for Improved Current in Heterojunction Technology Solar Cells**  
L. Ding, J.J. Diaz Leon, G. Christmann, L.-L. Senaud, L. Barraud, A. Descoedres, N. Badel, M. Despeisse, S. Nicolay & C. Ballif  
CSEM, Neuchâtel, Switzerland
- 2DO.2.6 Analysis of Infrared Light Trapping on Bifacial Silicon Heterojunction Solar Cells**  
F. Gérenton, S. Harrison, P. Carroy, A. Valla, A. Danel & D. Muñoz  
CEA, Le Bourget du Lac, France





## ORAL PRESENTATIONS 3DO.5

15:15 - 16:45 Increasing the Efficiency of Perovskite Solar Cells

## Chairpersons:

Uli Würfel (i)  
Fraunhofer ISE, Germany  
Rutger Schlatmann  
PVcomB, Germany

- 3DO.5.1 Special Introductory Presentation: Passivation of Grain Boundaries by Phenethylammonium in Formamidinium-Methylammonium Lead Halide Perovskite Solar Cell**  
D.S. Lee, J.S. Yun, J. Kim, A. Mahboubi-Soufiani, S. Chen, Y. Cho, X. Deng, J. Seidel, S. Lim, S. Huang & A.W.Y. Ho-Baillie  
UNSW Australia, Sydney, Australia
- 3DO.5.2 Perovskite Solar Cells with Mixed Metal SnPb and SnGe (Pb-Free) Light Harvesting Layer**  
N. Ito, T.S. Ripolles, M.A. Kamarudin, Y. Ogomi, S. Iikubo, T. Kinoshita & S. Hayase  
Kyushu Institute of Technology, Kitakyushu, Japan  
G. Kapil, T. Bessho & H. Segawa  
University of Tokyo, Japan  
K. Hamada, Q. Shen & T. Toyoda  
University of Electro-Communication, Chofu, Japan  
K. Yoshino  
University of Miyazaki, Japan  
T. Minemoto  
Ritsumeikan University, Shiga, Japan
- 3DO.5.3 Stable and Highly Transparent Perovskite Cell and Module for High Efficiency Perovskite/c-Si 4-Terminal Tandems**  
M. Najafi, D. Zhang, M. Dörenkämper, W. Verhees & S.C. Veenstra  
ECN, Eindhoven, Netherlands  
V. Zardetto, H. Fledderus, F. Di Giacomo, H. Lifka, P. Poedt & R.A.J.M. Andriessen  
TNO, Eindhoven, Netherlands  
M. Jaysankar & T. Aernouts  
imec, Leuven, Belgium  
G. Coletti & B. Geerligs  
ECN, Petten, Netherlands
- 3DO.5.4 Towards Inexpensive and Stable All-Evaporated Perovskite Solar Cells for Industrial Large-Scale Fabrication**  
T. Abzieher, J.A. Schwenzler, F. Sutterlüti, M. Pfau, M. Hetterich & U. Lemmer  
Karlsruhe Institute of Technology, Germany  
E. Lotter & M. Powalla  
ZSW, Stuttgart, Germany  
U.W. Paetzold  
Karlsruhe Institute of Technology, Karlsruhe, Germany
- 3DO.5.5 Enhancing the Radiative Efficiency of Perovskites Materials and Solar Cells by Improved Crystallization and Passivation Methods**  
B. Wenger & H.J. Snaith  
University of Oxford, United Kingdom

## ORAL PRESENTATIONS 5DO.8

15:15 - 16:45 Advanced PV Module Concepts

## Chairpersons:

Peter Hacke (i)  
NREL, United States  
Mauro Pravettoni  
SERIS, Singapore

- 5DO.8.1 Invited Special Introductory Presentation**
- 5DO.8.2 Hybrid 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
- 5DO.8.3 A Multidimensional Optimization Approach to Improve Module Efficiency, Power and Costs**  
J. Shahid, M. Mittag, M. Heinrich & U. Eitner  
Fraunhofer ISE, Freiburg, Germany
- 5DO.8.4 Novel Light-Weight Glass-Free PV Module Design Based on Use of Polycarbonate**  
V. Rosca & L.A.G. Okel  
ECN, Petten, Netherlands  
M. Brounne & J.-W. Heuseveldt  
Sabic, Bergen op Zoom, Netherlands
- 5DO.8.5 Pre-Qualification of Glass-Free Lightweight Modules for Building Integrated Photovoltaics**  
A.C. Oliveira Martins, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland  
V. Chapuis  
CSEM, Neuchâtel, Switzerland

## ORAL PRESENTATIONS 6DO.11

15:15 - 16:45 Solar Forecasting

## Chairpersons:

Wilfried G.J.H.M. Van Sark  
Utrecht University, Netherlands  
Manajit Sengupta  
NREL, United States

- 6DO.11.1 Comparison of Methods for Cloud Motion Vector Estimation on Satellite Images**  
D.G. Anagnostos & D. Soudris  
NTUA, Athens, Greece  
F. Cathoor  
imec, Leuven, Belgium



- 6DO.11.2 Modelling and Forecasting PV Production in the Absence of Behind-the-Meeter Measurements**  
T. Landelius & S. Andersson  
SMHI, Norrköping, Sweden  
R. Abrahamsson  
Tekniska Verken, Linköping, Sweden
- 6DO.11.3 Support Vector Regression for Spatio-Temporal PV Forecasting**  
R. Amaro e Silva, L.C. Teixeira da Silva & M.C. Brito  
University of Lisbon, Portugal
- 6DO.11.4 Ensemble Detrending for Solar Nowcasting**  
L. Martín-Pomares & A. Sanfilippo  
QEERI, Doha, Qatar
- 6DO.11.5 Short-Term Photovoltaic Power Forecasting Based on Artificial Neural Networks: A Numerical Weather Prediction-Free Approach**  
S. Theocharides, G. Makrides, M. Theristis & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
F. Almonacid & E.F. Fernández  
University of Jaén, Spain
- 6DO.11.6 Comparison of Irradiation Data from Different Numerical Weather Models and Their Combination in Multi-Model Forecasts**  
M. Bührer & K.G. Gutbrod  
meteoblue, Basel, Switzerland  
T. Kanefendt, D. Beinert & R. Fritz  
Fraunhofer IEE, Kassel, Germany

**VISUAL PRESENTATIONS 7DV.2**

15:15 - 16:45 PV Economics and Markets / PV-Related Strategies and Societal Issues

*Detailed information on this session is presented in the section entitled 'Visual Presentations'.***ORAL PRESENTATIONS 7DO.3**

17:00 - 18:30 Drivers Behind Global PV Market Development

**Chairpersons:**

María Getsioui  
European Commission DG RTD, Belgium  
Stefan Nowak (i)  
NET Nowak Energy & Technology, Switzerland

- 7DO.3.1 A Snapshot of Global PV Markets - The Latest Survey Results on PV Markets and Policies from the IEA PVPS Programme in 2017**  
G. Masson  
IEA PVPS, Brussels, Belgium  
I. Kaizuka  
RTS, Tokyo, Japan  
J. Lindahl  
Svensk Solenergi, Stockholm, Sweden  
A. Jäger-Waldau  
European Commission JRC, Brussels, Belgium  
G. Neubourg  
APERe, Brussels, Belgium  
P. Ahm  
PA Energy, Malling, Denmark  
J. Donoso Alonso  
UNEF, Madrid, Spain  
F. Tilli  
GSE, Rome, Italy
- 7DO.3.2 Established and Emerging Solar Markets in 2017: Overview on Global Solar Market Development**  
Ch. Werner  
Chris Werner Energy Consulting, Dessau, Germany  
A. Gerlach  
Alexander Gerlach New Energy Consulting, Ellrich, Germany  
Ch. Breyer  
Lappeenranta University of Technology, Finland  
G. Masson  
Becquerel Institute, Brussels, Belgium



- 7DO.3.3 Development of Innovative Self-Consumption and Aggregation Concepts for PV Prosumers to Improve Grid Load and Increase Market Value of PV: The PV-Prosumers4Grid Project**  
 L.A. Aguilar, M. Roos & M. Battaglia  
 BSW - Solar, Berlin, Germany  
 C. Grundner & M. Jimeno  
 eclareon, Berlin, Germany  
 D. Hendricks  
 ESHA, Brussels, Belgium  
 P. Bancourt  
 EREF, Brussels, Belgium  
 G. Lettner  
 Vienna University of Technology, Austria  
 R. Battisti  
 Ambiente Italia, Rome, Italy  
 K. Moosdorf  
 APESF, Aljezur, Portugal  
 D. Velte & E. Román Medina  
 Tecnalia, San Sebastián, Spain  
 A. Joyce  
 INETI, Lisbon, Portugal  
 G. Masson & C. Cambiè  
 Becquerel Institute, Brussels, Belgium  
 J. Donoso Alonso  
 UNEF, Madrid, Spain  
 C. Winter, N. Diewald & U. Winter  
 Fronius, Wels, Austria  
 W. Schram & W.G.J.H.M. van Sark  
 Utrecht University, Netherlands
- 7DO.3.4 Impact of Batteries and Electric Vehicles on the Competitiveness of Solar PV**  
 E. Vartiainen  
 Fortum Growth, Finland  
 G. Masson  
 Becquerel Institute, Brussels, Belgium  
 C. Breyer  
 Lappeenranta University of Technology, Finland  
 D. Moser  
 EURAC, Bolzano, Italy
- 7DO.3.5 Price-Bifaciality Relationship of Bifacial Modules in Vertical East-West Oriented PV Systems**  
 H. Hernandez, J. Bierbaum, J. Kang, S. Nold & R. Preu  
 Fraunhofer ISE, Freiburg, Germany  
 L. Bodlak  
 RENA, Freiburg, Germany
- 7DO.3.6 Quantifying the Impact of R&D Achievements on PV Project Financing Costs**  
 D. Feldman & R. Margolis  
 NREL, Washington, United States  
 R. Jones-Albertus  
 U.S. Department of Energy, Washington, United States

## ORAL PRESENTATIONS 3DO.6

17:00 - 18:30 Upscaling of Perovskite Photovoltaics

## Chairpersons:

Giorgio Bardizza  
 European Commission JRC, Italy  
 Ulrich Wilhelm Paetzold (i)  
 Karlsruhe Institute of Technology, Germany

- 3DO.6.1 Perovskite Solar Modules: A Path to Record-Breaking Devices**  
 A.L. Palma, F. Matteocci, L. Vesce, L.A. Castriotta, N. Yaghoobi Nia, E. Calabrò & A. Di Carlo  
 University of Rome II, Italy
- 3DO.6.2 Large Area Perovskite Deposition Enabled by Nanoparticle Adhesion Promoters**  
 M. Schultes & E. Ahlswede  
 ZSW, Stuttgart, Germany  
 N. Giesbrecht  
 Ludwig-Maximilians-University, Munich, Germany  
 P. Docampo  
 Newcastle University, United Kingdom
- 3DO.6.3 From Cell to Mini-Module – Blade Coating and Controlled Drying for Planar Inverted Perovskite Solar Cells**  
 U. Würfel, M.A. Yakoob, J. Herterich & L.E. Mundt  
 Fraunhofer ISE, Freiburg, Germany  
 M. Kohlstädt  
 University of Freiburg, Germany
- 3DO.6.4 Picosecond Laser Scribing of Perovskite Solar Cells Eliminates PbI<sub>2</sub> Residuals within Interconnection Scribe**  
 C. Schultz, A. Bartelt & B. Stegemann  
 HTW Berlin, Germany  
 A. Neubauer  
 Becker & Hickl, Berlin, Germany  
 M. Jost, L. Kegelmann, B. Rech, R. Schlatmann & S. Albrecht  
 HZB, Berlin, Germany
- 3DO.6.5 Processing of Large Area Perovskite-Based Solar Devices: High Efficiency and Stability Assessment**  
 M. Manceau, C. Roux, N. Lemaitre, S. Cros & S. Berson  
 CEA, Le Bourget du Lac, France
- 3DO.6.6 Efficient, Large-Area Scalable Perovskite-Si and Perovskite-CIGS Tandem Solar Modules**  
 M. Jaysankar, M. Debucquoy, T. Aernouts, R. Gehlhaar & J. Poortmans  
 imec, Leuven, Belgium  
 S. Paetel & E. Ahlswede  
 ZSW, Stuttgart, Germany  
 U.W. Paetzold  
 Karlsruhe Institute of Technology, Germany



## ORAL PRESENTATIONS 5DO.9

17:00 - 18:30 Energy Performance, PID and LID

## Chairpersons:

Ulrike Jahn (i)  
TÜV Rheinland Energy, Germany  
Steve Ransome  
Steve Ransome Consulting, United Kingdom

- 5DO.9.1 Special Introductory Presentation: The 35th Birthday of the Tiso-10-kW Solar Plant: Lessons Learnt in Safety and Performance**  
A. Virtuani, E. Annigoni & C. Ballif  
EPFL, Neuchâtel, Switzerland  
M. Caccivio, G. Friesen & D. Chianese  
SUPSI, Canobbio, Switzerland
- 5DO.9.2 The Completed IEC 61853 Standard on PV Module Energy Rating, Overview, Applications and Outlook**  
T. Huld, A.M. Gracia Amillo, T. Sample, E.D. Dunlop & E. Salis  
European Commission JRC, Ispra, Italy
- 5DO.9.3 Module Architectures to Prevent Potential-Induced Degradation: The Interplay between Material Properties, Moisture Ingress, and PID**  
E. Annigoni, A. Virtuani & C. Ballif  
EPFL, Neuchâtel, Switzerland
- 5DO.9.4 Temperature and Irradiance Dependency of Light Induced Degradation and Regeneration**  
M. Passaro, E. Garcia Goma & S. Roest  
Eternal Sun, The Hague, Netherlands  
C. Chan & A. Ciesla  
UNSW Australia, Sydney, Australia  
T. Luka  
Fraunhofer CSP, Halle (Saale), Germany
- 5DO.9.5 Identifying High Uncertainties in PV Soiling Measurements When Comparing Two Devices**  
A.T. Al-Asfour, F.G. Alzubi & A. Alkandary  
KISR, Safat, Kuwait

## ORAL PRESENTATIONS 6DO.12

17:00 - 18:30 Grid Integration

## Chairpersons:

Nina Munzke (i)  
Karlsruhe Institute of Technology, Germany  
Kristian Peter (i)  
ISC Konstanz, Germany

- 6DO.12.1 Myopic and Predictive Control Policies for Photovoltaic and Storage-Based Energy Ecosystems: A Technical and Economical Assessment**  
F. Sossan, E. Scolari, E. Namor & M. Paolone  
EPFL, Lausanne, Switzerland

- 6DO.12.2 Optimization of Component Dimensioning for a Combined Heat and Power System with Special Focus on PV Generator Size**  
G. Angenendt, S. Zurmühlen, H. Axelsen & D.U. Sauer  
RWTH Aachen University, Germany
- 6DO.12.3 Photovoltaic Energy Integration with Households' Demand: A Case Study of a Residential Smart Grids Pilot in the Netherlands**  
C. Gerçek & A.H.M.E. Reinders  
University of Twente, Enschede, Netherlands
- 6DO.12.4 Managing PV Power Injection and Storage, Enabling a Larger Consumption of Renewable Energy: A Case Study for the Belgian Electricity System**  
M. Meuris, P. Lodewijks, R. Ponnette, F. Meinke-Hubeny, P. Valkering, R. Belmans & J. Poortmans  
EnergyVille, Genk, Belgium
- 6DO.12.5 Techno-Economic Evaluation of Voltage Dependant Active and Reactive Power Control to Reduce Voltage Violations in Distribution Grids**  
R. Knecht, F. Carigiet, A. Schwab, P. Korba & F.P. Baumgartner  
ZHAW, Winterthur, Switzerland
- 6DO.12.6 Spatial Representation of Low-Voltage Network Hosting Capacity for Photovoltaic Roof-Top Installations Using an Open-Source Tool**  
M. Joos, N. Lebert & B. Gaiddon  
Hespul, Lyon, France  
E. Seguin & P.-E. Gautreau  
IGN, Saint Mandé, France

## VISUAL PRESENTATIONS 2DV.3

17:00 - 18:30 Thin Film and Foil-Based Si Solar Cells / Characterisation &amp; Simulation Methods for Si Cells / Manufacturing &amp; Production of Si Cells

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



Friday, 28 September 2018

## ORAL PRESENTATIONS 5EO.1

08:30 - 10:00 Inverters and Balance of Systems Components / Sustainability and Recycling

## Chairpersons:

Giorgio Graditi  
ENEA, Italy  
Karsten Wambach  
bifa Environmental Institute, Germany

- 5EO.1.1 **Keynote presentation**  
**A High Step-Up Resonant Converter with Single Switch for Photovoltaic Applications**  
H.-T. Yang & C. Hsu  
National Cheng Kung University, Tainan, Taiwan
- 5EO.1.2 **DC-DC Power Optimizers for Building Integrated Photovoltaic Applications - A Simulation-Based Evaluation**  
J. Eisenlohr, S. Gasparotto, H.R. Wilson & T.E. Kuhn  
Fraunhofer ISE, Freiburg, Germany
- 5EO.1.3 **Switched-Capacitors as Local Converters for Snake PV Modules: A Cost/Efficiency Exploration**  
P. Bauwens & J. Doutreligne  
Ghent University, Belgium  
A. Bakovasilis  
Aristotle University, Thessaloniki, Greece  
P. Manganiello, E. Voroshazi, J. Poortmans & F. Catthoor  
imec, Genk, Belgium
- 5EO.1.4 **Life Cycle Assessment of CIGS PV Modules: Update of Current Production Conditions in Germany and Investigation of a Planned Factory in China**  
A.-K. Briem  
University of Stuttgart, Germany  
M. Held  
Fraunhofer IBP, Stuttgart, Germany  
B. Dimmler  
NICE Solar Energy, Schwäbisch Hall, Germany
- 5EO.1.5 **Integration of Fluctuating Photovoltaic Power Plants into the Grid: Life Cycle Environmental Impacts of Infrastructure Adaptations for Photovoltaic Electricity**  
R. Itten, V. Stahel & M. Stucki  
ZHAW, Wädenswil, Switzerland
- 5EO.1.6 **Life Cycle Assessment of PV-Battery Systems for a Cloakroom and Club Building in Zurich**  
P. Stolz & R. Frischknecht  
Treeze, Uster, Switzerland  
T. Kessler & Y. Züger  
City of Zurich, Switzerland

## ORAL PRESENTATIONS 6EO.2

08:30 - 10:00 Energy System and Grid Integration

## Chairpersons:

Ingrid Weiss  
WIP - Renewable Energies, Germany  
Bert Herteleer  
Ekistica, Australia

- 6EO.2.1 **Energy Cluster Model for the Hunsrück-Hochwald National Park Region**  
D. Jung & H. te Heesen  
Trier University of Applied Sciences, Neubrücke (Nahe), Germany
- 6EO.2.2 **Performance of In-House Li-Ion Battery Storage System Based on Various Strategies**  
N. Munzke & B. Verma  
Karlsruhe Institute of Technology, Eggenstein-Leopoldshafen, Germany  
J. Barry  
Heidelberg University, Germany
- 6EO.2.3 **Residential Battery Storage Sizing Based on Daily PV Production and Load Consumption Profile Characterization**  
S. Afxentis, M. Florides, S. Theocharides, V. Venizelou & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus
- 6EO.2.4 **TH-E Box: THermodynamic and Electric Energy Box**  
K. Peter, F. Reichenbach, A. Minde, E. Gnann, J. Glatz-Reichenbach & R. Roescu  
ISC Konstanz, Germany
- 6EO.2.5 **A Modular Stand-Alone Photocatalytic Reactor for Waste Water Purification: The HPSolar Project**  
P. Bernardoni, M. Boschetti, D. Vincenzi, V. Cristino, S. Caramori, C.A. Bignozzi, S. Fugattini & A. Andreoli  
University of Ferrara, Italy
- 6EO.2.6 **Analysing the Voltage Stability of Photovoltaic Inverters Reactive Power Control in the Laboratory Including the Distribution GRID Transformer**  
F.P. Baumgartner & F. Carigiet  
ZHAW, Winterthur, Switzerland  
T. Strasser & R. Bründlinger  
AIT, Vienna, Austria

## ORAL PRESENTATIONS 7EO.3

08:30 - 10:00 PV Related Policies, Strategies and Societal Issues

## Chairpersons:

Christian Breyer  
Lappeenranta University of Technology, Finland  
Gaetan Masson (i)  
Becquerel Institute, Belgium

- 7EO.3.1 **Diversifying Land-Use Options for the Future Large Scale European PV Deployment**  
T. Huld, A. Jäger-Waldau, S. Szabó & N. Taylor  
European Commission JRC, Ispra, Italy



- 7EO.3.2 The Roadmap for PV Systems and Applications in the Netherlands**  
W. Folkerts, C. de Keizer & M.N. van den Donker  
SEAC, Eindhoven, Netherlands  
W.G.J.H.M. van Sark  
Utrecht University, Netherlands  
W. van Hooff  
TKI Urban Energy, Utrecht, Netherlands
- 7EO.3.3 "PV150" : Toward 150 GW PV in Japan by 2030**  
K. Sugibuchi, I. Kaizuka, H. Yamaya, T. Ohigashi & O. Ikki  
RTS, Tokyo, Japan
- 7EO.3.4 Solar Electricity in Africa: Overcoming Barriers and Lessons Which May Be Learnt from Previous Experiences in Europe**  
A. Virtuani  
O'Sole, Milan, Italy  
G. Agostinelli  
IFC, Washington, United States
- 7EO.3.5 Cost-Benefit Analysis of BIPV Specific Policies in Key European Countries**  
P. Macé & G. Masson  
Becquerel Institute, Brussels, Belgium  
F. Tilli  
GSE, Rome, Italy  
F. Frontini  
SUPSI, Canobbio, Switzerland  
S. Boddaert  
CSTB, Sophia Antipolis, France
- 7EO.3.6 EPBD Recast: A Real or a Missed Opportunity for the Market Uptake of Integrated Photovoltaic and Efficiency Solutions?**  
Y. Saheb  
OpenExp, Paris, France

**PLENARY SESSION 7EP.1**

10:30 - 11:30 A Vision for PV in the Energy Sector

**Chairpersons:**

Thomas Nordmann  
TNC Consulting, Switzerland  
Heinz Ossenbrink  
Band Gap, Germany

- 7EP.1.1 Invited Plenary Presentation**
- 7EP.1.2 Solar Photovoltaic Capacity Demand for a Sustainable Transportation Sector to Fulfil the Paris Agreement by 2050**  
C. Breyer, S. Khalili, E. Rantanen, M. Fasihi & D. Bogdanov  
Lappeenranta University of Technology, Finland
- 7EP.1.3 Sector Coupling in Europe to Reach the Climate Change Mitigation Goals by 2050**  
M.-C. Leonhard, M. Kamberaj, L. Richert & H. te Heesen  
Trier University of Applied Sciences, Neubrücke (Nahe), Germany

**CLOSING**

Key note, Highlights of the Conference, Poster Awards, Student Awards, Farewell



## Visual Presentations

Monday, 24 September 2018

## VISUAL PRESENTATIONS 2AV.1

13:30 - 15:00 Feedstock, Crystallisation, Wafering, Defect Engineering

- 2AV.1.1 Extraction and Characterization of Silicon Extracted from the Padma River Sand Using a Modified-Aluminothermic Process**  
A.B.M. Ismail & M.A. Kuddus  
University of Rajshahi, Bangladesh  
S.M. Mahabubuzzaman  
Walton HIL, Dhaka, Bangladesh
- 2AV.1.2 Study of Metal Impurity Extraction from Silicon**  
S.M. Karabanov, D.V. Suvorov, E.V. Slivkin & D.Y. Tarabrin  
RSREU, Ryazan, Russia  
A.S. Karabanov & O.A. Belyakov  
Helios-Resource, Saransk, Russia
- 2AV.1.3 Effects of Mg-Doping on Silicon Leaching for Solar Grade Feedstock Production**  
M. Zhu & J. Safarian  
NTNU, Trondheim, Norway  
A. Murgau  
Elkem Solar, Kristiansand, Norway
- 2AV.1.4 Phosphorus Removal from Al-Doped Silicon by Vacuum Refining**  
A. Hoseinpur & J. Safarian  
NTNU, Trondheim, Norway
- 2AV.1.5 Performance of Modules and Solar Cells Made of 100% Solar Silicon Purified by Direct Route**  
E. Forniés & M. Tojeiro  
Aurinka PV, Madrid, Spain  
A. Souto, A. Pérez Vázquez & G. Varela  
FerroGlobe, Arteixo, Spain  
T. Vlasenko  
Pillar, Kiev, Ukraine
- 2AV.1.6 Effect of Commercially Available SiO<sub>2</sub> Diffusion Barriers on the Material Quality of Directionally Solidified High Performance Multi-Crystalline Silicon Ingots**  
F. Sturm, C. Reimann, M. Trempa, S. Schwanke & J. Friedrich  
Fraunhofer IISB, Erlangen, Germany  
I. Kupka  
Fraunhofer THM, Freiberg, Germany  
C. Schenk  
Heraeus Quarzglas, Kleinostheim, Germany  
L. Weizhi  
Heraeus Materials Technology, Shanghai, China

- 2AV.1.7 Influencing the Incorporation of Oxygen during the Directional Solidification of Multi-Crystalline Silicon by Adjusting the Silicon Nitride Coating**  
S. Schwanke, C. Reimann & J. Friedrich  
Fraunhofer IISB, Erlangen, Germany  
M. Kuczynski, C. Hoislbauer & J. Sans  
AlzChem, Trostberg, Germany
- 2AV.1.8 Cost Effective Growth of Silicon Mono Ingots by the Application of the Multipulling Technique Combined with Active Crystal Cooling**  
F. Mosel, A.V. Denisov & B. Klipp  
PVA Crystal Growing Systems, Wetztenberg, Germany  
R. Kunert & P. Dold  
Fraunhofer CSP, Halle, Germany
- 2AV.1.9 Mathematical Modeling of Electromagnetic Stirring of Silicon Melt**  
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
- 2AV.1.10 Analysis of the Impact of Czochralski Growth Parameters on Silicon Grown-in Defects Formation**  
M. Jomâa, J.A. Bones, M. M'Hamdi, M. Juel & E.J. Øvrelid  
SINTEF, Oslo, Norway  
O. Jensen  
Institute for Energy Technology, Kjeller, Norway
- 2AV.1.11 Development of Methods for Reducing 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-VT, Hanau, Germany
- 2AV.1.12 Evaluation of a New Hybrid Crucible Concept for Crystallization of mc-Silicon Ingots**  
T. Bähr & M. Ghosh  
Access, Aachen, Germany  
C. Kranert  
Fraunhofer THM, Freiberg, Germany  
C. Morche, A. Zimmermann & H. Franz  
ALD-VT, Hanau, Germany
- 2AV.1.13 Influence of Process Parameter on the Bubble Formation in Fused Silica Crucibles during Czochralski Growth of Mono-Crystalline Silicon for Solar Cell Application**  
I. Kupka & L. Schmidtner  
Fraunhofer THM, Freiberg, Germany  
M. Trempa, C. Reimann & J. Friedrich  
Fraunhofer IISB, Erlangen, Germany
- 2AV.1.14 A Study on the Continuous Casting of High Purity Silicon Ingot Using Numerical Simulation Method**  
J.-K. Lee, J.S. Lee, Y.S. Ahn & G.-H. Kang  
KIER, Daejeon, Korea South





- 2AV.1.15 Computer Modeling of a DS Furnace for Multicrystalline Silicon Ingot Growth**  
A. Mokrani & D. Ouadjaout  
CRTSE, Algiers, Algeria  
E.H. Amara  
CDTA, Algiers, Algeria
- 2AV.1.16 The Crucible- Si3N4 Coating-Silicon Feedstock Quality Effect on the Electrical Properties of the Directional Solidified Multicrystalline Silicon Ingot**  
A. Lami, Y. Chettat, N. Drouiche & B. Palahouane  
CRTSE, Algiers, Algeria
- 2AV.1.17 Effect of Ga Doped Monocrystalline Silicon by Continuous Czochralski (CCz) Process on PERC Cell Efficiency and Light Induced Degradation**  
H. Xu & S. Keohane  
GT Advanced Technologies, Merrimack, United States
- 2AV.1.18 Thermal Stress Minimization in Silicon Ribbon Growth Processes by Thermal Gradients Modulation with 808 nm Laser Scanning**  
D.M. Pera, M.C. Brito, A.M. Valléra, J.M. Serra & J.M. Alves  
University of Lisbon, Portugal
- 2AV.1.19 Eco-Solar Factory: Utilisation of Kerf-Loss from Silicon Wafer Sawing for the Manufacturing of Silicon Nitride Crucibles**  
M.P. Bellmann  
SINTEF, Trondheim, Norway  
A. Ciftja  
Steuler Solar Technology, Porsgrunn, Norway  
G. Noja  
Garbo, Cerano, Italy
- 2AV.1.20 The Impact of Wafer Thickness (210 and 140 µm) for Photovoltaic Use on the Fracture Strength**  
H. Sekhar, T. Fukuda & H. Takato  
AIST, Koriyama, Japan  
K. Tanahashi & K. Shirasawa  
AIST, Tsukuba, Japan  
K. Ohkubo  
Noritake, Fukuoka, Japan  
H. Ono, Y. Sampei & T. Kobayashi  
Fukushima Technical Centre, Koriyama, Japan
- 2AV.1.21 Epitaxial Growth of Silicon by Electron Beam Evaporation Deposition**  
M. Stange, R. Dahl-Hansen, A.S. Azar & A. Ulyashin  
SINTEF, Oslo, Norway
- 2AV.1.22 Slurry Sawing of Multicrystalline Silicon with Low-Viscosity Carrier Liquid**  
T. Kaden & C. Look  
Fraunhofer THM, Freiberg, Germany  
V. Ischenko & M. Gröschel  
SiC Processing, Bautzen, Germany  
O. Anspach  
PV Crystalox Solar, Erfurt, Germany
- 2AV.1.23 Study of the Failure Mechanism of Crystalline Silicon: Relation between Crack Orientation and Failure Stress**  
S. Rodríguez-Conde, A. Moretón & O. Martínez  
UVa, Valladolid, Spain  
J. Barredo Egusquiza  
UPM, Madrid, Spain  
J. Ferrer  
Newgentechs, Valladolid, Spain

- 2AV.1.24 Cutting Performance of Structured Wire in Correlation to the Wire Geometry**  
R. Koeppge, F. Kaule, K. Buehler & S. Schoenfelder  
Fraunhofer CSP, Halle (Saale), Germany  
O. Anspach  
PV Crystalox Solar, Erfurt, Germany
- 2AV.1.25 Residual Stress Variation in Silicon Wafers with Diamond Wire Sawing Marks**  
A. Kumar, R.G.R. Prasath, S. Melkote & S. Danyluk  
Georgia Institute of Technology, Atlanta, United States
- 2AV.1.26 Model of Kerf in Diamond Wire Sawing of Silicon Wafers**  
A. Kumar & S.N. Melkote  
Georgia Institute of Technology, Atlanta, United States
- 2AV.1.27 Impact of Low-Temperature Annealing before Firing on LeTID in Multicrystalline Silicon**  
J. Lindroos, A. Schmid, A. Zuschlag, D. Skorcka, J. Fritz & G. Hahn  
University of Konstanz, Germany
- 2AV.1.28 Light Induced Degradation in Boron Doped Quasi-Monocrystalline Silicon After Phosphorus Diffusion Gettering and Dark Annealing**  
S. Chakraborty, M.L. Loria Manalo & R. Sharma  
NUS, Singapore, Singapore  
A.G. Aberle & J.B. Li  
SERIS, Singapore, Singapore
- 2AV.1.29 Lifetime Evolution during Regeneration in Boron-Doped Czochralski-Silicon**  
D.C. Walter, L. Helmich, D. Bredemeier & J. Schmidt  
ISFH, Emmerthal, Germany  
R. Falster & V.V. Voronkov  
SunEdison, Merano, Italy
- 2AV.1.30 Defect Analysis of APCVD Gettered Multicrystalline Silicon**  
M. Fleck, J. Lindroos, A. Zuschlag & G. Hahn  
University of Konstanz, Germany
- 2AV.1.31 Gettering and Passivation of Advanced High Performance Multicrystalline Silicon Material**  
C. Fischer, J. Lindroos, A. Zuschlag & G. Hahn  
University of Konstanz, Germany
- 2AV.1.32 Thermally Induced Oxygen Related Donor States in Cz-Silicon Studied by Spectral Photoluminescence**  
E. Olsen, M. Helander, T. Mehl & I. Burud  
NMBU, Ås, Norway  
R. Søndena  
Institute for Energy Technology, Kjeller, Norway
- 2AV.1.33 Quantifying the Impact of Grain Boundaries on Standard and High Performance mC-Silicon Solar Cells**  
A.P.J. Pachó, B. Petrelis & M. Rinio  
Karlstad University, Sweden



- 2AV.1.34 An Efficient Optimized RTP Process to Minimize Light Induced Degradation Phenomenon and their Effect on Surface Roughness in p-Type Cz-Si Wafers**  
Y. Kouhlane, D. Bouhaf, N. Khelifati, S. Mezghiche & A. Guenda  
CRTSE, Algiers, Algeria  
W. Hetatache  
University of Sétif, Algeria  
F. Derkaoui  
University of Blida, Algeria  
O. Vivian Nwadiaru  
University of Tlemcen, Algeria

**VISUAL PRESENTATIONS 2AV.2**15:15 - 16:45 **Homojunction Solar Cells**

- 2AV.2.1 Passivation of Black Silicon Solar Cells**  
D.V. Aghabekyan, L.M. Lakhoyan & A. Barseghyan  
National Polytechnic University of Armenia, Yerevan, Armenia
- 2AV.2.2 Dry-Etched Black Silicon: A Cost-Effective Production Route for PERC Solar Cells**  
C. Modanese, H.S. Laine, T.P. Pasanen, O. Aydin & H. Savin  
Aalto University, Espoo, Finland  
E. Salmi & S. Sneck  
Beneq, Espoo, Finland  
V. Weeda & E. Vartiainen  
Fortum, Espoo, Finland  
M.A. Juntunen  
Naps Solar Systems, Helsinki, Finland  
M. Tilli  
Okmetic, Vantaa, Finland  
R. Alcubilla González & P.R. Ortega  
UPC, Barcelona, Spain  
T. Savisalo  
Valoe, Mikkeli, Finland  
J.M. Pearce  
Michigan Technological University, Houghton, United States
- 2AV.2.3 Optimization of Surface Passivation for Black Silicon Based on Thermal Oxidation**  
S. Zhang, H. Qian, J. Peng, Q. Wei & Z. Ni  
Talesun Solar, Suzhou, China  
J. Jie & X. Zhang  
Soochow University, Suzhou, China
- 2AV.2.4 Industrially MCCE Textured Cells on Monolike Substrates**  
Z. Xu, H. Wang, Y. Wang, J. Liu, F. Lang, F. Li, J. Shi & D. Song  
Yingli Green Energy, Baoding, China
- 2AV.2.5 Industrial Applicability of AR-Coating-Free Black Silicon**  
T.P. Pasanen, V. Vähänissi, I.T.S. Heikkinen, H. Vahlman & H. Savin  
Aalto University, Espoo, Finland  
F. Wolny, A. Oehlke & M. Wagner  
SolarWorld Innovations, Freiberg, Germany  
M.A. Juntunen  
Naps Solar Systems, Helsinki, Finland  
E. Salmi & S. Sneck  
Beneq, Espoo, Finland  
A. Tolvanen & J. Hyvärinen  
Endeas, Espoo, Finland

- 2AV.2.6 The Black-SiN Method - A Novel Approach to Reduce the Reflection of Solar Cells**  
J. Hirsch, S. Großer & D. Lausch  
Fraunhofer CSP, Halle (Saale), Germany  
A.V. Okhorzina & N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany
- 2AV.2.7 Wet Chemical Surface Finishing for Lithography-Free Inverted Pyramids**  
E. Donercark, T. Colakoglu, M. Terlemezoglu, M.K. Abak, A. Bek & R. Turan  
METU, Ankara, Turkey
- 2AV.2.8 Green Black Silicon Texturing for Multi-Crystalline Silicon Wafer**  
P.-Y. Sun, P.-C. Tsai, H.-P. Hsu, A. Sutejo & C.-W. Lan  
NTU, Taipei, Taiwan  
A. Yang  
Solartech Energy, Hsinchu, Taiwan
- 2AV.2.9 Silicon Wafer Reflection Reduction with Maskless Plasma Etching by CHF<sub>3</sub> and H<sub>2</sub>**  
A.V. Okhorzina, J. Hirsch & N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany  
D. Lausch  
Fraunhofer CSP, Halle (Saale), Germany
- 2AV.2.10 Electroless-Plated Metallization for Mono- and Bi-Facial n-PERT Solar Cells**  
Y.-L. Lee, M.-S. Lin, K.-C. Lai, C.C. Chuang & C.-C. Li  
Motech Industries, Tainan, Taiwan
- 2AV.2.11 Influence of Plating Solution via Wet Process on High Efficiency Silicon Solar Cells**  
M.-S. Lin, Y.-L. Lee, K.-C. Lai, C.C. Chuang & C.-C. Li  
Motech Industries, Tainan, Taiwan
- 2AV.2.12 Optimization of Boron Doping by BCl<sub>3</sub> for n-Type Bifacial c-Si Solar Cell**  
E. Orhan, F. Es & R. Turan  
METU, Ankara, Turkey
- 2AV.2.13 Metallization Fraction of Bifacial pSPEER Shingle Solar Cells**  
M. Al-Akash, P. Baliozian, E. Lohmüller, T. Fellmeth, N. Wöhrle & R. Preu  
Fraunhofer ISE, Freiburg, Germany
- 2AV.2.14 Novel PERC Solar Cells with Advanced Passivated Multi-Layers**  
S.-Y. Chen, Y.-H. Lin & C.-H. Du  
ITRI, Hsinchu, Taiwan  
S.-H. Yang & Y.-C. Chen  
Tainergy Tech, Taoyuan, Taiwan
- 2AV.2.15 Aluminum/Porous Silicon Combination on Multicrystalline Silicon Nanostructure Passivation for Solar Cells Applications**  
M. Ben Rabha  
CRTE n, Hammam-Lif, Tunisia  
A. Bessadok Jemaic  
Riyadh College of Technology, Saudi Arabia
- 2AV.2.16 Modifying the Ratio between Highly- and Lightly-Doped Emitters for PERC with a Selective Emitter Structure by Wet Chemical Etch-Back Process**  
S. Joonwichien, Y. Kida, M. Moriya, S. Utsunomiya, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan
- 2AV.2.17 The Study of Surface Field and Junction on Large Area n-Type Solar Cell by Industrial Process**  
Z.-G. Tsai, H.-W. Yin, M.-Y. Chen & C.-L. Cheng  
AU Optronics, Taichung, Taiwan



- 2AV.2.18 Boron Autodoped LPCVD Polysilicon as a Surface Passivation and Contact Passivation Layer on the Front-Side of n-PERT Solar Cells**  
R.C.G. Naber & J.R.M. Luchies  
Tempress, Vaassen, Netherlands  
M. Jahn, R. Keding, M. Zimmer & A. Wolf  
Fraunhofer ISE, Freiburg, Germany
- 2AV.2.19 Improvement of Pull Strength for Plated Ni/Cu Electrodes on Silicon Solar Cells**  
K.-C. Lai, W.-T. Chung, M.-S. Lin, Y.-L. Lee, C.C. Chuang & C.-C. Li  
Motech Industries, Tainan City, Taiwan
- 2AV.2.20 Comparative Study of Boron-Rich Layer Removal by Different Approaches for IBC Solar Cells**  
K. Tao, S. Jiang, C. Hou, R. Jia, H. Sun, Y. Zhou & Z. Jin  
CAS, Beijing, China
- 2AV.2.21 Analysis of Doped Poly Si with Tunnel Silicon Oxide for Carrier Selective Solar Cell Application**  
H. Oh, J. Kang, J. Lee, Y.S. Choi & M.-I. Hwang  
Hyundai Heavy Industries, Gyeonggi, Korea South
- 2AV.2.22 Influence of Oxygen on Formation of Poly-Si Films by Al-Induced Crystallization of SiO<sub>x</sub> Films**  
J.-H. Yoon  
Kangwon National University, Chuncheon, Korea South
- 2AV.2.23 Effect of Light Absorption from Rear Side in Bifacial Interdigitated-Back-Contact (IBC) Crystalline Silicon Solar Cell**  
T. Tachibana, K. Tanahashi, T. Mochizuki, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan
- 2AV.2.24 X-Ray Photoelectron Spectroscopy (XPS) Study of the Printed-SiO<sub>x</sub> DL CAP in PERC-Type Solar Cell Application**  
Y.-S. Lin, C.-H. Ku, C.-F. Yu, S.-L. Lee, T.-C. Chen, T.-W. Guo & C.-C. Wen  
E-TON Solar Tech, Tainan, Taiwan  
J.-Y. Hung  
New E Materials, Kaohsiung, Taiwan  
J.-C. Wang  
Eternal Materials, Kaohsiung, Taiwan
- 2AV.2.25 Effect of Hydrogen Content on Structural, Optical and Electrical Properties of a Polycrystalline Emitter**  
N. Kaddouri, F. Kezzoula, H. Menari, A. Trad-Khodja & S. Nouali  
CRTSE, Algiers, Algeria
- 2AV.2.26 Application of Boron Doping Paste for Simplified Fabrication of Interdigitated Back Contact Solar Cells**  
A. Aliefendioglu, E.H. Çiftpinar & R. Turan  
METU, Ankara, Turkey
- 2AV.2.27 Laser Doping from PSG for Selective FSF of Screen Printed Rear-Junction n-PERT Cells**  
S. Singh, L. Tous, P. Choulat, J. Chen, F. Duerinckx, I. Gordon, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
R. Liu, L. Ma, X. Wu, J. Wang & Z. Liu  
Jolywood, Taizhou, China
- 2AV.2.28 Screen-Printed Interdigitated Back Contact Silicon Solar Cell: Design, Fabrication, and Analytical Characterization**  
Y.-W. Peng & J.-Y. Gan  
NTHU, Hsinchu, Taiwan

- 2AV.2.29 Bath-Life Time Analysis and Simulation of HF-HCl-Cl<sub>2</sub> Batch Processes for Texturing Monocrystalline Silicon Wafers**  
K. Halbfäß, A. Stapf, P. Nattrodt, B. Neubert & E. Kroke  
Freiberg University of Technology, Germany
- 2AV.2.30 The Impact of Advanced Texturing on Saturation Current Density in n-Type PERT Silicon Solar Cell Processing**  
J. John, S. Jambaldinni, M. Haslinger, M. Gocyla, I. Kuzma-Filipek, L. Tous, R. Russell, F. Duerinckx, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
A.T. Hajjiah  
Kuwait University, Safat, Kuwait
- 2AV.2.31 Avoiding Parasitic Plating on Ni/Cu Plated Monocrystalline Silicon Solar Cells by Optimization of Silicon Oxide Etching in Fluoride Media**  
C. Molto, P.P. Grand, J. Rousset & A. Duchatelet  
EDF, Palaiseau, France  
K. Kholostov & E. Drahi  
TOTAL, Paris la Defense, France  
A. Etcheberry & A.M. Goncalves  
UVSQ, Versailles, France
- 2AV.2.32 Characterization of Metal Oxide Barrier Layer in Screen-Printed Cu Paste Electrode / Mono c-Si Solar Cell**  
T. Saito, M. Tanabe, H.T. Hai, D. Ando, Y. Sutou, K. Shirasawa & J. Koike  
Tohoku University, Sendai, Japan  
T. Fukuda & Y. Kurimoto  
Material Concept, Sendai, Japan
- 2AV.2.33 Impact of Surface Morphology and Interfacial Oxide Thickness on Passivation Quality of p+ Polysilicon Passivating Contacts**  
S. Mack, F. Feldmann, A. Moldovan & A. Wolf  
Fraunhofer ISE, Freiburg, Germany  
M. Lenes  
Tempress, Vaassen, Netherlands  
J.M. Luchies  
Amtech, Vaassen, Netherlands
- 2AV.2.34 WetAlO<sub>x</sub>: A Novel Negative Charge and Cost Effective Passivation Method for Crystalline Silicon Solar Cells**  
E. Schmid, S. Schmitt, T. Boescke, E. Wefringhaus, F. Buchholz, C. Peter & R. Marczak  
ISC Konstanz, Germany  
A. Ramakrishnan, M. Mateescu & P. Kunze  
GP Solar, Konstanz, Germany
- 2AV.2.35 Industrial biPERC Solar Cells with Varied Rear Side Characteristics under Bifacial Illumination**  
N. Wöhle, A. Krieg, J.M. Greulich & S. Rein  
Fraunhofer ISE, Freiburg, Germany  
P. Palinginis, T. Weber & S. Steckemetz  
SolarWorld, Freiberg, Germany  
K. Ramspeck  
h.a.l.m. elektronik, Frankfurt am Main, Germany
- 2AV.2.36 In-Situ Photoluminescence Study of the Influence of Plasma Processes on Passivation Quality of c-Si Wafers Coated with Al<sub>2</sub>O<sub>3</sub>**  
M. Sreng  
IPVF, Palaiseau, France  
F. Silva & P. Roca i Cabarrocas  
CNRS, Palaiseau, France



- 2AV.2.37 Emitter Formation and Passivation Dependence on Crystal Grain Orientations after Atmospheric Pressure Dry Nanotexturing**  
A.I. Ridoy, B. Kafle, P. Saint-Cast, S. Lohmüller, M.H. Norouzi, M. Hofmann, J. Rentsch & R. Preu  
Fraunhofer ISE, Freiburg, Germany  
L. Clochard & E. Duffy  
Nines Photovoltaics, Dublin, Ireland
- 2AV.2.38 Optimizing TCO Layers for Novel Bifacial Crystalline Silicon Homojunction Solar Cells Integrating Passivated Contacts**  
E. Bruhat, T. Desruets, B. Grange & S. Dubois  
CEA, Le Bourget du Lac, France  
D. Blanc-Pélissier  
INSA Lyon, France
- 2AV.2.39 Rear Side Design Optimization and Loss Analysis for n-Type IBC Solar Cells Using Simulation**  
C. Sasidharan & S. Mondal  
TERI, New Delhi, India
- 2AV.2.40 Effect of Laser Parameters on Rear Contact Formation and Passivation of PERC Type Silicon Solar Cells**  
E. Genç, D. Türkay, G. Kökbudak, E. Semiz, F. Es, S. Yerci & R. Turan  
METU, Ankara, Turkey
- 2AV.2.41 Investigation on Post Cleanings on Modified Surface Using Laser Texturing**  
B. Radfar, F. Es & R. Turan  
METU, Ankara, Turkey
- 2AV.2.42 Evolution of Contact Formation on p-Type Crystalline Silicon Solar Cells**  
R.W. Mayberry & V. Chandrasekaran  
Heraeus, West Conshohocken, United States
- 2AV.2.43 Passivation of Crystalline Silicon Surfaces with Ultra-Thin Silicon Nitride Films Formed by Catalytic Chemical Vapor Deposition**  
H. Song & K. Ohdaira  
JAIST, Ishikawa, Japan
- 2AV.2.44 Fully Ion-Implanted IBC Silicon Solar Cell with Gap Structure between Emitter and BSF by Self-Aligned Process**  
K. Tanahashi, T. Tachibana, M. Moriya, Y. Kida, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan
- 2AV.2.45 Potential of Chemical Rounding for the Performance Enhancement of a Pyramid-Textured Bifacial Si Bottom Cell**  
H. Lee & Y. Ohshita  
Toyota Technological Institute, Nagoya, Japan  
I. Song, S.W. Lee, S.H. Bae, J.Y. Hyun, Y. Kang, H. Lee & D. Kim  
Korea University, Seoul, Korea South  
A. Ogura  
Meiji University, Kawasaki, Japan
- 2AV.2.46 Novel Texturisation Approach for Improving the Performance of Diamond Wire Cut Sawn Multi-Crystalline Silicon Wafer**  
B. Pal & P.P. Ray  
Jadavpur University, Kolkata, India  
S. Ray & U. Gangopadhyay  
MSIT, Kolkata, India  
S. Jana, S. Ghosh, D. Sarangi & H. Saha  
IEST Shibpur, Howrah, India

- 2AV.2.47 Development of Large Area n-Type Crystalline Silicon Solar Cell by Black Silicon Emitter Surface Having Passivation and Back Surface Field with a-Si:H Layers**  
S. Ray, S. Ghosh, N.C. Mondal, S. Mitra, H. Ghosh, A. Mondal & H. Saha  
IEST Shibpur, Howrah, India  
B. Pal  
Jadavpur University, Kolkata, India  
U. Gangopadhyay  
MSIT, Kolkata, India
- 2AV.2.48 Investigation of c-Si Surface Passivation with ALD Deposited HfO<sub>2</sub> Films Annealed in Air**  
B. Rajab, A.B. Afif & A. Gougam  
Masdar Institute, Abu Dhabi, United Arab Emirates
- 2AV.2.49 Passivation Studies for p-Type and n-Type TOPCon Solar Cells**  
S. Biswas, S. Mitra, H. Ghosh, N.C. Mondal, S.M. Hossain, S. Mukhopadhyay, P. Chaudhuri, H. Saha & S. Guha  
IEST Shibpur, Howrah, India

## VISUAL PRESENTATIONS 2AV.3

17:00 - 18:30 Heterojunction Solar Cells

- 2AV.3.1 Efficiency Improvement of CuI-Si Solar Cells through Progress in Hole Selective Layer Quality**  
J. Lin, S. Hwang, V.M. Han Cao & J. Lee  
Sungkyunkwan University, Suwon, Korea South
- 2AV.3.2 Nano-Rod Antireflection Film Hf-Doped In<sub>2</sub>O<sub>3</sub> Thin Films and Its Application to Silicon Heterojunction Solar Cells**  
G.H. Wang, L. Zhao, H.W. Diao & W.J. Wang  
CAS, Beijing, China
- 2AV.3.3 Stacks of a-SiO<sub>x</sub>:H/a-Si:H Passivation Layer for Low Parasitic Absorption and High Passivation in Silicon Heterojunction Solar Cells**  
K. Gotoh, M. Cui, R. Akaishi, Y. Kurokawa & N. Usami  
Nagoya University, Japan
- 2AV.3.4 Investigate the Characterization of p-Doped Polysilicon Passivated Contact**  
J.C. Lee & J.-Y. Gan  
NTHU, Hsinchu, Taiwan
- 2AV.3.5 Development of Silicon-Oxide Layer (SiO<sub>x</sub>:H) for High-Performance Silicon Heterojunction Solar Cells under Hot and Sunny Environment**  
A.A. Abdallah, B. Aissa, M.M. Kivambe, A. Belaidi & N. Tabet  
QEERI, Doha, Qatar  
J. Haschke, J. Cattin, M. Boccard & C. Ballif  
EPFL, Neuchâtel, Switzerland
- 2AV.3.6 The Impact of Indium Tin Oxide Deposition and Post Annealing on the Passivation Property of TOPCon Solar Cells**  
K. Tao, R. Jia, H. Sun, X. Dai, S. Jiang, Y. Zhou & Z. Jin  
CAS, Beijing, China
- 2AV.3.7 Different p-Type Silicon Front Emitters for Si Heterojunction Solar Cells**  
E. Bobeico, M. Della Noce, L. Lancellotti, L.V. Mercaldo, I. Usatii & P. Delli Veneri  
ENEA, Portici, Italy



- 2AV.3.8 Transparent MoO<sub>x</sub> and SiO<sub>x</sub> Window Layers for Heterojunction Silicon Solar Cells**  
F. Menchini, L. Serenelli, L. Martini, M. Izzi, G. Stracci, P. Mangiapane, E. Salza & M. Tucci  
ENEA, Rome, Italy
- 2AV.3.9 Effects of Deposition and Annealing Temperature on Sputtered ITO**  
F. Menchini, L. Serenelli, G. Stracci, M. Izzi, E. Salza, L. Martini & M. Tucci  
ENEA, Rome, Italy  
D. Caputo & G. de Cesare  
University of Rome "La Sapienza", Italy
- 2AV.3.10 Crystallinity and Profilometry of Thin Silicon Films on Rough Substrates by Raman Spectroscopy**  
M. Ledinsky, Z. Hájková, A. Vetushka & A. Fejfar  
ASCR, Prague, Czech Republic  
A. Tomasi, J.P. Seif & C. Ballif  
EPFL, Neuchâtel, Switzerland  
B. Paviet-Salomon  
CSEM, Neuchâtel, Switzerland  
D. Lachenal  
Meyer Burger, Hauterive, Switzerland  
S. De Wolf  
KAUST, Thuwal, Saudi Arabia
- 2AV.3.12 Rear Device Architectures for Evaluating Passivated Organic/Silicon Hybrid Cells**  
J. Hack, A. Iyer, M. Chen & R.L. Opila  
University of Delaware, Newark, United States
- 2AV.3.13 Recent Progress in Front/Back Contacted c-Si Heterojunction Solar Cells Using nc-SiO<sub>x</sub>:H Layers**  
E. Özkol, Y. Zhao, G.R. van Kuler, P. Procel Moya, G. Yang, G. Limodio, A.W. Weeber, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands
- 2AV.3.14 Electron Selective Contacts Based on Al<sub>2</sub>O<sub>3</sub>/TiO<sub>2</sub>/ZnO Stacks for Crystalline Silicon Solar Cells**  
L.A. Zafoschnig, P. Ortega, I. Martín, G. Masmitja, G. López & R. Alcubilla González  
UPC, Barcelona, Spain
- 2AV.3.15 Amorphous Silicon-Free Metal Oxides Based Carrier Selective Contacts to Crystalline Silicon Solar Cells**  
S. Patwardhan, S. Maurya, A. Kumar & K.R. Balasubramaniam  
IIT Bombay, Mumbai, India
- 2AV.3.16 Enhanced Passivation Quality of Crystallized Doped Amorphous Silicon Layer with Wet Chemical Oxide**  
A.E. Aytac, G. Kökbudak, E. Donercark & R. Turan  
METU, Ankara, Turkey
- 2AV.3.17 Contactless Investigation of the p-Type Doping Concentration Level of Single GaAs Micro-Crystals Grown on Silicon for Multijunction Solar Cells**  
A. Jaffré, J. Alvarez, J.P. Connolly, J.-P. Kleider & D. Mencaraglia  
CNRS, Gif-sur-Yvette, France  
H.-L. Chen, H. Makhloufi, C. Renard & S. Collin  
University of Paris Saclay, Orsay, France
- 2AV.3.18 Comparison between Amorphous Silicon Layers Deposited for Heterojunction Solar Cells at 13.56 Mhz and 140 Mhz Excitation Frequency**  
B. Leszczynska, C. Strobel, S. Leszczynski, M. Albert & J.W. Bartha  
Dresden University of Technology, Germany  
F. Stahr & J. Kuske  
FAP, Dresden, Germany

- 2AV.3.19 Black Silicon with Tunnel Oxide Passivated Contacts**  
M.E. Kloster, M.-L. Witthøft, R.S. Davidsen, D.H. Petersen, O. Hansen & B. Iandolo  
Technical University of Denmark, Kongens Lyngby, Denmark
- 2AV.3.20 Approach for Developing Amorphous Silicon Passivation Layers and p-Type Microcrystalline Layers for Highly Efficient HIT Solar Cells Using a Dynamic VHF-PECVD Process 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
- 2AV.3.21 Deposition of Intrinsic Amorphous Silicon Layers for Heterojunction Solar Cells by Hot-Wire CVD**  
M. Justianto, M. Höfer, T. Harig & V. Sittinger  
Fraunhofer IST, Braunschweig, Germany
- 2AV.3.22 From Wafers, to Modules, to Mass Production: Solving All Bottlenecks in Silicon Heterojunction Technology**  
C. Ballif & M. Boccard  
EPFL, Neuchâtel, Switzerland  
M. Despeisse  
CSEM, Neuchâtel, Switzerland
- 2AV.3.23 PERC and nPERT Industrial Low-Cost Cells Provided with Front Polysilicon Passivated Contact for Tandem Application**  
L.J. Geerligs, Y. Wu, P. Manshanden, M.K. Stodolny, J. Anker, E. Bende & S.L. Luxembourg  
ECN, Petten, Netherlands  
D. Zhang  
ECN, Eindhoven, Netherlands
- 2AV.3.24 Silicon Heterojunction IBC Process Simplification: Implementation of Novel "Nano-Envelope" in Situ Dry Clean with Efficiencies above 22.5%**  
H. Sivaramakrishnan Radhakrishnan, M.D. Gius Uddin, M. Xu, I. Gordon, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium
- 2AV.3.25 Optimization of Silicon Heterojunction Cells: A Recipe for More Than 26% Efficient Cells**  
M.Y. Ghannam  
Kuwait University, Safat, Kuwait
- 2AV.3.26 Ultra-Thin Tunneling SiO<sub>x</sub> and AlO<sub>x</sub> Passivating Layers for MoO<sub>x</sub> Based Selective Hole Contacts**  
M. Ah Sen, P. Spinelli, E. Hoek, B.W.J. Kikkert, A.W. Weeber & P.C.P. Bronsveld  
ECN, Petten, Netherlands
- 2AV.3.27 Impact of the Film Stoichiometry of a-Si<sub>n</sub>x:H Layers on Hydrogen Diffusion and the Surface Passivation Quality**  
S. Jafari, V. Naumann, J. Hirsch & D. Lausch  
Fraunhofer CSP, Halle (Saale), Germany  
N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany
- 2AV.3.28 A Transition to Thinner Si Wafers at HJT Mass Production: Ahead of ITRPV Schedule**  
D. Andronikov, A. Abramov, S. Abolmasov, K. Emtsev, G. Ivanov, I. Nyapshaev, D. Orekhov, A.V. Semenov, G. Shelopin, E. Terukova & E.I. Terukov  
R&D Center TFTE, St. Petersburg, Russia  
N. Belkova, A. Dubrovskiy, P. Ishmuratov, A. Ivanov, D. Saykin, A. Smirnov, E. Sokolov, N. Saymurzanoi & V. Tarasov  
Hevel Solar, Novocheboksarsk, Russia



- 2AV.3.29 Study of Changes in Intrinsic a-Si:H Passivation Layer Induced by the Growth of n-Doped Microcrystalline Layer**  
H. Meddeb, O. Sergeev, M. Vehse & C. Agert  
DLR, Oldenburg, Germany
- 2AV.3.30 Improvement of Microcrystalline Doped Layer Properties with Argon and Hydrogen Plasma Treatments**  
H. Meddeb, O. Sergeev, M. Vehse & C. Agert  
DLR, Oldenburg, Germany
- 2AV.3.31 Fabrication and Analysis of Silicon Surface Texturing at Various Coverage Ratios for Improved Solar Cell Performance**  
N. Avishan & A. Bek  
METU, Ankara, Turkey
- 2AV.3.32 Front/Back PolySi/SiO<sub>2</sub> Passivated Contact Device with Voc > 710 mV**  
D.L. Young, V. LaSalvia, B. Nemeth, S. Theingi, A. Kale, D. Findley, M. Page & P. Stradins  
NREL, Golden, United States
- 2AV.3.33 Ultimate Behavior of an Al<sub>2</sub>O<sub>3</sub> Interlayer in a Directly Grown Multilayer Graphene-Silicon Schottky Junction Solar Cell**  
M.A. Rehman, I. Akhtar, N.D. Cong & Y. Seo  
Sejong University, Seoul, Korea South

Tuesday, 25 September 2018

## VISUAL PRESENTATIONS 6BV.1

08:30 - 10:00 Solar Resource and Forecasting / Building, Infrastructure, Landscape and other Applications of PV / Grid and Energy System Integration

- 6BV.1.1 Improvement of Accuracy and Precision of Spectral Irradiance Measurements in Annual Spectroradiometer Intercomparison**  
M. Halwachs & M. Rennhofer  
AIT, Vienna, Austria  
R. Galleano & W. Zaaïman  
European Commission JRC, Ispra, Italy  
M. Pravettoni  
SERIS, Singapore, Singapore  
M. Theristis & A. Phinikarides  
University of Cyprus, Nicosia, Cyprus  
N. Riedel & A. Thorseth  
Technical University of Denmark, Roskilde, Denmark  
M. Po & K. Hoogendijk  
EKO Instruments Europe, Den Haag, Netherlands  
E.J. Haverkamp  
Radboud University Nijmegen, Netherlands  
A. Minuto & M. Marzoli  
RSE, Milan, Italy  
V. Tatsiankou  
Spectrafy, Ottawa, Canada  
R. Roldán  
SUPSI, Canobbio, Switzerland  
I.R. Cole  
Loughborough University, United Kingdom  
D. Alonso-Álvarez  
Imperial College, London, United Kingdom  
N. Ferretti & A. Drobisch  
PI Berlin, Germany  
G. Belluardo  
EURAC, Bolzano, Italy  
R. Fucci  
ENEA, Naples, Italy  
M. Friederichs  
PV Lab Germany, Potsdam, Germany  
F. Plag & D. Friedrich  
PTB, Braunschweig, Germany
- 6BV.1.2 Studying the Impact of Spectral Irradiance Variation on the Outdoor Performance of PV Modules in the UAE**  
A. Alnuaimi, J. Quadir, J.J. John, A. Elnosh & M. Stefanchik  
DEWA, Dubai, United Arab Emirates
- 6BV.1.3 Development and Industrialization of an Handy and Wireless Irradiation Sensor Enabling Distributed Global, Diffuse, and Direct Irradiation Monitoring with No Need of Tracking Systems Nor Moving Parts**  
A. Rossi, L. Botti & R. Zaza  
Alitec, Cascina, Italy
- 6BV.1.4 Validation of the Meteonorm Satellite Irradiation Dataset**  
S.C. Müller & J. Remund  
Meteotest, Bern, Switzerland





- 6BV.1.5 Radiation Data from Satellites and Numerical Weather Models - A Comparison with Surface Measurements**  
P. Lütolf & E. Parlow  
University of Basel, Switzerland  
M. Bühner & K.G. Gutbrod  
meteoblue, Basel, Switzerland
- 6BV.1.6 Assessment of Error Sources in FARMS-NIT under Clear-Sky Conditions**  
Y. Xie & M. Sengupta  
NREL, Golden, United States
- 6BV.1.7 IEA PVPS Task 16 and IEA SolarPACES V: State of the Project and Results of the First Workshops**  
J. Remund  
Meteotest, Bern, Switzerland  
P. Blanc  
MINES ParisTech, France  
R. Perez  
SUNY, Albany, United States
- 6BV.1.8 Discussion on Improvement of Solar Power Prediction Accuracy for Short-Term (24-72h)**  
C. Chen & C. Yang  
CMA, Wuhan, China
- 6BV.1.9 Short-Term Solar Irradiance Forecasting Based on Sunshine Number**  
M. Paulescu & E. Paulescu  
West University of Timisoara, Romania  
O. Mares & D. Calinoiu  
Politehnica University of Timisoara, Romania
- 6BV.1.10 Satellite-Based Solar Irradiance Forecasting: A Spatio-Temporal Autoregressive Algorithm for Tropical Insular Areas**  
S. Cros, M. Turpin & A. Guérin de Montgareuil  
Reuniwatt, Sainte-Clotilde, Reunion
- 6BV.1.11 Impact of Rapid Changes in Solar Irradiance on PV Installations**  
F. Kuonen & U. Muntwyler  
BUAS, Burgdorf, Switzerland
- 6BV.1.12 Research on Ultra-Short Term Forecasting Method for Photovoltaic Power Generation with Consideration to the Atmosphere Transparency Correction**  
C. Yang, C. Cheng & Z. Chen  
CMA, Wuhan, China
- 6BV.1.13 Machine Learning Techniques for Forecasting Single-Site PV Production**  
M. Boegli & P.-J. Alet  
CSEM, Neuchâtel, Switzerland  
M. Pierro & D. Moser  
EURAC, Bolzano, Italy
- 6BV.1.14 A Hybrid Solar Radiation Forecasting Based on Data Mining and Wavelet Analysis**  
R. Kumar & V. Vijay  
IIT Jodhpur, India
- 6BV.1.15 24300 Simulations – The Influence of Irradiance Modelling on the PV Yield**  
M. Hofmann, R. Hunfeld & S. Lindemann  
Valentin Software, Berlin, Germany

- 6BV.1.16 Simplified Model for Solar Energy Potential Estimation in Urban Environments**  
A. Calcabrini, H. Ziar, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands
- 6BV.1.17 Optimisation of Physical Based Ray-Tracing Model for PV Plants Simulation**  
G. Tourasse  
KiloWattsol, Lyon, France
- 6BV.1.18 Analysis of Albedo Irradiance in the Context of Bifacial Photovoltaics Potential Utilising Multiband (Spectrally Resolved) Satellite Imagery**  
I.R. Cole & T.R. Betts  
Loughborough University, United Kingdom
- 6BV.1.19 Study of Electric Energy Complementarity in the Generation of Electric Power in Colombia**  
D.J. Rodriguez Patarroyo, J. Hernández & J. Camargo  
District University of Bogotá, Colombia
- 6BV.1.20 Experimental Comparison of Maximum Power Estimators for a Single Unit Photovoltaic Plant**  
E. Scolari, F. Sossan & M. Paolone  
EPFL, Lausanne, Switzerland
- 6BV.1.25 Really Building with BIPV**  
A. De Vries  
Stichting Monitoring Zonnestroom, Utrecht, Netherlands  
A. Kahn  
4WWWVIE, Ouderkerk aan de Amstel, Netherlands  
R. Comuth  
Adviesbureau Comuth, Maastricht, Netherlands  
A. van Deursen  
HD Solar, Someren, Netherlands  
M. Arninkhof  
Holland Solar, Utrecht, Netherlands  
G. Verpaalen  
Kameleon Solar Specials, Roosendaal, Netherlands  
C. Maas  
Chatim, Heerlen, Netherlands  
S. Kin  
SolarSwing Energy, Delft, Netherlands  
P. de Jong  
Solinso, Kessel, Netherlands  
W. van de Wall  
Wallvision, Heeze, Netherlands  
Z. Vroon  
Zuyd Hogeschool, Heerlen, Netherlands  
A. Kuypers  
TNO, Eindhoven, Netherlands  
J.C.P. Kester  
ECN, Petten, Netherlands  
R.M.E. Valckenborg  
SEAC, Eindhoven, Netherlands  
W.G.J.H.M. van Sark  
Utrecht University, Netherlands  
R. Loonen  
Eindhoven University of Technology, Netherlands  
Y. Aartsma, I. van Straten & E. Teunissen  
Berenschot, Utrecht, Netherlands
- 6BV.1.26 Energy Performance Evaluation of a Photovoltaic Window**  
F. Serrano-Casares & V. Navas  
UMA, Malaga, Spain





- 6BV.1.27 Beyond Watt per Module and Costs Per Watt - Lightweight Indicators for Photovoltaic Modules**  
S. Schindler, D. Götz & J. Schneider  
Fraunhofer CSP, Halle (Saale), Germany
- 6BV.1.28 Building Integrated Photovoltaic Facade Design: An Analysis of Decision Criteria**  
D. Efurosibina Attoye, K.A. Tabet Aoul & A. Hassan  
UAEU, Al Ain, United Arab Emirates
- 6BV.1.29 In-Situ Performance Evaluation and Prediction of BIPV Systems Using Normalized Efficiency**  
C.-S. Lee, H.-M. Lee, M.-J. Choi, K.-Y. Lee & J.-H. Yoon  
Hanbat National University, Yuseong-gu, Korea South
- 6BV.1.31 Evaluation of Thermal Properties for BIPV in Glass Façade**  
H. Ishii  
LIXIL, Tokyo, Japan
- 6BV.1.32 Comparative Performance Measurements of Identical BIPV-Elements in Different Climatic Environments - A Round Robin Action of IEA PVPS Task 15**  
P. Illich  
UAS Technikum Vienna, Austria  
G.C. Eder  
OFI, Vienna, Austria  
K.A. Berger & G. Újvári  
AIT, Vienna, Austria  
P. Rechberger  
FH-OOE, Wels, Austria  
D. Moor  
Ertex Solar, Amstetten, Austria  
S. Boddaert  
CSTB, Sophia Antipolis, France  
M. Ritzen  
ZUYD, Heerlen, Netherlands
- 6BV.1.33 Approach for an Empirical Light Attenuation Model to Predict Nominal Power of Modules with Ceramic Printed Front Glasses**  
C. Kutter, M. Heinrich, H.R. Wilson, A. Pfreundt, U. Eitner & H. Wirth  
Fraunhofer ISE, Freiburg, Germany
- 6BV.1.34 Analysis of Power Generation Performance for Design Elements of BIPV System through Mock-Up Demonstration**  
S. Lee, E. Ryu, K.-J. Kim & J.-J. Choi  
KCL, Jincheon-gun, Korea South
- 6BV.1.35 Building the World's Largest Bifacial Solar Noise Barrier**  
M.M. de Jong & W. Folkerts  
SEAC, Eindhoven, Netherlands  
J.C.P. Kester  
ECN, Petten, Netherlands  
D. van der Graaff  
Rijkswaterstaat, Utrecht, Netherlands  
S. Verkuilen  
Heijmans Infra, Rosmalen, Netherlands

- 6BV.1.36 Research Project CIGS-Façade: PV Façades - Chances and Limits**  
D. Geyer & P. Lechner  
ZSW, Stuttgart, Germany  
D. Gürlich  
University of Applied Science Stuttgart, Germany  
C. Conejo Gangkofner  
NICE Solar Energy, Schwäbisch Hall, Germany
- 6BV.1.37 A Feasibility Study of Snow Load Reduction on Roofs Using a Photovoltaic System in Heating Mode**  
I. Frimannslund  
Multiconsult, Oslo, Norway  
T. Thiis  
NMBU, Ås, Norway
- 6BV.1.38 Optimized Orientation and Proportion of Transparent Components Based on the Least Annual Heat Demand**  
A. Rahmani & R. Wagner  
Karlsruhe Institute of Technology, Germany
- 6BV.1.39 Comparison of the Electrical and Thermal Performance of Double Skin Façade and Insulating Glazing Unit Integrating Semi-Transparent Photovoltaics**  
Z. Ioannidis, E.D. Rounis, A.K. Athienitis & T. Stathopoulos  
Concordia University, Montreal, Canada  
A. Buonomano  
University of Naples, Italy
- 6BV.1.40 Using the Hot Air under a Building Integrated PV Roof in Combination with a Ventilation Heat Pump to Realise Energy Efficient Dwellings**  
C. de Keizer, R.M.E. Valckenborg & W. Folkerts  
SEAC, Eindhoven, Netherlands  
D. Hoogvliet & W. de Vries  
Inventum Technologies, Houten, Netherlands  
R. Borro  
Rebor, Amsterdam, Netherlands  
M. Laureijssen  
Unilin Insulation, Oisterwijk, Netherlands
- 6BV.1.41 Finding the Most Suitable PV Technology for a ZigZag-Structured PV Façade in NW-Europe**  
R.M.E. Valckenborg, C. Tzikas & W. Folkerts  
SEAC, Eindhoven, Netherlands  
S. Sasidharan & R. Santbergen  
TU Delft, Netherlands  
W. van de Wall  
Wallvision, Heeze, Netherlands
- 6BV.1.42 High Quality Solutions of Building-Integrated Photovoltaics (BIPV) – Results of the World Wide Competition in 2017**  
G. Becker, F. Flade, R. Krippner, B. Schiebelsberger & W. Weber  
SeV Bavaria, Munich, Germany
- 6BV.1.43 Performance of Façade-Integrated Photovoltaics at High Latitudes**  
A.G. Imenes & B. Paudyal  
University of Agder, Grimstad, Norway
- 6BV.1.44 Experimental Study on Fire Property Regarding BIPV Module Applied to Façade**  
H. Ishii  
LIXIL, Tokyo, Japan



- 6BV.1.45 The Use of Photovoltaic Technologies in the Built Environment: Open Issues and Research Perspectives**  
A. Scognamiglio  
ENEA, Portici, Italy  
F. Frontini  
SUPSI, Canobbio, Switzerland  
A. Krstic-Furundzic, M. Devetakovic & B. Sudimac  
University of Belgrade, Serbia
- 6BV.1.46 Results of PVOPTI-Ray Project: Optimisation of Reflecting Materials and Photovoltaic Yield in an Urban Context**  
S. Zamini, M. Revesz & A. Schneider  
AIT, Vienna, Austria  
P. Weihs, S. Oswald & H. Trimmel  
BOKU, Vienna, Austria  
S. Krispel & M. Peyerl  
Smart Minerals, Vienna, Austria
- 6BV.1.47 Performance Assessment of Floating PV Systems in Central Europe**  
K. Sinapis, M.M. de Jong & W. Folkerts  
SEAC, Eindhoven, Netherlands
- 6BV.1.48 Experimental Performance of a Curtain Wall BIPV Element under Realistic Boundary Conditions**  
J. Goncalves, J. Lehmann, W. Parys & D. Saelens  
KU Leuven, Belgium  
G.H. Yordanov & K. Baert  
KU Leuven, Genk, Belgium
- 6BV.1.49 Method for the Analysis of Technical and Economic Feasibility of Grid-Connected Photovoltaic Systems Integrated in Buildings' Facades**  
I. Custódio & R. Rütther  
UFSC, Florianópolis, Brazil
- 6BV.1.50 Feedback on the Performance Monitoring of a Rooftop BIPV Installation**  
Y.B. Assoa & P. Schneuwly  
CEA, Le Bourget du Lac, France
- 6BV.1.51 Higher Energy Efficient Facades with Solar Energy**  
S. Naderi  
Islamic Azad University, Tehran, Iran
- 6BV.1.52 Design of Building-Integrated Photovoltaic/Thermal Curtain Wall Façade Modules and Development of Grasshopper Component for Rhinoceros 3D Architectural Modeling Plug-in**  
O. Kruglov, C. Vallianos, D. Sun, E.D. Rounis & A.K. Athienitis  
Concordia University, Montreal, Canada
- 6BV.1.53 The Integration of Photovoltaics System and an Electric Battery in a Tertiary Building at RABAT to Slash the Annual Electricity Bill by 46%**  
S. Idrissi Kaitouni, A. Benlarabi & B. Ikken  
IRESEN, Rabat, Morocco
- 6BV.1.54 Solar Decathlon AFRICA: An In-Depth Outlook on the Participating Prototype Net-Zero-Energy Houses**  
S. Idrissi Kaitouni & B. Ikken  
IRESEN, Rabat, Morocco
- 6BV.1.55 Applying GIS to Evaluate the Photovoltaic Solar Potential in an Urban Environment Case of Casablanca City / Morocco**  
E.M. Achbab, H. Atika, O. Saddiqi, A. El Hassani El Alaoui, M. Mehdi & H. Rhinane  
University of Hassan II, Casablanca, Morocco
- 6BV.1.56 Development of a Photovoltaic Powered Poultry Egg Incubator**  
W.I. Okonkwo & O. Onyekwere  
University of Nigeria, Nsukka, Nigeria
- 6BV.1.62 PV Beyond Electricity, Heat Pumps Hybridization for a Multiplicative Effect towards NZEB**  
A. Sanz Martinez  
TECNALIA, Derio, Spain  
R. Fuente Dacal  
UPV/EHU, Bilbao, Spain  
A.J. Martin  
Energy Panel, Lucena, Spain
- 6BV.1.63 Storage Management of Shared PV-Battery-Systems in Multi-Apartment Buildings**  
L. Gaisberger & P. Rechberger  
University of Applied Sciences Upper Austria, Wels, Austria
- 6BV.1.64 Use and Benefits of the Combination of PV and Meteorological Networks**  
P. Rechberger & R. Höller  
FH-OOE, Wels, Austria  
W. Traummüller  
Blue Sky, Attnang, Austria  
K. Erk  
Fronius, Thalheim, Austria  
T. Grubinger  
SCCH, Hagenberg, Austria  
M. Schmidthaler  
Energie AG Trading, Linz, Austria  
M. Schwarz  
Energieinstitut an der JKU, Linz, Austria
- 6BV.1.65 The Possible Role of PV in the Future Power Supply of the Faroe Islands**  
H.G. Beyer & H.G. Beyer  
University of the Faroe Islands, Torshavn, Faroe Islands
- 6BV.1.66 Modelling Different PV-Based Communal Grids Architectures for Rural Developing Communities**  
N. Opiyo  
University of Southampton, United Kingdom
- 6BV.1.67 SimZukunft: Studies about Integrating a Large Amount of PV into the Grid of a Small Swiss Town**  
N. Pflugradt & U. Muntwyler  
BUAS, Burgdorf, Switzerland
- 6BV.1.68 Modelling Control Methods for PV-Based Communal Grids with Different Line Resistances and Impedances**  
N. Opiyo  
University of Southampton, United Kingdom
- 6BV.1.69 Study of Approaches to the Creation of a Stand-Alone Microgrid on the Basis of Renewable Energy Sources for Guaranteed Power Supply of Small Settlements**  
P.P. Bezrukikh  
JSC ENIN, Moscow, Russia  
S.M. Karabanov  
Solar Consult, Ryazan, Russia
- 6BV.1.70 Performance of a 40 kWp PV Irrigation Demonstrator Combining Variable and Constant Pressure Pumping**  
I.A. Barata Carrêlo, R.H. Almeida & L. Narvarte Fernández  
UPM, Madrid, Spain



- 6BV.1.71 Main Final Results of MASLOWATEN – the H2020 Project for the Market Uptake of Large Power PV Irrigation Systems**  
R.H. Almeida, I.A. Barata Carrêlo, L. Narvarte Fernández, F. Martinez-Moreno & L.M. Carrasco  
UPM, Madrid, Spain  
J. Fernandez-Ramos  
UMA, Malaga, Spain
- 6BV.1.72 Energy Management of Combined PV, Storage and HP-Systems Using Forecasts and Variable Tariffs**  
P. Rechberger & H. Kirchsteiger  
University of Applied Sciences Upper Austria, Wels, Austria
- 6BV.1.74 Experimental Evaluation of the Integration of Microgrids Supplied by Hybrid Energy Sources**  
J.P. Alves Verissimo, C.F. de Oliveira Barbosa, M.A. Barros Galhardo, W. Negrao-Macedo, V.P. de Oliveira Alves, T.V. Pinheiro da Silva & J. Tavares Pinho  
UFPA, Belém, Brazil  
L. Oliveira de Albuquerque  
UFPA, Belem, Brazil
- 6BV.1.75 The Development and Test of the PV Concentrator System with Electrical and Thermal Output**  
A.V. Yurchenko & A.V. Okhorzina  
Tomsk Politechnical University, Russia  
N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany
- 6BV.1.76 Innovative Solar Spectral Beam Splitting Concepts: Alternative Fuels Production**  
G. Mittelman  
Agricultural Research Organization, Rishon lezion, Israel  
A. Kribus  
Tel Aviv University, Israel
- 6BV.1.77 Optimal Energy Management in Microgrid Using a Particle Swarm Optimization Algorithm**  
M. Ait Benali & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco
- 6BV.1.78 Automatic Topology Identification for Energy Load Management in Electro Mobility Charging Applications to Increase Share of Local Renewables**  
P. Klement, B. Ravanbach, B. Hanke & K. von Maydell  
DLR, Oldenburg, Germany
- 6BV.1.79 PV Thermal Inspections Using Drones for Efficient and Low Cost Asset Management, Following IEC 62446-3**  
R. Pardell, A. Figueres & J. Rebull  
Cleandrone, Valldoreix, Spain
- 6BV.1.80 Computational Diagnostics of Regional Photovoltaic Smoothing Potential for Composite Orientations and Configurations**  
N. Riaz & S. Repo  
Tampere University of Technology, Finland
- 6BV.1.81 High Gain Bi-Directional DC-DC Converter for Battery Charging Applications Interligated to a DC Nanogrid for Residential Prosumer**  
F. Viana da Silva Queiroz & F.L.M. Antunes  
UFC, Fortaleza, Brazil

- 6BV.1.82 Distributed Solar Power for Government Buildings in Ghana - The Case of Ministry of Energy, Ghana**  
W.K. Ahiataku-Togobo & M. Adabla  
Ministry of Energy, Accra, Ghana
- 6BV.1.83 Implementation of a Grid-Friendly Control Strategy in a Solar Net-Zero Energy Residential Building**  
R. Dumoulin, A. Rey, A.K. Athienitis & B. Lee  
Concordia University, Montreal, Canada  
K. Lavigne, A. Daoud & M. Fournier  
IREQ, Shawinigan, Canada
- 6BV.1.84 Smart Control of a Grid Connected PV Power Plant - Tunisian Electrical Grid Case Study**  
K. Mansouri, K. Jemai & L. Sbitta  
University of Gabes, Tunisia

**VISUAL PRESENTATIONS 3BV.2**13:30 - 15:00 **Cl(G)S, CdTe and Related Thin Film Solar Cells and Modules**

- 3BV.2.1 Enhanced Efficiency of Cu(In,Ga)Se<sub>2</sub> Solar Cells with a Thin CdS Buffer Layer via a (Zn,Mg)O Second Buffer Layer**  
H. Li, F. Qu, X. Lin, H. Gu & W. Wang  
CAS, Beijing, China
- 3BV.2.2 Elucidation of Mechanism behind the Performance Improvement in Nanoparticle Based ClSe Solar Cells upon Na Addition**  
S.J. Ahn, S. Rehan, J. Moon, Y.-J. Eo, A. Cho, J. Gwak & S.K. Ahn  
KIER, Daejeon, Korea South
- 3BV.2.3 High-Speed Shunt-Free Laser Scribing and Back-End Interconnection Technology for ClGS Module Production**  
V.S. Gevaerts, A.F.K.V. Biezemans, H. Het Mannetje, H. Linden & J. Bosman  
Solliance Solar Research, Eindhoven, Netherlands
- 3BV.2.4 CuInSe<sub>2</sub> Formation from Electroplated Metallic Layers Using Continuous-Wave Laser Annealing**  
P. Arnou, D. Siopa, M.H. Wolter & P.J. Dale  
University of Luxembourg, Belvaux, Luxembourg  
M.A. Scarpulla  
University of Utah, Salt Lake City, United States
- 3BV.2.5 The Impact of MoO<sub>x</sub> Back Interface Layer on Low-Temperature Growth of Submicron Cu(In,Ga)Se<sub>2</sub> Solar Cells**  
Y. Liu, W. Liu, S. Shi, Z. He, S. Lin, Y. Zhang, Z. Zhou, F.-F. Liu & Y. Sun  
Nankai University, Tianjin, China
- 3BV.2.6 Investigation on Sb-Doped Induced Cu(InGa)Se<sub>2</sub> Films Grain Growth by Sputtering Process with Se-Free Annealing**  
L. Zhang, D.-M. Zhuang, M. Zhao, Y. Wei, X. Lyu, X. Peng, G. Ren, Y. Wu & C. Wang  
Tsinghua University, Beijing, China
- 3BV.2.7 Effect of Selenization Ramping Temperature Profile on the Structural and Morphological Properties of Cu(In,Ga)Se<sub>2</sub> Thin Films Absorber Layers Using Two Step Growth Process**  
F.B. Dejene  
University of the Free State, Phuthaditjhaba, South Africa



- 3BV.2.8 Investigation of High-Quality CBD-Zn(S,O,OH) Buffer Layer on CIGS-Absorbers**  
M. Ostrysz, S. Song, J. Gwak & A. Cho  
KIER, Daejeon, Korea South
- 3BV.2.9 Molybdenum Bilayer Thin Film on Large Area by Cylindrical Rotating DC Magnetron Sputtering for CIGS Solar Cell Application**  
S.R. Dhage, A.C. Badgujar & B.S. Yadav  
ARCI, Hyderabad, India
- 3BV.2.10 Laser Patterning of CIGSe Absorber Layers: Revealing Enhanced Charge Carrier Recombination within Laser-Affected Zones by Means of Time-Resolved Photoluminescence Spectroscopy**  
C. Schultz, A. Bartelt & B. Stegemann  
HTW Berlin, Germany  
C. Junghans  
Becker & Hickl, Berlin, Germany  
S.S. Schmidt & R. Schlatmann  
HZB, Berlin, Germany
- 3BV.2.11 Modification of GGI Profile in Low Temperature Co-Evaporation Deposited Cu(In,Ga)Se<sub>2</sub> Thin Film by VCu-Enhanced Diffusion Aiming at Increasing Voc and FF**  
S. Lin, W. Liu, Y. Zhang, S. Cheng, Y. Liu, S. Shi, Z.Q. Zhou, Q. He & Y. Sun  
Nankai University, Tianjin, China
- 3BV.2.12 Engineering of Band Alignment at the CuInSe<sub>2</sub>/In<sub>2</sub>S<sub>3</sub> Interface of the CIGS-Based Thin Film Solar Cells**  
E. Ghorbani & K. Albe  
Technical University of Darmstadt, Germany
- 3BV.2.13 Co-Optimized CdS Buffer and Gallium Profile toward High-Efficiency Penternary Cu(In,Ga)(Se,S)<sub>2</sub> Solar Cell**  
C.-Y. Huang, P. Parashar, H.-M. Chou, Y.-S. Lin & A. Lin  
NCTU, Hsinchu, Taiwan
- 3BV.2.14 Photovoltaic Glazing from Bottom-Up Electrodeposition of CIGS on Patterned Mo/Glass Substrates**  
T. Sidali, A. Bou, S. Leyder & P.-Y. Thoulon  
Crosslux, Rousset, France  
D. Coutancier, E. Chassaing, B. Theys & D. Lincot  
CNRS, Palaiseau, France  
R. Garuz & D. Barakel  
IM2NP, Marseille, France
- 3BV.2.15 Alkali Reactivity on Aged CIGS Absorber Deposited on Flexible Substrates Studied by XPS**  
S. Béchu, V. Achard, A. Loubat, M. Balestrieri, T. Hildebrandt, M. Jubault & F. Donsanti  
IPVF, Palaiseau, France  
M. Frégnaux, J. Vigneron, M. Bouttemy & A. Etcheberry  
UVSQ, Versailles, France  
D. Lincot  
CNRS, Palaiseau, France
- 3BV.2.16 A Study of the Long-Term Effects of Alkali Atom Inclusion on CIGS Solar Cells**  
T. Kohl, J. de Wild, D.G. Buldu, N.A. Rivas & F. Renner  
Hasselt University, Diepenbeek, Belgium  
G. Brammert, M. Meuris & B. Vermang  
imec, Diepenbeek, Belgium  
J. Poortmans  
imec, Leuven, Belgium

- 3BV.2.17 Stability of CIGS Solar Cells under Illumination with Damp Heat and Dry Heat: A Comparison**  
M. Theelen, K. Beyeler & H. Steijvers  
TNO, Eindhoven, Netherlands  
N. Barreau  
IMN-UMR, Nantes, France
- 3BV.2.18 Assessment of CIGS Device Processing on Innovative Insulating Non-Glass Substrates**  
F. Kessler & R. Würz  
ZSW, Stuttgart, Germany  
L. Fourdrinier, A. Lafort & S. Le Cruz  
CRM Group, Liège, Belgium
- 3BV.2.19 3D-Imaging of Cu(In,Ga)Se<sub>2</sub> Grain Boundaries by Time-of-Flight-Secondary Ion Mass Spectrometry**  
W. Hempel, J. Hanisch, T. Magorian-Friedlmeier & M. Powalla  
ZSW, Stuttgart, Germany
- 3BV.2.20 Systematic Studies on Characteristics of CIGS Absorbers Grown on Flexible PI/Mo Substrate under Different Processing Temperature**  
K. Kim, I. Jeong, Y.-J. Eo, D.H. Shin, S.K. Ahn, A. Cho, S. Song, Y. Cho, J.S. Yu, J.-S. Cho, S. Ahn, J.H. Park, J. Gwak & J.H. Yun  
KIER, Daejeon, Korea South
- 3BV.2.21 Molybdenum Back Interface Engineering Using Ultrathin Intermediate Layers for Solution Processed Cu<sub>2</sub>(Cd,Zn)SnS<sub>4</sub> Solar Cells**  
S. Zhuk, T.K.S. Wong, V. Tunuguntla & L.H. Wong  
NTU, Singapore, Singapore  
S. Tripathy, T.I. Wong & G.K. Dalapati  
A\*Star, Singapore, Singapore  
A. Stsiapanau & A. Smirnov  
BSUIR, Minsk, Belarus
- 3BV.2.22 Characterization of Sputtered CdSexTe<sub>1-x</sub> Films and Its Application in CdTe Solar Cells**  
C.X. Li, L.L. Wu, F.G. Wang, Y.L. Chen & L.H. Feng  
Sichuan University, Chengdu, China
- 3BV.2.23 Improved Back Contact Barrier of CZTSE Solar Cells by Incorporating Nanoscale Ge Bi-Layers**  
S. Lee  
Indiana State University, Terre Haute, United States  
K.J. Price  
Morehead State University, United States  
E. Saucedo & S. Giraldo  
IREC, Barcelona, Spain
- 3BV.2.24 Characterization of Cu<sub>2</sub>ZnSn(SxSe<sub>1-x</sub>)<sub>4</sub> Thin Films Prepared by Annealing of Stack Precursors in Se Vapor**  
E.P. Zaretskaya & V.F. Gremenok  
NASB, Minsk, Belarus  
M.S. Tivanov  
BSU, Minsk, Belarus  
S. Özcelik & N. Akcay  
University of Gazi, Ankara, Turkey  
R. Juskenas & R. Giraitis  
SRIC for Physical Sciences and Technology, Vilnius, Lithuania  
A. Saad  
Al-Balqa Applied University, Amman, Jordan



- 3BV.2.25 Efficiency Improvement of CdTe Solar Cells with Ultra-Thin CdS Layer**  
M. Leoncini, E. Artegiani, M. Cavallini & A. Romeo  
University of Verona, Italy
- 3BV.2.26 In Situ Gel Formation of High-Quality Kesterite Thin Films**  
V. Trifiletti, S. Mostoni, R. Scotti & S. Binetti  
University of Milan, Italy
- 3BV.2.27 Effect of Annealing Condition on Formation of Cu<sub>2</sub>ZnSnS<sub>4</sub> Thin Films Using CS<sub>2</sub>**  
K. Yoshikawa, T. Shimizu, T. Ito & S. Shingubara  
Kansai University, Osaka, Japan  
S. Tanaka  
NICT, Kobe, Japan  
K. Takase  
Nihon University, Tokyo, Japan
- 3BV.2.28 Phases Control of CZTSSe during Selenization**  
R. Sun, D.-M. Zhuang, M. Zhao, Y. Wei, G. Ren, Y. Wu, L. Zhang, X. Lyu & X. Peng  
Tsinghua University, Beijing, China
- 3BV.2.29 Partial and Total Substitution of Zn by Mg in the Cu<sub>2</sub>ZnSnS<sub>4</sub> Structure**  
D.M. Mena Romero, D. Victoria Valenzuela & C.L. Azanza Ricardo  
UNAM, Querétaro, Mexico  
L.M. Rivera González  
UTEQ, Querétaro, Mexico
- 3BV.2.30 Surface Passivation by Alkali Metal Containing Solution for Cu<sub>2</sub>ZnSnSe<sub>4</sub> Solar Cells**  
H. Tampo, S. Kim, H. Shibata & S. Niki  
AIST, Tsukuba, Japan
- 3BV.2.31 Impedance Spectroscopy of CdTe PV Modules – Comparative Study**  
T. Finsterle, L. Cerná, P. Hrzina & V. Benda  
Czech Technical University of Prague, Czech Republic  
S. Kichou  
Czech Technical University of Prague, Bustehrad, Czech Republic
- 3BV.2.32 Effect of Temperature Profile on the Formation of CZTSe Absorber Layer**  
V. Kumar & U.P. Singh  
KIIT University, Bhubaneswar, India
- 3BV.2.33 The Effect of Zinc Oxide Doped with CdS Deposited by Chemical Bath Deposition for Photovoltaic Application**  
S. Ullah, F. Bouhjar, M. Mollar & B. Marí  
UPV, Valencia, Spain  
H. Ullah & A. Chahboun  
Abdelmalek Essaadi University, Tangier, Morocco
- 3BV.2.34 Effect of Temperature on CZTS Based Thin Film Solar Cell Performance**  
A. Chowdhury, M. Rahaman, M. Islam & M. Rahman  
BRAC University, Dhaka, Bangladesh
- 3BV.2.35 Stoichiometry Evaluation in the Partial and Total Substitution of Zn by Mg in the Cu<sub>2</sub>ZnSnS<sub>4</sub> Structure by XRD**  
C.L. Azanza Ricardo, D.M. Mena Romero & D. Victoria Valenzuela  
UNAM, Querétaro, Mexico
- 3BV.2.36 Fabrication of p-Type Na Doped SrCuSeF and n-Type ITO Bilayer Ohmic Tunnel Junction and Its Application to the Back Contact of CdS/CdTe Solar Cells**  
T. Wada, K. Miki & D. Tamai  
Ryukoku University, Otsu, Japan  
Y. Shiina, S. Okamoto & T. Okamoto  
Kisarazu College, Chiba, Japan

- 3BV.2.37 Effect of the Chemical Composition Ratio Cu/(Zn+Sn) and Cu/Zn onto the Structural, Morphological, and Optical Properties of Cu<sub>2</sub>ZnSnS<sub>4</sub> (CZTS) Thin Films for PV Applications**  
K. Abouabassi, H. Kirou, L. Atourki, A. Elfanaoui, K. Bouabid, M. Nya & A. Ihlal  
University of Ibn ZOHR, Agadir, Morocco  
M.Y. Messous  
CNESTEN, Rabat, Morocco  
A. Almaggoussi  
Cadi Ayyad University, Marrakech, Morocco
- 3BV.2.38 A Unified 2D Solver for Modeling Carrier and Defect Transport on an Equal Footing in CdTe Solar Cells**  
A.R. Shaik, C. Ringhofer & D. Vasileska  
Arizona State University, Tempe, United States  
D. Brinkman  
SJSU, San Jose, United States

**VISUAL PRESENTATIONS 3BV.3**

15:15 - 16:45 Perovskite, Organic and Dye-Sensitised Devices

- 3BV.3.1 Evaluation Emerging PV Performance under Energy Harvesting for IOT (Internet of Things) Applications**  
Y.-S. Long, E.-Y. Wang & T.-C. Wu  
ITRI, Hsinchu, Taiwan
- 3BV.3.2 Measurement Technique Influence on Reported Efficiency Values for Perovskite Solar Cells**  
B.C. Duck, L. Lin, K.F. Anderson, T.W. Jones, C.J. Fell & G.J. Wilson  
CSIRO Energy Technology, Mayfield West, Australia
- 3BV.3.3 Quantitative Assessment of Humidity in Encapsulation Materials for Moisture-Sensitive Devices**  
J. Hepp, S. Langner, M. Woiton, G. Jovicic, K. Burlafinger & C.J. Brabec  
FAU, Erlangen, Germany  
A. Vetter, C. Camus, H.-J. Egelhaaf & J. Hauch  
ZAE Bayern, Erlangen, Germany
- 3BV.3.4 Indoor Calibration of Large Area Organic PV Modules**  
G. Bardizza, E. Salis, D. Pavanello, T. Sample, H. Müllejans & E.D. Dunlop  
European Commission JRC, Ispra, Italy
- 3BV.3.5 Toward High Performance Organic Solar Cells: Development of Materials**  
H.J. Son  
KIST, Seoul, Korea South
- 3BV.3.6 Investigations of Antireflective Coatings for Organic Solar Cells**  
S.X. Suleymanov, V.G. Dyskin, M.U. Djanklich, N.A. Kulagina & O.A. Dudko  
Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan
- 3BV.3.7 Perovskite/Silicon-Heterojunction Two-Terminal Tandem Solar Cells**  
S. Zhu, X. Yao, Q. Ren, C. Zheng, B. Shi, F. Hou, Y. Ding, Y. Zhao & X. Zhang  
Nankai University, Tianjin, China



- 3BV.3.8 Bifacial Dye Sensitized Solar Cell Prototyped Using Carbon Fibre Mesh as Counter Electrode**  
M. Gheorghe & S. Gheorghe  
NANOM MEMS, Rasnov, Romania  
N. Olariu & G. Mantescu  
Valahia University of Targoviste, Romania
- 3BV.3.9 Improvement of Light Harvesting with a Multi-Resonance Tandem Geometry in Thin-Film Solar Cells**  
B. Godefroid & G. Kozyreff  
Free University of Brussels, Belgium
- 3BV.3.10 Graphene Modified SnO<sub>2</sub>-TiO<sub>2</sub> as Efficient and Stable Photoanodes for Dye Sensitized Solar Cell**  
K. Basu, G. Singh Selopal, M. Mohammadnezhad, F. Vetrone & F. Rosei  
INRS, Quebec, Canada  
H. Zhao  
Qingdao University, China
- 3BV.3.11 Lead Sulfide Nanocrystal Co-Sensitized Dye-Sensitized Solar Cell: Scalable Deposition Process and Significant Improvement in Power Conversion Efficacy**  
U. Mehmood, A. Al-Ahmed, A.S. Hakeem & F.A. Al-Sulaiman  
KFUPM, Dhahran, Saudi Arabia  
M. Afzaal  
University of Salford, United Kingdom  
S. Abdullahi Haladu  
University of Dammam, Saudi Arabia
- 3BV.3.12 3-Dimensional Dye Sensitized Solar Cell Sub-Module with Oblique Angled Cell Array for Enhanced Power and Energy Density Output Utilizing Non-Linear Relation in Cosine Law of Light Incident Angle**  
M.J. Yun, Y.H. Sim, S.I. Cha & D.Y. Lee  
KERI, Changwon, Korea South
- 3BV.3.13 Solution Grown (100)pc Oriented BiFeO<sub>3</sub> Thin Films: Photoconductivity and Ferroelectric Studies**  
S. Nandy & S. Sudakar  
IIT Madras, Chennai, India
- 3BV.3.14 Simple and Dopant-Free Hole-Transporting Material Based on Carbazole for Efficient Planar Perovskite Solar Cells: N, N-di-p-methoxyphenylamine-substituted (2-Ethylhexyl)-9H-Carbazole and N, N-di-p-methylthiophenylamine-substituted (2-Ethylhexyl)-9H-Carba**  
J. Zhang, X. Jia, S. Wang, Y. Zhu, Z. Chen, S. Zhang, B. Lin, N. Yuan & J. Ding  
Changzhou University, China
- 3BV.3.15 Enhancement of Hole-Extraction at the In<sub>2</sub>O<sub>3</sub>:H / CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub> Interface by Graphene: Investigated by Modulated Surface Photovoltage Spectroscopy**  
S.H.B. Vinoth Kumar, R. Muydinov & B. Szyszka  
Berlin University of Technology, Germany  
T. Koltsova & O. Tolochko  
SPbPU, St. Petersburg, Russia  
D. Erfurt & A. Steigert  
HZB, Berlin, Germany
- 3BV.3.16 Fully Inorganic Charge Transport Layers for High Efficiency Perovskite Solar Cells and Modules**  
A. Walter, S.-J. Moon, B. Niesen, B.A. Kamino, J.J. Diaz Leon, G. Cattaneo, S. Nicolay & C. Ballif  
CSEM, Neuchâtel, Switzerland

- 3BV.3.17 Low-Temperature Electron Transport Layers for Perovskite Solar Cells**  
V. La Ferrara, A. De Maria, G. Rametta, M. Della Noce, L.V. Mercaldo, C. Borriello, A. Bruno & P. Delli Veneri  
ENEA, Portici, Italy
- 3BV.3.18 The Effect of Potassium Doping on Perovskite Solar Cells Performance and Stability**  
M.F. Vildanova, A.B. Nikolskaia, S.S. Kozlov, O.I. Shevaleyevskiy & L.L. Larina  
RAS, Moscow, Russia
- 3BV.3.19 Growth of Compact CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub> Thin Films Controlled by Ligand Chemistry**  
J. Jiang, S. Wang, X. Jia, X. Fang, W. Liu, J. Ding & N. Yuan  
Changzhou University, China
- 3BV.3.20 Study of CH<sub>3</sub>NH<sub>3</sub>Zn<sub>2</sub>PbI<sub>3</sub> as an Active Layer of Organo-Metal Halide Perovskite Solar Cells**  
N. Soleimanioun, S. Sharma & S.K. Tripathi  
Panjab University, Chandigarh, India  
A. Kumar  
Punjab Technical University, Jalandhar, India  
M. Rani  
DAV University, Jalandhar, India
- 3BV.3.21 Fabrication and Characterization of CH<sub>3</sub>NH<sub>3</sub>(Cs)Pb(Sn)I<sub>3</sub>(Cl) Perovskite Solar Cells with TiO<sub>2</sub> Nanoparticle Layers**  
N. Ueoka, T. Oku & A. Suzuki  
University of Shiga Prefecture, Hikone, Japan  
H. Sakamoto & M. Yamada  
Osaka Gas, Japan  
S. Minami, S. Miyauchi & S. Tsukada  
Osaka Gas Chemicals, Japan
- 3BV.3.22 Effects of Excess PbI<sub>2</sub> Addition to CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub>-xCl<sub>x</sub> Perovskite Solar Cells**  
N. Ueoka, T. Oku, Y. Ohishi, H. Tanaka & A. Suzuki  
University of Shiga Prefecture, Hikone, Japan
- 3BV.3.23 Enhancing the High Efficiency of Perovskite Solar Cell Using TiO<sub>2</sub> Nanorod as Effective Electron Transfer Layer**  
M. Kim, Y. Jo & D.S. Kim  
KIER, Ulsan, Korea South  
D. Huh & H. Lee  
Korea University, Seoul, Korea South
- 3BV.3.24 Photonic Annealing of Perovskite Thin Films with Alkyl Halide Additives**  
T. Druffel  
University of Louisville, United States
- 3BV.3.25 The Impact of Time on Efficiency Variation of CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub> Perovskite Solar Cells via Sandwich Deposition Technique**  
C.-H. Kuan, W.-C. Hsieh, P.-T. Kuo, H.-J. Syu & C.-F. Lin  
NTU, Taipei, Taiwan
- 3BV.3.26 Perovskite Solar Cells Prepared by 3-Step Method Using Additional CH<sub>3</sub>NH<sub>3</sub>I or HC(NH<sub>2</sub>)<sub>2</sub>I Spin-Coating: Multiple Bandgap Structure for Efficiency Improvement**  
Y. Okamoto  
University of Tsukuba, Japan  
T. Yasuda & M. Sumiya  
NIMS, Tsukuba, Japan  
Y. Suzuki  
University of Tsukuba, Ibaraki, Japan





- 3BV.3.27 Fabrication of High Efficiency Single Halide Lead Perovskite Solar Cells by Sandwich Deposition Technique**  
T. Avula & C.-F. Lin  
NTU, Taipei, Taiwan
- 3BV.3.28 Improving Carrier Transport Ability to Enhance Sandwich Deposition Technique Synthesized CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub>-xCl<sub>x</sub> Perovskite Solar Cells**  
P.-T. Kuo, H.-J. Syu & C.-F. Lin  
NTU, Taipei, Taiwan
- 3BV.3.29 Coevaporation of Methylammonium Lead Iodide Perovskites Absorbers and Their Optical and Structural Properties**  
T. Gallet & A. Redinger  
University of Luxembourg, Luxembourg
- 3BV.3.30 Perovskite Solar Cells with Sulfide-Based Interlayer**  
A.B. Nikolskaia, L.L. Larina, M.F. Vildanova, S.S. Kozlov & O.I. Shevaleevskiy  
RAS, Moscow, Russia
- 3BV.3.31 Design of High-Performance Perovskite Solar Cells Adapted to the Tandem Concept and Suitable to Harsh Climates**  
S. Laalioui, K. Belrhiti Alaoui & B. Ikken  
IRESEN, Rabat, Morocco  
K. El Assali & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco
- 3BV.3.32 Simulation Study of Tandems of Perovskite and IBC c-Si Solar Cells**  
S. Silvestre, J. Puigdollers González, P. Ortega & D. Serra  
UPC, Barcelona, Spain  
E. Mas-Marzá & F. Fabregat-Santiago  
UJI, Castellón, Spain
- 3BV.3.33 Stability Improvements of the Perovskite Photovoltaic Cells**  
D. Strachala, J. Hylsky & J. Vanek  
Brno University of Technology, Czech Republic
- 3BV.3.34 Exploring the Use of Colloid as a Binder in Screen Printing Vehicles for Perovskite Solar Cells Metallization**  
C. Montes, L. Ocaña, L. De Sousa-Vieira, J.S. Moreno-Ramírez, M. Friend & M. Cendagorta  
ITER, Granadilla de Abona, Spain  
S. González-Pérez & B. González-Díaz  
ULL, La Laguna, Spain
- 3BV.3.35 Innovative Intermitent Coating Techniques in the R2R Manufacturing of Perovskite Solar Cells and Nano-Imprint Structuring for Efficiency Optimization**  
T. Exlager, K. Crone & N. Meyer  
Coatema, Dormagen, Germany  
H. Hauser  
Fraunhofer ISE, Freiburg, Germany  
I. de Vries & P. Groen  
TNO, Eindhoven, Netherlands
- 3BV.3.36 Producing Uniform and Smooth Thin Layers of Perovskite under Ambient Conditions by Adjusting to the Existing Levels of Moisture**  
C. Montes, L. Ocaña, L. De Sousa-Vieira, J.S. Moreno-Ramírez, M. Friend & M. Cendagorta  
ITER, Granadilla de Abona, Spain  
S. González-Pérez, B. González-Díaz & C. Hernandez-Rodriguez  
ULL, La Laguna, Spain

- 3BV.3.37 Optimization of Three-Terminal Perovskite / c-Si Tandem Solar Cells**  
R. Santbergen & M. Zeman  
Delft University of Technology, Netherlands  
H. Uzu & K. Yamamoto  
Kaneka, Osaka, Japan
- 3BV.3.38 Preparation of Large Area Perovskite Solar Cells Modules by Industrial Methods**  
S. Wang, J. Zhang, Y. Zhu, X. Jia, Z. Chen, K. Zhang, B. Lin, N. Yuan & J. Ding  
Changzhou University, China
- 3BV.3.39 Active Materials and Interfaces for Stable Perovskite Solar Cells**  
A. Abate  
HZB, Berlin, Germany

**VISUAL PRESENTATIONS 4BV.4**17:00 - 18:30 **III-V-Based Devices for Terrestrial and Space Applications**

- 4BV.4.1 GaAs p-n Solar Cells with MOVPE Growth Rate of 120  $\mu\text{m/h}$**   
H. Sodabanlu, K. Watanabe, Y. Nakano & M. Sugiyama  
University of Tokyo, Japan  
A. Ubukata  
TNSC, Tokyo, Japan  
T. Sugaya  
AIST, Tsukuba, Japan
- 4BV.4.2 Dichroic Pentaprism for the Spectral Splitting of Concentrated Solar Radiation**  
A. Parretta  
University of Ferrara, Italy  
M. Izzi & M. Tucci  
ENEA, Rome, Italy
- 4BV.4.3 Machine Learning for Realistic Yearly Averaged Photovoltaic Efficiency Calculations**  
J.M. Ripalda  
IMM - CSIC, Madrid, Spain  
J. Buencuerpo  
NREL, Golden, United States  
I. Garcia  
UPM, Madrid, Spain
- 4BV.4.4 Coupling Effects in InGaP/InGaAs/Ge Triple Junction PV Cells of Different Structures**  
V. Paraskeva & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
N. Armani, A. Malchiodi, F. Trespidi & G. Timò  
RSE, Piacenza, Italy
- 4BV.4.5 Isotope Heterointerfaces in Triple-Junction Solar Cells: Influence on IV-Curve Shape and Optimization**  
M.A. Mintairov, V.V. Evstropov, S.A. Mintairov, M.Z. Shvarts & N.A. Kalyuzhnyy  
RAS / Ioffe, St. Petersburg, Russia
- 4BV.4.6 CPVIndia - Evaluation of a 53 kW CPV System in India**  
M. Steiner, A. Wekkeli & G. Siefert  
Fraunhofer ISE, Freiburg, Germany  
S. Ojha, S. Sardar, J. Singh, V. Singh & J. Singh Chandok  
NETRA NTPC, Gr. Noida, India





- 4BV.4.7 Internal Sun Tracking CPV4ALL Module: Improvement and Novel Characterization of the 4-Lobed Parabolic Mirror with Tolerance Manufacturing**  
S. Bernardis & P. Voarino  
CEA, Le Bourget du Lac, France  
G. Ickes, H. Hagedorn, H. Reus & T. Schmauder  
Buhler Leybold Optics, Alzenau, Germany  
M. Schottner, H. Rooms & P.-J. Bolt  
TNO, Eindhoven, Netherlands  
J. Bos-Coenraad, S.G.D. van Es & J.J. Schermer  
Radboud University, Nijmegen, Netherlands
- 4BV.4.8 Solar Panel Design Aspects and Challenges for a Lunar Mission**  
M. Garg & N.S. Murthy  
Axiom Research Labs, Bangalore, India
- 4BV.4.9 Open and Close Loop Control of Solar Tracker Applied to Small Size HCPV System**  
L.E. Peñaranda Chenche, M. Barros de Almeida, R. Mendes Finzi Neto, O.S. Hernandez Mendoza & E. Pedone Bandarra Filho  
Federal University of Uberlândia, Brazil
- 4BV.4.10 Optimization of MBE Grown III-V Phosphide for Multijunction Solar Cells**  
A. Michaud & J. Fernandez Martin  
Total New Energies, Palaiseau, France  
T. Bideau, L. Largeau, J.-C. Harmand & S. Collin  
C2N, Marcoussis, France
- 4BV.4.11 On the Development of a Novel Triple-Stacked Solar Cell**  
S. Michael  
Naval Postgraduate School, Monterey, United States
- 4BV.4.12 Concentrator Solar Cells (up to 100 Suns) for Space Applications**  
M.B. Kagan, S.V. Pushko, N.T. Vagapova, E.V. Slystchenko, A.A. Naumova, M.A. Genali, B.V. Zhalnin, E.V. Obrucheva, S.K. Sharov & A.A. Lebedev  
OJSC RPE "KVANT", Moscow, Russia

## Wednesday, 26 September 2018

## VISUAL PRESENTATIONS 5CV.1

08:30 - 10:00 PV Module Design, Manufacture, Performance and Reliability

- 5CV.1.1 Influence of the Module Temperature on the Performance and EL-Image of Pre-cracked PV-Modules**  
C. Buerhop-Lutz, M. Krause, T. Winkler, J. Hauch & C. Camus  
ZAE Bayern, Erlangen, Germany  
C.J. Brabec  
FAU, Erlangen, Germany
- 5CV.1.2 Sequential Stress Test Methods to Predict Outdoor Performance of Monofacial and Bifacial Module Designs**  
W.J. Gambogi, T. Felder, S. MacMaster, K. Roy-Choudhury, B.-L. Yu & T.-J. Trout  
DuPont, Wilmington, United States  
A. Borne  
DuPont, Geneva, Switzerland  
H. Hu  
DuPont, Shanghai, China
- 5CV.1.3 The Influence of Module Structure on Degradation Modes of Multi-Crystalline Silicon Photovoltaic Modules by Dynamic Mechanical Loading Test**  
Y. Ino, S. Asao, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan
- 5CV.1.4 Temperature and Power Yield Difference of N-Mono Si Halved Cell Modules in Outdoor Shading Testing**  
J. Jiang, J. Ni, D. Rong, Y. Zhang, T. Feng, Y. Li, C. Ma, J. Shi & D. Song  
Yingli Green Energy, Baoding, China
- 5CV.1.5 Evaluation of Reliability and Field Performance of a Novel Shading-Free PV Module**  
T. Feng, J. Jiang, J. Ni, D. Rong, Y. Li, Y. He, C. Ma, J. Shi & D. Song  
Yingli Green Energy, Baoding, China
- 5CV.1.6 Early Potential Induced Degradation (PID) Detection in the Field: Cell Shunt Resistance Characterisation at Different Degradation Rates**  
M. Florides, G. Makrides & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus
- 5CV.1.7 Investigation and Analysis of Bifacial Photovoltaics Modules with Reflective Layer**  
E. Sng  
REC Solar, Singapore, Singapore  
C.X. Ang & I. Lim  
University of Glasgow, United Kingdom
- 5CV.1.8 Importance of Power Stabilization of Crystalline PV Modules**  
R. Ebner & G. Újvári  
AIT, Vienna, Austria  
W. Mühleisen & Ch. Hirschl  
CTR, Villach, Austria  
G.C. Eder & Y. Voronko  
OFI, Vienna, Austria  
F. Vollmaier  
PVP Photovoltaik, Wies, Austria



- 5CV.1.9 Architecture, Design and Simulation for a Shade Resilient Smart Module**  
S.Z. Mirbagheri Golroodbari, A.C. de Waal & W.G.J.H.M. van Sark  
Utrecht University, Netherlands
- 5CV.1.10 Resistance of PID Sensitive PV Modules to Alternating High Voltage Stress (A-HVS)**  
J. Arp  
PV Lab Germany, Potsdam, Germany  
B. Jaeckel  
UL International, Neu-Isenburg, Germany
- 5CV.1.11 Outdoor Performance Characterization of a Novel Shadow Tolerant Module**  
K. Sinapis & W. Folkerts  
SEAC, Eindhoven, Netherlands  
L.H. Slooff, L.A.G. Okel & M.J. Jansen  
ECN, Petten, Netherlands
- 5CV.1.12 Comparative Assessment of Anti-Soiling Nanocoated Photovoltaic Modules in an Arid Desert Environment**  
A. Alkandary, A.T. Al-Asfour & F.G. Alzubi  
KISR, Shuwaikh, Kuwait
- 5CV.1.13 Assessment of Technology- and Weather-Specific Temperature Losses of Various Photovoltaic Technologies**  
C. Camus, J. Bogenrieder & J. Hauch  
ZAE Bayern, Erlangen, Germany  
A. Adrian  
ISC Konstanz, Germany  
C.J. Brabec  
University of Erlangen-Nuremberg, Germany
- 5CV.1.14 Evaluation of PV and PV/T Systems under Various Cooling Conditions**  
M. Al-Damook, D.W. Dixon-Hardy, P.J. Heggs, S.W.O. Luhaib, J. Cottom & P. Mason  
University of Leeds, United Kingdom  
Z. Hussein Obaid  
University of Anbar, Iraq  
M. Al Qubeissi  
Coventry University, United Kingdom
- 5CV.1.15 Novel Computational Fluid Dynamics Modeling of Spatial Convective Heat Transfer over PV-Modules Mounted on an Inclined Surface with an Underlying Air Gap**  
M.G. Chowdhury, L. Somma, H. Goverde, I.T. Horvath, E. Voroshazi, J. Poortmans & F. Catthoor  
imec, Heverlee, Belgium  
D. Goossens  
KU Leuven, Belgium
- 5CV.1.16 The Study on the Anti-PID Performance of High Efficiency Bifacial Cell Module**  
X. Cai, Z. Ni, C. Chen, P. Ke, H. Chen, Q. Zhang & H. Cao  
Talesun Solar, Suzhou, China
- 5CV.1.17 Crystalline Silicon Photovoltaic Modules Degradation Mode in Different Climatic Zones in China**  
H. Song, P. Xu, Z. Wu, Y. Xia & M. Yun  
CPVT, Wuxi, China
- 5CV.1.18 Effect of Temperature in Potential Induced Degradation Recovery Process of PV Modules with the Application of Reverse Bias Pulse Voltage**  
H. Win, T. Kiroshiro, Y. Kawaguchi, G.S. Huai, A. Rahayu, F. Ohashi, H. Yoshida & S. Nonomura  
Gifu University, Japan  
Y. Hara & A. Masuda  
AIST, Tsukuba, Japan

- 5CV.1.19 Potential-Induced Degradation (PID) of n-Type and p-Type Silicon Solar Cells**  
M. Schwark & J. Slamberger  
AIT, Vienna, Austria
- 5CV.1.20 Field Performance Analysis of Bi-Facial Modules in South Africa**  
M. Basappa Ayanna, S. Miene, L. Pratt, K.T. Roro & S. Koopman  
CSIR, Pretoria, South Africa  
M. Diale  
University of Pretoria, South Africa
- 5CV.1.21 New Developments in Modeling and Numerical Simulations of Temperature and Yield of Commercial Photovoltaic Panels under Desert Environment**  
S. Ahzi, S.P. Aly, N. Barth, B.W. Figgis & A.A. Abdallah  
QEERI, Doha, Qatar
- 5CV.1.22 Study about Electrically Conductive Adhesives for the High Density Module with Shingled Array of Solar Cells**  
H. Jee, M. Park, K. Jeon & C. Jeong  
KITECH, Gwangju, Korea South
- 5CV.1.23 Reducing Uncertainty in Outdoors PV Module Characterisation**  
F. Martinez-Moreno, C.H. Rossa & E. Lorenzo  
UPM, Madrid, Spain
- 5CV.1.24 Towards Efficient and Accurate Energy Yield Modelling of Bifacial PV Systems**  
I.T. Horvath, P. Manganiello, H. Goverde, E. Voroshazi, F. Catthoor & J. Poortmans  
imec, Leuven, Belgium  
D.G. Anagnostos  
NTUA, Athens, Greece  
B. Aldalali  
Kuwait University, Khaldiya, Kuwait
- 5CV.1.25 BIPV Modules with Plated Bifacial n-PERT Cells and Smart Wire Interconnection: Manufacturing, Monitoring and Energy Yield Analysis**  
A.S.H. van der Heide, H. Goverde, L. Tous, R. Russell, E. Voroshazi & J. Poortmans  
imec, Leuven, Belgium  
K. Spiliotis, J. Lehmann, D. Saelens & J. Driesen  
KU Leuven, Heverlee, Belgium
- 5CV.1.26 Cell Temperature Model Using Relative Humidity as an Input Variable**  
M. Piliouge Rocha, J. Carretero & M. Sidrach-de-Cardona  
UMA, Malaga, Spain  
M. López-Salvatierra  
I.E.S. Zurbarán, Cáceres, Spain
- 5CV.1.27 Quantification of the Infra-Red Response of Various Cell Technologies on the Energy Yield**  
H. Goverde, J. Govaerts & I.T. Horvath  
imec, Genk, Belgium  
B. Aldalali  
Kuwait University, Khaldiya, Kuwait  
E. Voroshazi, J. Szlufcik, F. Catthoor & J. Poortmans  
imec, Leuven, Belgium
- 5CV.1.28 Adaptable PV Performance Modelling**  
S. Ransome  
Steve Ransome Consulting, Kingston upon Thames, United Kingdom  
J. Sutterlueti  
Gantner Instruments, Schruns, Austria



- 5CV.1.29 Investigation on the Quality of Adhesive Joints of Shingled Solar Cells by Accelerated Lifetime Testing**  
I. Ullmann, D. Rudolph, J. Rabanal-Arabach, A. Schneider & A. Halm  
ISC, Konstanz, Germany
- 5CV.1.30 IV Measurement of Bifacial PV Module Using Monofacial Illumination by Applying Dynamic Bifacialities**  
A.N.N. Alquannah & A.T. Al-Asfour  
KISR, Shuwaikh, Kuwait
- 5CV.1.31 Performance Simulations of a 72-Cell, a-Si HET Module with Different Tab-Interconnection Geometries**  
J. Eymard, B. Commault & F. Gérenton  
CEA, Le Bourget du Lac, France  
R. Clerc & M. Hebert  
University of Lyon, Saint-Etienne, France
- 5CV.1.32 Current-Voltage Characteristic Driven Yield Investigation of Bifacial Modules**  
D. Daßler, S. Malik, H. Hanifi, J. Fröbel & M. Ebert  
Fraunhofer CSP, Halle, Germany
- 5CV.1.33 Novel Power-Enhancing Ribbon for Solar Cell Interconnection**  
T. Zhou, M. König & A. Henning  
Heraeus, Hanau, Germany  
S. Hoffmann, L. Pitta Bauermann, E. Fokuhl, D. Eberlein, A. Kraft & U. Eitner  
Fraunhofer ISE, Freiburg, Germany
- 5CV.1.34 Super Lightweight Flexible HJT Solar Panels**  
A. Abramov, D. Andronikov, K. Emtsev, D. Orekhov, E.I. Terukov, E. Terukova & S. Yakovlev  
R&D Center TFTE, St. Petersburg, Russia  
S. Shakhray  
Hevel Solar, Moscow, Russia
- 5CV.1.35 Influence of Near Field Shadowing on the Performance Ratio at Thin Film Modules**  
S. Wendlandt & L. Podlowski  
PI Berlin, Germany
- 5CV.1.36 Energy Yield Comparison Between Bifacial and Monofacial PV Modules - Real World Measurements and Validation with Bifacial Simulations**  
J.N. Bonilla Castro, M. Herz, C. Monokroussos & M. Schweiger  
TÜV Rheinland Energy, Cologne, Germany
- 5CV.1.37 Techno-Commercial Performance Evaluation of 5 Different PV Technologies in Same Weather Conditions - A One Year Practical Case Study**  
R. Bohra, R.R. Gowda & M.R. Krishnan  
Infosys, Bangalore, India
- 5CV.1.38 The Performance of Different Module under Composite Test Conditions**  
M.-A. Tsai, K.-W. Lu, W.-L. Yang, S.-H. Chen, H.-S. Wu & T.-C. Wu  
ITRI, Hsinchu, Taiwan

**VISUAL PRESENTATIONS 6CV.2**

**13:30 - 15:00 Design and Installation of PV Systems**

- 6CV.2.1 Modeling of Lead Acid and Lithium Ion Batteries Used in PV System**  
N. Achaibou & B. Saoudi  
USTHB, Algiers, Algeria

- 6CV.2.2 Optimization of Solar Photovoltaic and Wind Hybrid Systems**  
R. Vardanyan & V. Dallakyan  
NPUA, Yerevan, Armenia
- 6CV.2.3 Quality Control of PV Modules at Origin: Essential Risk Mitigation Strategy for PV Developers**  
R.J. Gómez, F. Prieto, C. Acinas, L. Pérez & V. Parra  
Energis Solar, Alcobendas, Spain
- 6CV.2.4 Nonlinear Controller Design for Maximum Power Point Tracking in Photovoltaic Systems**  
H. Yatimi & E. Aroudam  
Abdelmalek Essaadi University, Tetouan, Morocco
- 6CV.2.5 Impact of Dynamic-Mechanical Load on PV Modules Mounted on Single-Axis Tracker**  
D. Stellbogen, P. Lechner, O. Schanz, S. Hummel & J. Schnepf  
ZSW, Stuttgart, Germany  
M. Kaiser  
Canadian Solar, Munich, Germany
- 6CV.2.6 Few Technological Enablers with Profound Impact on Very Large Photovoltaic Electric Power Plants**  
S. Salkalachen  
Indian Institute of Science Campus, Bangalore, India  
H.K. Nagarajan  
Metro Village, Tiruchirapalli, India
- 6CV.2.7 Technical Evaluation of a Stand-Alone PV Heat Pump System for Space Heating/Cooling Applications without Batteries**  
C. Lorenzo Navaro, L. Narvarde Fernández & F. Martinez-Moreno  
UPM, Madrid, Spain
- 6CV.2.8 1.2 GW PV Installation in Chernobyl Exclusion Zone – Revitalizing Radioactive-Contaminated Zone with Renewable Solar Energy Generation**  
C. Tjengdrawira, L. Botet, V. Lebrun, J. Dantine & T. Dewez  
Tractebel Engineering, Gennevilliers, France  
R. Cariou  
CEA, Grenoble, France
- 6CV.2.9 PV Systems Based on Bifacial Modules: The Factors That Influence the Bifacial Gain**  
S. Liu, Z. Wang, S. Zhang, Y. Tang & J. Lv  
LONGi Solar, Xi'an, China
- 6CV.2.10 Evaluation and Comparison of the Operational Aspects of Two Topologies for the Integration of Several Hybrid Renewable Energy Systems for Grid-Connected and Stand-Alone Applications**  
K. Novaes, A.R. Arrifano Manito, M. Pinho Almeida, G. Figueiredo, A.R. Mocelin, T.A. Flores Melendez & R. Zilles  
University of São Paulo, Brazil  
J. Tavares Pinho  
Federal University of Para, Belém, Brazil
- 6CV.2.11 Maximizing the Energy Output for Local Climate Conditions: Advanced Technology Selection and PV System Design Toolbox**  
E. Garcia Goma, R. Santbergen, H. Ziar, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands  
B. Prudon  
Waterschap Rivierenland, Tiel, Netherlands  
B. Roeffen  
Blue21, Delft, Netherlands  
H. van Laar  
Hakkers, Werkendam, Netherlands



- 6CV.2.12 Non-Uniformity on the Backside of a Bifacial Panel for Different Configurations Including Spectral Reflectivity**  
M. Vuylsteke, H. Goverde, I. Horvath, A.S.H. van der Heide, E. Voroshazi, J. Szlufcik & J. Poortmans  
imec, Genk, Belgium
- 6CV.2.13 Concept and Design of PV System for Harvesting Salt and Electricity at the Salt Farm Floor**  
C. Lim, C. Kim & S. Lee  
Green Energy Institute, Jeollanamdo, Korea South  
S.-M. Lee & B.-S. Kim  
KEPRI, Jeollanam-do, Korea South
- 6CV.2.14 Comparative Analysis of a Novel Low Concentration Dual Photovoltaic/Phase Change Material System with a Conventional Photovoltaic System**  
J. Sarwar, A.E. Abbas & K. Kakosimos  
UET, Lahore, Pakistan
- 6CV.2.15 An Empirical Techno-Commercial Assessment of Inverter DC Loading of Photovoltaic Assets in Asian Locations**  
A.M. Nobre, J. Tan, S. Karthik, R.S. Baker, R. Malhotra & A. Khor  
Cleantech Energy, Singapore, Singapore
- 6CV.2.17 High-Voltage Gain DC–DC Converter, Interleaved with Coupled Inductors for a PV System to Supply Data Centers**  
K. Lopes Dos Santos & F.L.M. Antunes  
UFC, Fortaleza, Brazil
- 6CV.2.18 Photovoltaic System Equipped with Flat Reflectors: New MPPT Model in Case of Non-Uniform Illumination on PV Modules**  
C. Abdel Nour, A. Migan Dubois & C. Marchand  
GeePs, Gif-sur-Yvette, France  
J. Badosa  
CNRS, Palaiseau, France  
V. Bourdin  
LIMSI, Orsay, France  
T. Akiki  
Holy Spirit University of Kaslik, Jounieh, Lebanon
- 6CV.2.19 Yield Simulations for Horizontal Axis Trackers with Bifacial PV Modules in PVsyst**  
B. Wittmer & A. Mermoud  
PVsyst, Satigny, Switzerland
- 6CV.2.20 Reduction of the Carbon Footprint Using Photovoltaic Energy on Irrigation Systems. Case Study on a Semi-arid Zone in the Southeast of Spain**  
J.P. Chazarra Zapata  
University Miguel Hernandez, Alicante, Spain  
R. Egea Pérez  
EMUASA, Murcia, Spain  
F.J. López Peñalver  
University of Alicante, Spain
- 6CV.2.21 Comparison between Central and String Inverters Performance for the Utility-Scale PV Plant in Nova Olinda Brazil**  
G. Nobile, M. Cacciato, G. Scarcella & G. Scelba  
University of Catania, Italy  
A.G.F. Di Stefano & F. Bizzarri  
ENEL, Catania, Italy

- 6CV.2.22 Sizing of Photovoltaic Systems for Self-Consumption in Commercial and Industrial Applications**  
T. Roessler  
Yingli Namene, Munich, Germany
- 6CV.2.23 PV Battery Systems Sizing to Account for the Provision of Ancillary Services under Different Scenarios for Energy Policies and Tariffs**  
A.R. Arrifano Manito, K. Novaes, M. Pinho Almeida, G. Figueiredo & R. Zilles  
USP, São Paulo, Brazil  
J. Tavares Pinho  
UFPA, Belém, Brazil
- 6CV.2.24 The Dutch Photovoltaic Portal 2.0**  
V. Schepel, A. Tozzi, P. Nepal, J.H. Castro Barreto, H. Ziar, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands
- 6CV.2.25 New Photovoltaic System Based on Solar Radiation Splitting Technology**  
M. Toneyzer, P. Bernardoni & D. Vincenzi  
University of Ferrara, Italy  
P. Decarli  
Trentino Rainbow Energy, Altopiano della Vigolana, Italy
- 6CV.2.26 Inflatable System for Ubiquitous Deployment of Organic Photovoltaics**  
A. Bernardi, G. Corso, R. Po, G. Giannotta & A. Cominetti  
eni, Novara, Italy
- 6CV.2.28 PHOTOPUR-PV-Powered Water Decontamination for Wine Growers**  
J. da Costa Fernandes, F. Ziebold, S. Lapp, M. Schmidt & E. Bollin  
University of Applied Sciences, Offenburg, Germany
- 6CV.2.29 Custom PV System Integration into High Performance Autonomous Heliostats for Optimal Thermo Solar Plants**  
J. Ulbikas, D. Horbacauskas & V. Ulbikaite  
Modern E-Technologies, Vilnius, Lithuania  
J. Doneliene & M. Rudzikas  
PROTECH, Vilnius, Lithuania  
M.A.C. Pérez  
Thermal Power Engineering, Madrid, Spain  
S. Bundgaard & J. Pelle  
Aalborg CSP, Denmark  
R.J. Serrano & I. Palomino  
Acciona Industrial, Alcobendas, Spain
- 6CV.2.30 Cloud Enhancement Phenomenon and Its Effect on PV Generators**  
M. Järvelä, K. Lappalainen & S. Valkealahti  
Tampere University of Technology, Finland
- 6CV.2.31 Dual-Axis Sun Tracking System Development Using Microcontroller ATmega 328 for Maximum Solar Energy Generation**  
H.S. Akbar, M.W. Aziz & O.O. Raouf  
University of Kirkuk, Iraq  
A.I. Siddiq & M.N. Fathulla  
Kirkuk Technical College, Iraq
- 6CV.2.32 New Approach for the Design of Large Scale Photovoltaic Plants Which Takes into Account the Integration of Project Data, Tools and Cost Analysis Through the Digitalization of the Processes**  
D. Guida, A. Sabene, W. Ferrara & M. Carbone  
ENEL Green Power, Rome, Italy



## VISUAL PRESENTATIONS 5CV.3

15:15 - 16:45 **PV Module Design, Manufacture, Performance and Reliability / Inverters and Balance of System Components / Sustainability and Recycling**

- 5CV.3.1 Reliability Investigation on Bifacial c-Si Photovoltaic Modules Using Multiple Sequential Tests**  
C. Lien, S.-Y. Ting, S.-H. Chen, K.-W. Lu, W.-L. Yang, C.F. Hsieh, H.-S. Wu & T.-C. Wu  
ITRI, Hsinchu, Taiwan
- 5CV.3.2 Study on Reliability of p-PERC and n-PERT Bifacial Modules**  
Y. Li, J. Ni, Y. Geng, Y. He, T. Feng, C. Ma, J. Shi & D. Song  
Yingli Green Energy, Baoding, China
- 5CV.3.3 PET- Versus Polyolefin-Based Backsheet: Comparison of Degradation Behavior**  
A. Omazic & G. Oreski  
PCCL, Leoben, Austria  
G.C. Eder  
OFI, Vienna, Austria  
C. Hirschl  
CTR, Villach, Austria  
M. Edler  
ISOVOLTAIC, Lebring, Austria  
G. Pinter  
University of Leoben, Austria  
M. Erceg  
University of Split, Croatia
- 5CV.3.4 Multi-Imaging of PV Module Inhomogeneities in 17 kW PV Power Plant and Mutual Correlations**  
M. Bokalic, K. Brecl & M. Topic  
University of Ljubljana, Slovenia
- 5CV.3.5 Enhancement of Reliability for Photovoltaic Modules by More Severe Test in Accordance with Particular Environment of Taiwan**  
C.-Y. Gao, C.-H. Lin & B.-C. Kuo  
TERTEC, Taoyuan, Taiwan  
C.-W. Huang, C.-H. Chen & Q.-R. Li  
BSMI, Taipei, Taiwan
- 5CV.3.6 Durasol - A French Multisite Platform for Assessing the Durability of Solar Material and Systems**  
J. Merten, B. Braisaz, O. Doucet & O. Raccurt  
CEA, Le Bourget du Lac, France  
D. Barakel  
IM2NP - CNRS, Marseille, France  
J.-L. Canaletti  
SPE University of Corsica, Ajaccio, France  
M. David  
University of la Réunion, St. Pierre, France  
F. Mezzasalma  
CEA, St-Paul-lez-Durance, France  
D. Nelias  
INSA Lyon, Villeurbanne, France

- 5CV.3.7 The Influence of the EVA Film Quality on the Degradation of PV Modules under Harsh Test Conditions**  
K. Brecl, M. Bokalic & M. Topic  
University of Ljubljana, Slovenia  
C. Barretta & G. Oreski  
PCCL, Leoben, Austria  
B. Malic  
Jozef Stefan Institute, Ljubljana, Slovenia
- 5CV.3.8 PV Module Glass Stress Testing**  
G. Mathiak, D. Grimm, L. Falk, L. Rimmelspacher, W. Herrmann & F. Reil  
TÜV Rheinland Energy, Cologne, Germany
- 5CV.3.9 Temperature Mapping of PV Modules**  
A.C. Besen, E. Arikan & M. Aldemir  
GTC, Adiyaman, Turkey
- 5CV.3.10 Development of Packaging Materials for Hot Spot Resistance PV Modules with High Efficiency**  
Y. Sun, J. Qi, Q. Zhu & C. Zhu  
LONGi Solar Technology, Taizhou, China
- 5CV.3.11 Determination of Moisture Ingress and Diffusion Path in Encapsulation Layers of Standard PV Modules**  
L. Neumaier, D. Holzmann, W. Mühleisen, J. Zikulnig & C. Hirschl  
CTR, Villach, Austria
- 5CV.3.12 Statement of Certified PV Module Registration and Policy in Taiwan**  
C.-C. Chou  
ITRI, Hsinchu, Taiwan
- 5CV.3.13 Characterization of Degraded Site in Crystalline Silicon Photovoltaic Cells Exposed to Acetic Acid Vapor**  
T. Tanahashi, N. Sakamoto, H. Shibata & A. Masuda  
AIST, Tsukuba, Japan
- 5CV.3.14 Review of Statistical and Analytical Degradation Models for PV Modules and Systems and Improvements**  
I. Kaaya & K.-A. Weiß  
Fraunhofer ISE, Freiburg, Germany  
S. Lindig & D. Moser  
EURAC, Bolzano, Italy
- 5CV.3.15 A Benchmark for Visual Identification of Defective Solar Cells in Electroluminescence Imagery**  
C. Buerhop-Lutz, J. Hauch & C. Camus  
ZAE Bayern, Erlangen, Germany  
S. Deitsch & F. Gailwitz  
Nuremberg Institute of Technology, Germany  
A. Maier & C.J. Brabec  
FAU, Erlangen, Germany
- 5CV.3.16 Single Diode Model Applied to PV Module Aging**  
N. Hrelja, M. Van Iseghem & E. Lajoie-Mazenc  
EDF R&D, Moret sur Loing, France  
E. Moulines  
Ecole Polytechnique, Palaiseau, France
- 5CV.3.17 Electroluminescence System for In Situ Characterization of PV Modules**  
M. Ezquer Mayo, A. Barrenetxea, J. Moracho, J. Díaz & A.R. Lagunas  
CENER, Sarriguren, Spain



- 5CV.3.18 Evaluation of Industrial Frameless Double Glass Silicon Cells Modules Using a Novel Accelerated Aging Test Procedure**  
J. Dupuis, E. Lajoie-Mazenc, F. Sicard & D. Binesti  
EDF R&D, Moret-sur-Loing, France  
S. Mousel & K. Radouane  
EDF EN, Paris La Defense, France
- 5CV.3.19 Anti-Reflective Properties of Reactive Ion Etched Glasses**  
E. Zugasti, J. Bengoechea, A. Turumbay, M. Murillo, M.J. Rodriguez & A.R. Lagunas  
CENER, Sarriguren, Spain
- 5CV.3.20 Digitalization in PV – Virtual Application of Real Weather Data on PV Modules for Lifetime Prediction**  
U. Zeller & M. Pander  
Fraunhofer CSP, Halle (Saale), Germany  
D. Daßler  
Anhalt University of Applied Sciences, Koethen, Germany
- 5CV.3.21 Development of Non-Destructive Methods for Acetic Acid Detection in Photovoltaic Modules**  
C. Barretta & G. Oreski  
PCCL, Leoben, Austria  
N. Kyranaki  
CREST, Loughborough, United Kingdom  
K. Resch-Fauster & G. Pinter  
University of Leoben, Austria
- 5CV.3.22 Wireless System for In-Situ Monitoring of Moisture Ingress in PV Modules**  
M. Jankovec, J. Slapšak & M. Topic  
University of Ljubljana, Slovenia
- 5CV.3.23 Scanning Acoustic Microscopy as a Non-Destructive Method for the Investigation of PV Module Components**  
L. Verissimo Mesquita, D.E. Mansour, L. Pitta Bauermann & D. Philipp  
Fraunhofer ISE, Freiburg, Germany
- 5CV.3.24 Using UV LEDs for PV Module Aging and Degradation Study**  
S. Mitterhofer, M. Jankovec & M. Topic  
University of Ljubljana, Slovenia
- 5CV.3.25 Degradation Analysis from Long-Term PV Module IV Curve Field Monitoring**  
D. Stellbogen, P. Lechner & O. Schanz  
ZSW, Stuttgart, Germany
- 5CV.3.26 Multi-Wire Interconnection: The Impact of the Lamination Process and Encapsulant Properties on Solder Joint Formation**  
R. Van Dyck & S. De Jonge  
KU Leuven, Belgium  
T. Borgers, J. Govaerts, A. van der Heide, E. Voroshazi, J. Szlufcik & J. Poortmans  
imec, Genk, Belgium  
P. Nivelle  
imomec, Diepenbeek, Belgium
- 5CV.3.27 Analysis and Development of Transport Phenomena Models for PV Modules**  
L. Castillon & G. Oreski  
PCCL, Leoben, Austria  
G. Pinter  
University of Leoben, Austria

- 5CV.3.28 Nanoindentation Analysis of the Encapsulant in a PV Module after Accelerated Aging**  
D.E. Mansour, I. Kaaya, D. Philipp & L. Pitta Bauermann  
Fraunhofer ISE, Freiburg, Germany  
S.-S. Tuca  
Keysight Technologies, Böblingen, Germany
- 5CV.3.29 DaySy Photoluminescence Measures the Shunt Resistance in Installed PV Modules**  
L. Stoicescu & M. Reuter  
Solarzentrum Stuttgart, Germany
- 5CV.3.30 Investigating the Effect of Soiling on the Power Production of PV Panels Exposed to Wind: Wind Tunnel Approach**  
R. Lundholm, H. Goverde, J. Poortmans, G. Chowdhury & J. Govaerts  
imec, Leuven, Belgium  
D. Goossens  
KU Leuven, Heverlee, Belgium
- 5CV.3.31 Automatic Quantitative Analysis of Silicon Solar Panels Based on Statistical Parameters from Electro- and Photoluminescence Images**  
M. Guada, S. Pena, O. Martínez, M.A. González & J. Jiménez  
UVa, Valladolid, Spain  
L. Pérez  
Enertis Solar, Madrid, Spain
- 5CV.3.32 Long Term Performance Evaluation of PV Module Backsheets: Module Accelerated Sequential Testing (MAST)**  
A. Sinha, S. Tatapudi & G. Tamizhmani  
Arizona State University, Mesa, United States  
W.J. Gambogi, T.J. Trout & K. Roy-Choudhury  
DuPont, Wilmington, United States
- 5CV.3.33 Degradation Analysis of m-Si Photovoltaic Modules for Early Life Defects Observed in Harsh Climate of Morocco**  
A. Bouaichi, A. Alami Merrouni, B. Ikken, A. Ghennioui, H. Zitouni, C. Hajjaj & A. Benlarabi  
IRESEN, Rabat, Morocco  
C. Messaoudi & A. El Amranil  
OATE, Errachidia, Morocco
- 5CV.3.34 Cell to Module Gains for Back Contact Module Technology**  
N. Guillevin, B.K. Newman, E.E. Bende, L.A.G. Okel, M.J. Jansen & N.J.J. Dekker  
ECN, Petten, Netherlands  
J. Ortiz Gonzalez & W. Eerenstein  
Exasun, The Hague, Netherlands
- 5CV.3.35 Proposing an Electro-Thermal SPICE Model to Investigate the Effect of Partial Shading on CIGS PV Modules**  
J. Carolus, Z. Purohit, T. Vandenbergh, M. Meuris & M. Daenen  
Hasselt University, Belgium  
B. Tripathi  
PDP, Gujarat, India
- 5CV.3.36 Overview of the “Darkbus” Defect: Causes, Consequences and Solutions**  
B. Braisaz, L. Sicot, V. Barth, H. Robin, M. Vite, W. Favre & P.-J. Ribeyron  
CEA, Le Bourget du Lac, France  
F. Rametta, L. Todaro, A. Canino, A. Ragonesi, M. Sciuto & A. Battaglia  
3SUN, Catania, Italy  
C. Gerardi  
ENEL Green Power, Rome, Italy





- 5CV.3.37 Selection Map for PV Module Installation Based on Shading Tolerability and Temperature Coefficient**  
H. Ziar, S. Mishra, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands
- 5CV.3.38 Avanced Testing of PV Module Encapsulants**  
S. Pingel, S. Fechner, S. Janke & L. Podlowski  
PI Berlin, Germany  
B. Stannowski  
HZB, Berlin, Germany
- 5CV.3.39 Current Collection Efficiency Mapping of Solar Modules in Daylight**  
A. Gerber, V. Huhn, B.E. Pieters & U. Rau  
Forschungszentrum Jülich, Germany
- 5CV.3.40 Multi-Scale Mechanical Model for Photovoltaic Module Reliability**  
P. Nivelle, J. D'Haen, W. De Ceuninck & M. Daenen  
Hasselt University, Belgium  
T. Borgers, J. Govaerts, E. Voroshazi & J. Poortmans  
imec, Genk, Belgium
- 5CV.3.41 Scaling up Laser Line Photoluminescence Imaging for Outdoor Inspections**  
G.A. dos Reis Benatto, M. Chi, N. Riedel, A.A. Santamaria Lancia, O. Bjarlin Jensen, S. Thorsteinsson & P.B. Poulsen  
Technical University of Denmark, Roskilde, Denmark
- 5CV.3.42 Key Performance Indicators and PV Module Reliability**  
G. Kleiss  
Kleiss Consulting, Bonn, Germany
- 5CV.3.43 Assessments for Distance through Insulation (DTI) of PV Encapsulant/ Backsheet Materials**  
H.-H. Hsieh, W.-H. Wang, M.-T. Kuan & C.-C. Wang  
ITRI, Hsinchu, Taiwan
- 5CV.3.44 Transient Effects and Internal Series Resistance Calculation on Bifacial Silicon PV Modules**  
J. Lopez-Garcia, D. Pavanello & T. Sample  
European Commission JRC, Ispra, Italy
- 5CV.3.45 Development of Conductive Back-Sheet for Manufacture of PV Modules with Back-Contact Cells**  
I.J. Bennett  
DSM Innovation, Geleen, Netherlands
- 5CV.3.46 Performance of Various Polymeric PV Backsheet Designs in Different UV Tests**  
J. Jung  
Agfa Gevaert, Mortsels, Belgium  
S. Suga  
Suga Test Instruments, Tokyo, Japan
- 5CV.3.47 Investigating the Degradations of Front and Back Sides of c-Si PV Cells that Exposed in Acetic Acid**  
N. Kyranaki  
CREST, Loughborough, United Kingdom  
J. Zhu & T.R. Betts  
Loughborough University, United Kingdom  
R. Gottschalg  
Fraunhofer CSP, Halle, Germany

- 5CV.3.48 PV Modules Inspection through Photoluminescence in Daylight Conditions**  
L.J. San José, R. Herrero Martín & I. Antón Hernández  
UPM, Madrid, Spain
- 5CV.3.54 Accreditation for the PV Inverter Test Bench of the PV Laboratory**  
U. Muntwyler, A. Werder, L. Borgna, D. Gfeller & E. Schuepbach  
BUAS, Burgdorf, Switzerland
- 5CV.3.55 Development of a Multichannel Data Logger for the Measurement of Microclimatic Parameters within Enclosures of (Externally Mounted) PV-Inverters**  
J. Zikulnig, L. Neumaier, W. Mühleisen, C. Hirschl & D. Holzmann  
CTR, Villach, Austria  
H. Heigl  
Fronius, Thalheim, Austria
- 5CV.3.56 Reliable-Thermal Design Smart Converters for NZEB Application**  
G. Graditi, G. Adinolfi, R. Ciavarella & V. Palladino  
ENEA, Portici, Italy
- 5CV.3.57 Substring-MPPT for 4 Terminal 3-Substring Modules**  
R. Brace, A. Neumann, T. Czarnecki & R. Merz  
University of Applied Sciences, Karlsruhe, Germany
- 5CV.3.58 Effectiveness of Various MPPT Controllers in Photovoltaic Systems**  
Y. Rais, A. Zakriti, A. Khamlichi & A. Asselman  
ENSA, Tetouan, Morocco
- 5CV.3.59 Modelling the Probability to Fail for PV Systems at Specific Locations due to the Impact of Cosmic Rays**  
M. Halwachs, M. Schwark, K.A. Berger & R. Ebner  
AIT, Vienna, Austria
- 5CV.3.60 New PV System Concept – Inductive Power Transfer for PV Modules**  
F. Carigiet, R. Knecht & F.P. Baumgartner  
ZHAW, Winterthur, Switzerland  
C.J. Brabec  
FAU, Erlangen, Germany
- 5CV.3.61 A Comparative Study on the Durability of Metallic Coated Profiles as Structural Elements Used in PV Solar Energy Fields**  
P. Verpoort, B. Corlu & J. De Strycker  
ArcelorMittal, Zelzate, Belgium  
C. Dieu  
ArcelorMittal, Flémalle, Belgium
- 5CV.3.62 Technical and Economic Comparative Study of DC Cables Operated in Solar PV Farms in Iran**  
I. Kazemi  
Islamic Azad University, Damavand, Iran  
M. Zandi & N. Aboufazeli  
Shahid Beheshti University, Tehran, Iran
- 5CV.3.68 Life Cycle Assessment of Perovskite Solar Cells in Single and Tandem Configuration**  
J.C. Gomez Trillos, U. Brand, S. Peterhammer & T. Vogt  
DLR, Oldenburg, Germany
- 5CV.3.69 An Assessment of a Photovoltaic Plant in Tehran (Iran): Life-Cycle Approach**  
A. Bakhtiari, S. Eslami, H. Akhbari & Y. Gholami  
Shahid Beheshti University, Tehran, Iran





- 5CV.3.70 A Strategy for 2nd Life c-Si-PV-Panels Based on Failure Assessment of Scrap PV-Modules**  
U. Ricklefs, H. Weigand, E.A. Stadlbauer, J. Glatthaar, E. Kamdje, J. Barnikel, R. Gissel & J. Henkel  
THM, Giessen, Germany  
M. Dax  
Ruehl Solar, Lohra Kirchvers, Germany  
V. Schaub  
AWLD, Aslar, Germany  
H.G. Stevens  
SM-innotech, Bocholt, Germany  
B. Jehle  
ZME, Heuchelheim, Germany
- 5CV.3.71 Study about Silicon Material - Received from EOL-PV Waste and Intended as Secondary Raw Material**  
W. Palitzsch & S. Rudolph  
Loser Chemie, Zwickau, Germany  
I. Röver  
FRESITEC, Freiberg, Germany
- 5CV.3.72 Earth First! Greening the PV Industry with an Universal PV-Module Recycling Concept!**  
W. Palitzsch  
Loser Chemie, Zwickau, Germany  
U. Loser  
GERAU, Grunau, Germany
- 5CV.3.73 Indium, Silicon and Silver from PV Waste for New Photovoltaics and Other Applications - Latest News from CABRISS (EU Collaborative Project)**  
W. Palitzsch, P. Schönherr & A. Killenberg  
Loser Chemie, Zwickau, Germany
- 5CV.3.74 Planning and Optimizing the PV Material Life Cycle - Case Study Switzerland**  
U. Muntwyler & E. Schuepbach  
BUAS, Burgdorf, Switzerland  
R. Eppenberger  
SENS, Zurich, Switzerland

**VISUAL PRESENTATIONS 1CV.4**

**17:00 - 18:30 Fundamental Studies / New Materials and Concepts for Photovoltaic Devices**

- 1CV.4.1 Modeling of the Outdoor Operating Temperature of Polycrystalline Photovoltaic Module. Case Study: Harsh Climatic Conditions of Benguerir City, Morocco**  
C. Hajjaj, A. Alami Merrouni, A. Ghennioui, H. Zitouni, A. Bouaichi, B. Ikken & A. Benlarabi  
IRESEN, Rabat, Morocco  
M. Benhmida & S. Sahnoun  
University of Chouaib Doukkali, El Jadida, Morocco
- 1CV.4.2 Approach for Simulating Outputs of PV Module/Array of Different Technologies with High Accuracy**  
S. Kichou & P. Wolf  
CTU, Bustehrad, Czech Republic
- 1CV.4.3 Comprehensive Approach to Accurate Albedo Modelling and Simulation for Solar Engineering Applications**  
H. Ziar, F. Fatih Sönmez, O. Isabella & M. Zeman  
Delft University of Technology, Netherlands

- 1CV.4.4 Multi-Property Solar Cell Device Optimization and Its Application for Alternative Charge Transport Materials and Contacts**  
A.A.B. Baloch & F. El-Mellouhi  
QEERI, Doha, Qatar  
N. Tabet & F.H. Alharbi  
HBKU, Doha, Qatar
- 1CV.4.5 SLALOM: Open-Source, Portable and Easy-to-Use Solar Cell Optimizer. Application to the Design of InGaN and CZTS Solar Cells**  
S. Ould Saad Hamady & N. Fressengeas  
Université de Lorraine, Metz, France
- 1CV.4.6 A Planar Indium-Tin-Oxide Thermophotovoltaic Emitter with High-Temperature Verification**  
D.-H. Wu & Y.-B. Chen  
NTHU, Hsinchu, Taiwan  
P. Parashar, H.-M. Chou, Y.-S. Lin, Y.-C. Lai, P. Yu & A. Lin  
NCTU, Hsinchu, Taiwan
- 1CV.4.7 Rapid Calculation of the Backsheet Coupling Gain Using Ray Groups**  
A. Pfreundt, M. Mittag, M. Heinrich & U. Eitner  
Fraunhofer ISE, Freiburg, Germany
- 1CV.4.8 Generalized Reciprocity Relation in p-i-n Junction Solar Cells**  
K. Toprasertpong, A. Delamarre, K. Watanabe, Y. Nakano & M. Sugiyama  
University of Tokyo, Japan  
J.F. Guillemoles  
CNRS, Chatou, France
- 1CV.4.9 Simulation of Some Effects of Grain Boundaries in Solar Cells**  
T.O. Saetre  
University of Agder, Grimstad, Norway
- 1CV.4.10 Nanostructured Photocathodes with Enhanced Photocurrent via Carrier Multiplication by Inexpensive Dye Sensitization**  
P. Marathe, R.K. Pati, I. Mukhopadhyay & A. Ray  
PDP University, Gandhinagar, India  
S. Kawasaki  
Nagoya Institute of Technology, Japan
- 1CV.4.11 Electronic Transport and Optical Properties of 2D Layered Lead-Iodide Perovskites**  
G.R. Berdiyrov & M. El-Amine Madjet  
QEERI, Doha, Qatar
- 1CV.4.12 Smart Stress Sensing and Smart Fracture Probing - Enabling Thinner, but More Robust and Reliable, Silicon Solar Cells for Next Generation Solar PV Systems**  
A.S. Budiman, S.K. Tippabhottla & I. Radchenko  
SUTD, Singapore, Singapore  
N. Tamura  
ALS, Berkeley, United States
- 1CV.4.13 Evaluating the Potential of Optical Materials as Solar Cell Absorbers**  
B. Dzurak  
CTU, Prague, Czech Republic  
L. Danos  
Lancaster University, United Kingdom  
T. Markvart  
University of Southampton, United Kingdom



- 1CV.4.14 Surface Defect Spectroscopy of Transparent Conductive Oxides**  
E. Horynova & R. Nevyhosteny  
CTU, Prague, Czech Republic  
N. Neykova, Y.Y. Chang & J. Holovsky  
ASCR, Prague, Czech Republic
- 1CV.4.15 Multiphysics Modeling and Optimization of the Induction Heating Process for Germanium Crystal Growth**  
D. Ouadjaout  
CRTSE, Algiers, Algeria  
N. Derguini  
CDTA, Algiers, Algeria
- 1CV.4.16 Quantifying Radiative and Non-Radiative Carrier Lifetime of Solar Cells by Combined Optical and Electrical Characterisation**  
V. Tsai, M. Bliss, T.R. Betts & R. Gottschalg  
Loughborough University, United Kingdom
- 1CV.4.17 Improved Photo-Electrochemical Properties of Strained SnO<sub>2</sub>**  
Z. Kerrami, A. Sibari & M. Benaissaa  
University Mohammed V-Agdal, Rabat, Morocco  
O. Mounkachi & A. Benyoussef  
MASclR, Rabat, Morocco
- 1CV.4.18 Enhanced Electrical and Optical Properties of Zinc Oxide Ultrathin Film Using Graphene Sheet for Solar Cell Application**  
A.F. Abdelaal, M.K. Hossain, A. Ibrahim, B. Salhi & T. Laoui  
KFUPM, Dhahran, Saudi Arabia
- 1CV.4.19 Enhanced Performance of a Graphene/n-GaAs Schottky Barrier Solar Cell by Means of a AlGaAs/GaAs Thin Multi-Quantum Well Layer**  
A.C. Varonides  
University of Scranton, United States
- 1CV.4.25 High-Throughput Search for Tandem-Cell Materials**  
R. Kormath Raghupathy, H. Wiebeler, T.D. Kühne & S.H. Mirhosseini  
University of Paderborn, Germany
- 1CV.4.26 Optimal Band Gap Energies for Two-Step Photon Up-Conversion Solar Cells with Partial Absorptivity**  
Y. Harada, T. Matsuo, S. Asahi & T. Kita  
Kobe University, Japan
- 1CV.4.27 Interfacial Buffer Layer for the Integration in CNT/a-Si Hybrid Thin Films Solar Cells**  
H. Meddeb, O.V. Sergeev, M. Vehse & C. Agert  
DLR, Oldenburg, Germany  
P.M. Rajanna & A.G. Nasibulin  
Skoltech, Moscow, Russia
- 1CV.4.28 Fabrication of Ultra-Smooth and Stable Perovskite Films Using an Aqueous Solvent under Ambient Condition**  
H. Ait Dads, L. Nkhaili, A. El Kissani, H. El Aakib, M. Chaik, M. Ait Ali & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco  
Y. Jouane  
University of Limoges, France
- 1CV.4.29 Advanced Silver Paste Formulation for High Efficiency Silicon Solar Cells**  
C. Yüce, C. Xu & N. Willenbacher  
Karlsruhe Institute of Technology, Germany  
M. König  
Heraeus, Hanau, Germany

- 1CV.4.30 Rare Earth Doped Compounds for Enhancing the Efficiency of Silicon BICPV via Spectral Conversion**  
J. Day, T.K. Mallick & S. Sundaram  
University of Exeter, Penryn, United Kingdom
- 1CV.4.31 Thick Films of CY:PMMA as a Luminescent Solar Concentrator for Photovoltaic Windows**  
M. Jobin & C. Ruiz Diaz  
HES-SO, Geneva, Switzerland
- 1CV.4.32 Efficient Light Collection via Dielectric Nanoparticles in Ultrathin Cu(In,Ga)Se<sub>2</sub> Solar Cells and Modules**  
M. Schmid  
University of Duisburg-Essen, Germany  
P. Manley & G. Yin  
HZB, Berlin, Germany
- 1CV.4.33 Application of Reduced Graphene Oxide (rGO) on a-Si: H Solar Cell for Performance Enhancement**  
A. Nandi, S. Ghosh, S. Majumdar, S.M. Hossain & H. Saha  
IEST Shibpur, Howrah, India  
S. Mandal  
IIT Delhi, New Delhi, India
- 1CV.4.34 Optical and Structural Properties of RF-Sputtered ZnS:Cr Thin Films**  
C.M. Samba Vall, M. Chaik, H. El Aakib, M. Elyaagoubi & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco  
M. Aggour  
Ibn Tofail University, Kenitra, Morocco
- 1CV.4.35 Improvement the Efficiency of Solar Cell a-Based on GaAsNsb/Si**  
A. Aissat & S. Nacer  
University of Blida, Algeria  
J.-P. Vilcot  
IEMN, Villeneuve of Ascq, France
- 1CV.4.36 Synthesis, Structural and Photo Physical Properties of Perovskite Oxide (KNbO<sub>3</sub>)<sub>1-x</sub>-(La<sub>2</sub>NiMnO<sub>6</sub>)<sub>x</sub> for Photovoltaic Application**  
M.S. Sheikh, A. Dutta, T.K. Bhowmik & T.P. Sinha  
Bose Institute, Kolkata, India  
S.K. Ghosh & S.K. Rout  
Birla Institute of Technology, Ranchi, India
- 1CV.4.37 Silicon Nanowire for Solar Energy Application**  
B. Salhi, M.K. Hossain & F. Al-Sulaiman  
KFUPM, Dhahran, Saudi Arabia
- 1CV.4.38 Optimization of Technology for Creation of Composite Antireflection Coatings for Silicon Solar Cells**  
S.X. Suleymanov, V.G. Dyskin, M.U. Djanklich, N.A. Kulagina & O.A. Dudko  
Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan
- 1CV.4.39 Effects of ZnO Ratios on Structural and Optical Properties of SnO<sub>2</sub> Thin Films**  
M.A. Benali & H. Tabet-Derraz  
Djillali Liabes University, Sidi Bel Abbes, Algeria
- 1CV.4.41 Effect of Annealing Process on Crystalline Silicon Solar Cells with Down-Conversion SiNx::Tb<sup>3+</sup> - Yb<sup>3+</sup> Films**  
Y.-C. Lee, S.-C. Wu & I.-S. Yu  
NDHU, Hualien, Taiwan  
L. Dumont, J. Cardin, C. Labbe & F. Gourbilleau  
CIMAP, Caen, France



- 1CV.4.42 Characterization of a Novel Photovoltaic Backsheet Based on Polyamide-Ionomer Alloy Technology**  
C. Thellen, A. Rothacker, R. Davis & D. Santoleri  
Tomark-Worthen, Nashua, United States
- 1CV.4.43 Novel (ZnSe)<sub>0.1</sub>(SnSe)<sub>0.9</sub> Absorber for Use in Thin-Film Solar Cells**  
T.M. Razykov, B. Ergashev, K.M. Kouchkarov, A.A. Mavlonov & R. Yuldoshov  
Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan  
A. Bosio & N. Romeo  
University of Parma, Italy  
E. Artegianni & A. Romeo  
University of Verona, Italy
- 1CV.4.44 Thermal Modelling of Hybrid Photovoltaic-Thermoelectric-Flat Plate Water Collector**  
A. Tiwari  
Qassim University, Buraidah, Saudi Arabia
- 1CV.4.45 Effect of Co and Cr Doping on the Optical Band Gap of ZnTe**  
M. Chaik, H. El Aakib, C. Sambeval, M. Elyaagoubi & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco
- 1CV.4.46 Differential Bandgap Solar Cell Proposal and Analysis**  
A. Place  
Caltech, Princeton, United States
- 1CV.4.47 Stable Nanoscale Inorganic Bulk pn Homo Junctions for Solar Cells**  
S. Menezes  
InterPhases Solar, Moorpark, United States  
A. Samantilleke  
University of Minho, Braga, Portugal
- 1CV.4.48 Precursor Compositions Effect on the Photovoltaic Performance of Non-Vacuum Proceed CuSbS<sub>2</sub> Solar Cells and Its Defect Properties**  
S. Banu, Y. Cho & A. Cho  
KIER, Daejeon, Korea South
- 1CV.4.49 Solder Joint Analysis of Tin-Lead and Bismuth Based Lead Free PV Ribbons in High Throughput Manufacturing**  
N.S. Pujari, J. Sundaramurthy & S. Sarkar  
Alpha Assembly Solutions, Bangalore, India  
M. Murphy & C. Bilgrien  
Alpha Assembly Solution, New Jersey, United States
- 1CV.4.50 The Research of the Al<sub>2</sub>O<sub>3</sub> Passivation Layer in Sb<sub>2</sub>Se<sub>3</sub> Thin Film Solar Cells**  
C. Ma, H. Guo, X. Guo, K. Zhang, N. Yuan & J. Ding  
Changzhou University, China
- 1CV.4.51 Nanosphere Colloidal Coating for Improvement of Solar Cell Efficiency**  
N. Seyedpour Esmaeilzad, I.M. Öztürk, M. Zolfaghariborra & A. Bek  
METU, Ankara, Turkey
- 1CV.4.52 Spectrally Selective Solar Cells for Simultaneous Use of Photosynthesis and Photovoltaics**  
N. Osterthun, V. Steenhoff, N. Neugebohm, K. Gehrke, M. Vehse & C. Agert  
DLR, Oldenburg, Germany
- 1CV.4.53 Electron Selective La:BaSnO<sub>3</sub> Thin Films via Pulsed Laser Deposition – Effect of Deposition Pressure**  
A. Kumar, A.K. Singh & K.R. Balasubramaniam  
IIT Bombay, Mumbai, India

- 1CV.4.54 Studying Transition Metal Doped In<sub>2</sub>S<sub>3</sub> by Means of Hybrid Density-Functional Theory**  
K. Albe & E. Ghorbani  
Technical University, Darmstadt, Germany
- 1CV.4.55 Optical and Compositional Properties of ALD Grown TiO<sub>x</sub>**  
O. Akdemir, H. Nasser, M. Zolfaghariborra, E. Aygün, R. Turan & A. Bek  
METU, Ankara, Turkey
- 1CV.4.56 Design Limitations and Opportunities for Using CIGS Flexible Solar Cell Technology to Create Integrated Plastic and Composite Photovoltaic Products**  
S. Kristensen, M.H.B. Driesser, H. de Moor & E. Geldof  
Avans University Applied Science, 's-Hertogenbosch, Netherlands
- 1CV.4.57 Reliability of Electrically Conductive Adhesives**  
G. Oreski, S. Pötzt & A. Omazic  
PCCL, Leoben, Austria  
G.C. Eder  
OFI, Vienna, Austria  
L. Neumaier & C. Hirschl  
CTR, Villach, Austria  
R. Ebner  
AIT, Vienna, Austria  
J. Scheurer  
Polytec PT, Karlsbad, Germany  
W. Pranger  
Ulbrich of Austria, Müllendorf, Austria
- 1CV.4.58 Hole Transport Transparent Conductive Oxide: Towards Dopant Free Si-Based Solar Cells**  
O. Akdemir, H. Nasser, M. Zolfaghariborra, R. Turan & A. Bek  
METU, Ankara, Turkey
- 1CV.4.59 Sputter-Deposited CuGaO<sub>2</sub> as a Hole Conductor for Transparent Recombination Junctions for Methylammonium-Pb-Halide Tandem Solar Cells**  
R. Wenisch, Y. Wang & I. Laueremann  
HZB, Berlin, Germany
- 1CV.4.60 Evaluation of Different Module Designs and Determination of Different Physical Loss Mechanisms by Means of a Practical Multi-Physic Model**  
H. Hanifi & J. Schneider  
Fraunhofer CSP, Halle (Saale), Germany
- 1CV.4.61 Intrinsic Stability Enhancement and Ionic Migration Mitigation by Fluorinated Cations Incorporation in Hybrid Lead Halide Perovskites**  
F. El-Mellouhi, S.N. Rashkeev, A. Belaidi, B. Merzougui, N. Tabet & F.H. Alharbi  
QEERI, Doha, Qatar
- 1CV.4.62 Influence of Ni Doping on the Optical and Structural Properties of CuO Thin Films Deposited by RF Sputtering**  
H. El Aakib & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco  
J.F. Pierson  
University of Lorraine, Nancy, France
- 1CV.4.63 CsSnI<sub>3</sub>-xCl<sub>x</sub> Based Metal Halide for the Near IR Absorption Perovskite Solar Cells**  
M.-H. Jung  
Sejong University, Seoul, Korea South
- 1CV.4.64 Using White Encapsulants in PV Modules**  
M. Li & C. Quan  
HIUV, Shanghai, China



- 1CV.4.65 Coating Paper with Paper. A Planarization Strategy towards Efficient Silicon Thin Film Solar Cells to Power Optoelectronic Devices**  
M.P. Ferreira, A.T. Vicente, T. Mateus, M.J. Mendes, S. Zakir, H. Águas, E. Fortunato & R. Martins  
New University of Lisbon, Caparica, Portugal
- 1CV.4.66 Metal Oxide Layers for All Transparent Photovoltaics**  
J. Kim, M. Patel & H.-S. Kim  
Incheon National University, Korea South
- 1CV.4.67 Highly Loaded PbS/CdS Quantum Dots for Application in Solar-to-Electrical and Solar-to-Chemical Energy Conversion**  
J.-Y. Kim  
Hoseo University, Asan, Korea South
- 1CV.4.68 Fabrication of Sb<sub>2</sub>S<sub>3</sub> Planar Thin Film Solar Cell with Vapor Transport Deposition Method**  
Y. Zeng, F. Liu, M.A. Green & X. Hao  
UNSW Australia, Sydney, Australia
- 1CV.4.69 Si with Self Organized Quasiperiodical Microrelief for Plasmonic Solar Cells**  
S.V. Mamykin, A.V. Korovin, N.V. Kotova, T.R. Barlas, O.S. Kondratenko, I.B. Mamontova & V.R. Romanyuk  
NAS, Kiev, Ukraine
- 1CV.4.70 Application of Taguchi Approach to Optimize the Spray Pyrolysis Process of the Quaternary CuIn<sub>x</sub>Ga(1-x)(Se,S)<sub>2</sub> with Good Optical Properties**  
A. Bouich  
University of Hassan II, Casablanca, Morocco  
B. Hartiti & M. Ebn Touhami  
Ibn Tofail University, Kenitra, Morocco  
D.M.F. Santos  
IST-ULisboa, Lisbon, Portugal
- 1CV.4.71 Energy Yield Modelling of Intermediate Reflectors in Perovskite-Silicon Photovoltaic Tandem Modules**  
M. Langenhorst, R. Schmager, J. Lehr, U. Lemmer, B.S. Richards & U.W. Paetzold  
Karlsruhe Institute of Technology, Germany
- 1CV.4.72 Electronic Properties of Twist-Angle Interlayer of WSe<sub>2</sub>/MoSe<sub>2</sub> Heterostructure**  
N.D. Cong, C.W. Seok, I. Akhtar, M.A. Rehman & Y. Seo  
Sejong University, Seoul, Korea South
- 1CV.4.73 Delamination of Thin-Film Photovoltaics: An Innovative Approach to High Specific Power**  
D.L. McGott, M.D. Kempe, S. Glynn, N. Bosco, T.M. Barnes, N.M. Haegel & M.O. Reese  
NREL, Golden, United States  
C.A. Wolden  
Colorado School of Mines, Golden, United States
- 1CV.4.74 ZnO Based Nanostructures Fabricating by Chemical Bath Deposition for Dye-Sensitized Solar Cell Application**  
C. Li & Q. Zhang  
Kochi University of Technology, Kami, Japan
- 1CV.4.75 Innovative Solar Spectral Beam Splitting Concepts: Cogeneration and Photochemistry**  
G. Mittelman, H. Vitoshkin & B. Lew  
Agricultural Research Organization, Rishon Lezion, Israel  
H. Mamane & A. Kribus  
Tel Aviv University, Israel

- 1CV.4.76 Ultra-Fast Plasmonic Ag NPs Production for Light Trapping in Thin Si Solar Cells**  
A. Araújo Cardoso, M.J. Mendes, T. Mateus, J. Costa, D. Nunes, E. Fortunato, H. Águas & R. Martins  
New University of Lisbon, Caparica, Portugal
- 1CV.4.77 Carbon Nanotubes Thermoelectric Paste for Enhancing the Solar Cells Efficiency under High Temperature Conditions**  
S. Abdelatif & H. Ghali  
The British University in Egypt, Cairo, Egypt



Thursday, 27 September 2018

## VISUAL PRESENTATIONS 6DV.1

13:30 - 15:00 Operation, Performance and Maintenance of PV Systems

- 6DV.1.1** **Effect of Dust on Solar Photovoltaic Modules in Shiraz**  
S.A. Bahreini & M. Yaghoubi  
Shiraz University, Iran
- 6DV.1.2** **Effect of Dust Deposition on Photovoltaic System Performance of Various Tilt Angle in Residential Area of Shiraz/Iran**  
A. Khodakaram-Tafti & M. Yaghoubi  
Shiraz University, Iran
- 6DV.1.3** **Effect of Dusting from Industrial Zone on Photovoltaic**  
J. Vanek, M. Sturm, J. Hlysky & D. Strachala  
Brno University of Technology, Czech Republic  
E. Koopman Ovando  
USP, Sao Paulo, Brazil
- 6DV.1.4** **Local and Inter-Annual Variability in PV Soiling Rate**  
M. Gostein & B. Stueve  
Atonometrics, Austin, United States  
K. Passow  
First Solar, San Francisco, United States
- 6DV.1.5** **Modeling of the Influence of Dust Soiling on PV Panels for Desert Applications: The Example of the Solar Test Facility at Doha – Qatar**  
N. Barth, B.W. Figgis, A.A. Abdallah, S.P. Aly & S. Ahzi  
QEERI, Doha, Qatar
- 6DV.1.6** **Analysing the Effect of Snow on the PV Regulator Response in a Simple PV System**  
J. Solis & S. Hamanee  
Karlstad University, Sweden  
M. Nilsson  
Glava Energy Center, Sweden
- 6DV.1.8** **Unique Soiling Detection System for PV Modules**  
M. Korevaar, J. Mes, T. Bergmans & X. van Mechelen  
Kipp & Zonen, Delft, Netherlands  
A. Alami Merrouni  
IRESEN, Rabat, Morocco  
P. Nepal  
Delft University of Technology, Netherlands
- 6DV.1.9** **New Experimental Results on the Impact of Soiling on High Concentration Photovoltaic Module Performance**  
A. Barhdadi, W. Anana, F. Chaouki & B. Laarabi  
University Mohammed V-Agdal, Rabat, Morocco  
V. Gilioli & D. Verdilio  
Becar, Monteveglio, Italy
- 6DV.1.10** **Deep Analyses of Soiled Photovoltaic Modules under Different Moroccan Climates**  
B. Laarabi, F. Safsafi, F.-E.-Z. Daoudi & A. Barhdadi  
University Mohammed V-Agdal, Rabat, Morocco

- 6DV.1.11** **Innovative Cleaning Technique for Solar Biaxial Tracker PV Modules**  
D. Dahlioui, S. El Ayane, M. Rhourri, S. Medaghri Alaoui & A. Barhdadi  
University Mohammed V, Rabat, Morocco  
E. Menard & J. Boardman  
HeliosLite, Le Bourget du Lac, France
- 6DV.1.12** **The Soiling Effect on the Performance and the Cleaning Cost of Amorphous Photovoltaic System in Benguerir, Morocco**  
H. Zitouni, A. Ghennioui, C. Hajjaj, A. Bouaichi, B. Ikken & A. Benlarabi  
IRESEN, Rabat, Morocco  
M. Regragui  
University Mohammed V-Agdal, Rabat, Morocco
- 6DV.1.13** **Deployment of Photovoltaic Systems in Public Buildings of Saudi Arabia Including the Effects of Dust Accumulation**  
J. Alshahrani & P. Boait  
De Montfort University, Leicester, United Kingdom
- 6DV.1.14** **Long Term Evaluation of Anti-Reflection and Anti-Soiling Coating for Existing Photovoltaic Modules**  
K. Nishioka & Y. Ota  
University of Miyazaki, Japan
- 6DV.1.15** **Low-Cost Soiling Detector for Photovoltaic Applications**  
L. Micheli  
NREL, Golden, United States  
E.F. Fernández & F. Almonacid  
University of Jaén, Spain  
M. Muller  
Leidos, Denver, United States
- 6DV.1.16** **Photovoltaic (PV) Degradation Rate Trend Assessment with Time Series Change Point Analysis**  
A. Livera, G. Makrides, A. Kyprianou & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus
- 6DV.1.17** **I-V Characteristics of Broken Bypass Diode on PV Module**  
S. Oke, H. Sakai & H. Tottori  
NIT, Tsuyama College, Japan  
I. Nanno & T. Hamada  
NIT, Ube College, Japan  
N. Ishikura  
NIT, Yonago College, Japan  
M. Fujii  
NIT, Oshima College, Suo-oshima, Japan
- 6DV.1.18** **Influence of the Irradiance on the Detection and Performance of PID-Affected PV-Modules**  
C. Buerhop-Lutz, T. Pickel, F. Wenz, J. Hauch & C. Camus  
ZAE Bayern, Erlangen, Germany  
C. Zetzmann  
Rauschert, Pressig, Germany  
C.J. Brabec  
FAU, Erlangen, Germany



- 6DV.1.19 Image Processing for Daylight Electroluminescence PV Imaging Acquired in Movement**  
G.A. dos Reis Benatto, C. Mantel, N. Riedel, A. Alejo Santamaria Lancia, S. Thorsteinsson, P.B. Poulsen, S. Forchhammer, A. Thorseth & C. Dam-Hansen  
Technical University of Denmark, Roskilde, Denmark  
K.H.B. Frederiksen  
Kenergy, Horsens, Denmark  
J. Vedde  
SiCon, Birkerød, Denmark  
M. Larsen & H. Voss  
Sky-Watch, Støvring, Denmark  
H.R. Parikh, S.V. Spataru & D. Sera  
AAU, Aalborg, Denmark
- 6DV.1.20 Low-Cost Electroluminescence System for Infield PV Modules**  
M. Abdullah Eissa  
Helwan University, Giza, Egypt  
J. Almeida Silva, J.M. Serra & K. Lobato  
University of Lisbon, Portugal  
A.M. Bassiuny  
Helwan University, Cairo, Egypt
- 6DV.1.21 A Health Check of the Italian Solar Photovoltaic Park Using Satellite-Based Solar Resource Data**  
A. Virtuani  
O'Sole, Milan, Italy  
A. Skoczek & J. Betak  
Solargis, Bratislava, Slovakia
- 6DV.1.22 System Failure Analysis Tool for PV Plants – A Software Concept for Non-Specialists**  
A. Horn, W. Mühleisen & C. Hirschl  
CTR, Villach, Austria  
R. Ebner  
AIT, Vienna, Austria  
M. Spielberger  
PVSV, Guttaring, Austria  
H. Sonnleitner  
ENcome Energy Performance, Klagenfurt, Austria
- 6DV.1.23 Automatic Detection of Potential Induced Degradation in Solar Cells Using Image Processing Analysis**  
A. Farress, A. Benlarabi, A. Ghennioui, A. Bennouna & B. Ikken  
IRESEN, Rabat, Morocco  
M.N. Saidi & A. Tamtaoui  
INPT, Rabat, Morocco
- 6DV.1.24 An Enhanced Fault Diagnosis Approach for PV Array Based on I-V Characteristics and Neural Networks**  
M. Ouassaid & Y. Chouay  
University Mohammed V-Agdal, Rabat, Morocco
- 6DV.1.25 Evaluation of Irradiance Sensor Technologies for Plant Monitoring of PV Systems with CIGS Thin Film Modules**  
S. Grünsteidl, P. Borowski & T. Dalibor  
Avancis, Munich, Germany
- 6DV.1.26 Performance Comparison of Photovoltaic Modules under Low Sunlight**  
A.C. Besen, E. Arikan & F. Sarihan  
GTC, Adiyaman, Turkey

- 6DV.1.27 Delta Structure for Constant Daily Power Profile in PV Irrigation Systems**  
R.H. Almeida, I.A. Barata Carrêlo, L. Narvarte Fernández & E. Lorenzo Pigueiras  
UPM, Madrid, Spain
- 6DV.1.28 Harmonized Data Collection from the Field**  
D. Moser  
EURAC, Bolzano, Italy  
L. Azpilicueta  
SOLARUNITED, Brussels, Belgium  
L. Garreau-Iles  
DuPont, Paris, France  
G. Masson & G. Serra  
Becquerel Institute, Brussels, Belgium
- 6DV.1.29 Investigation on Response Characteristics of PV-PCS at Step Change in Solar Irradiance**  
H. Konishi, J. Hashimoto & K. Otani  
AIST, Koriyama, Japan
- 6DV.1.30 A Decision Support System Based on Earth Observation Exploitation for Renewable Energy Plants Management**  
A. Masini  
Flyby, Livorno, Italy  
C. Lanzetta  
I-EM, Livorno, Italy  
F. Bizzarri, G. Leotta, G.L. Giuliattini Burbui, P. Guerrisi & M.L. Lo Trovato  
ENEL, Rome, Italy
- 6DV.1.31 Orthomapper: Autonomous Computer Vision Based Tool for Solar Farms as-Built Layout Drawing Accurate Creation**  
R. Pardell, A. Figueres & J. Rebull  
Cleandrone, Valldoreix, Spain
- 6DV.1.32 Review of Guidelines for PV System Performance and Degradations**  
B.R. Paudyal, A.G. Imenes & T.O. Saetre  
University of Agder, Grimstad, Norway
- 6DV.1.33 LabVIEW and Arduino Based Real-Time Virtual Instrumentation of the PV Panel Characteristics**  
A. El Hammoui, S. Motahhir, A. Chalh, A. El Ghzizal & A. Derouich  
USMBA, Fez, Morocco
- 6DV.1.34 Drift Problem Analysis for PV System**  
A. Chalh, S. Motahhir, A. El Hammoui, A. El Ghzizal & A. Derouich  
USMBA, Fez, Morocco
- 6DV.1.35 Evaluation of 1 MW Arak Photovoltaic Power Plant According to IEC-61724 Standard**  
A.A. Ghadimi & M. Pirzadi  
Arak University, Iran
- 6DV.1.36 Electrical and Thermographic Characterization of a Photovoltaic Generator of 1.3 MWp**  
J.E. Camejo, R. Ramos Heredia, R.A. Proenza Yero & M.M. Sánchez Ferrer  
SERC, Santiago de Cuba, Cuba
- 6DV.1.37 Application of Bayesian Belief Network in Non-Conventional Energy Sources to Improve Performance & Reliability**  
A. Chandra  
HMRC, Telford, United Kingdom





- 6DV.1.38 Observations in PV Module Operating Voltage Distribution Along a PV Array. An In-Deep Look on Mismatch Losses**  
E. Lorenzo, C.H. Rossa & F. Martinez-Moreno  
UPM, Madrid, Spain
- 6DV.1.39 Web Platform of Real-Time Performance Monitoring and Smart Analysis PV Systems**  
C. Ghannaj  
ENSET, Rabat, Morocco  
A. Benazzouz  
IRESEN, Rabat, Morocco
- 6DV.1.40 Comparative Study of the Photovoltaic Productivity of the Three Silicon Technologies in Ouarzazate City**  
Y. Darmane  
University Ibn Zohr, Ouarzazate, Morocco
- 6DV.1.41 Estimation of the PV Output Power in the Various Setting Directions and Angles from the IV Characteristics of the Inclined PV Module**  
K. Saito & M. Sato  
Fukushima University, Japan  
M. Kondo  
AIST, Koriyama, Japan
- 6DV.1.42 Performance Analysis of a Remote Hybrid PV System Based on Real and Modelled Data in Indonesia**  
K. Kunaifi & A.H.M.E. Reinders  
University of Twente, Enschede, Netherlands
- 6DV.1.43 Yield of Small Roof-Top PV Systems in Germany 2017**  
H. te Heesen & M. Rimpler  
Trier University of Applied Sciences, Neubrücke (Nahe), Germany  
V. Herbot  
Ulm University of Applied Sciences, Germany
- 6DV.1.44 Data-Filtering-Dependent Variability of Long-Term Degradation Rates of MW-Scale Photovoltaic Power Plants from "Non-Ideal" Monitoring and Weather Data**  
C. Camus, M. Hüttner, J. Hauch & C.J. Brabec  
ZAE Bayern, Erlangen, Germany  
D. Lassahn & C. Kurz  
Meteocontrol, Augsburg, Germany
- 6DV.1.45 Performance of Si-Heterojunction Modules with Different Cell Interconnection and Module Technologies**  
A. Titov, K. Emtsev, D. Andronikov, A. Abramov, E.I. Terukov & D. Orekhov  
R&D Center TFTE, St. Petersburg, Russia  
B. Bulygin & A. Dubrovskiy  
Hevel Solar, Novocheboksarsk, Russia  
I. Shakhray  
Avelar Solar Technology, Moscow, Russia
- 6DV.1.46 Cell-Level Analysis of Multi-Megawatt PV Plants**  
J. Schlipf & A. Fladung  
Aerial PV Inspection, Aachen, Germany
- 6DV.1.47 Validation of PV System Performance Modelling in View of Köppen-Geiger-Photovoltaic Climate Classification**  
J. Ascencio-Vásquez, K. Brecl & M. Topic  
University of Ljubljana, Slovenia

- 6DV.1.48 Assessment of a 25 Year Old 1.6 kWp System with Crystalline MIS Solar Modules Operated in Moderate Climate Conditions**  
T. Fehling, G. Kleiss & B. Nacke  
Leibniz University of Hannover, Germany  
J. Arp  
PV Lab, Potsdam, Germany
- 6DV.1.49 Double Diode Model of PV Panel for Power Estimation under Real Outdoor Conditions**  
M. Kumar & A. Kumar  
IIT Roorkee, India
- 6DV.1.50 PV Power Prediction in Qatar Based on Machine Learning Approach**  
K. Benhmed, F. Touati, M. Al-Hitmi, N.A. Chowdhury, A.Jr. San Pedro Gonzales, Y. Qiblawey & M. Benammar  
Qatar University, Doha, Qatar
- 6DV.1.51 Prioritization of Test Execution with Operational Profile Mechanism for Software Reliability of Solar Energy Monitoring System**  
W.S. Jang & R.Y.C. Kim  
Hongik University, Sejong, Korea South

**VISUAL PRESENTATIONS 7DV.2**

15:15 - 16:45 PV Economics and Markets / PV-Related Strategies and Societal Issues

- 7DV.2.1 Implementation of Business Models for Renewable Energy Aggregators: Experience from the European Project BestRES**  
S. Caneva, P. Alonso, S. Challet & I. Weiss  
WIP - Renewable Energies, Munich, Germany
- 7DV.2.2 Cooperatively-Owned Batteries as a Concept to Prevent Local Grid Congestion**  
G. Leghissa, M.N. van den Donker, C. Tzikas & W. Folkerts  
SEAC, Eindhoven, Netherlands  
G.P.J. Verbong  
Eindhoven University of Technology, Netherlands
- 7DV.2.3 Solar PV Electrification in New Regions and the Globalized Energy Transition**  
H.J.J. Yu  
CEA, Gif-sur-Yvette, France
- 7DV.2.4 Economic Viability of PV Home Storage Systems in Dependence of the Electricity Price Composition**  
V. Jülch, R. Hollinger & T. Erge  
Fraunhofer ISE, Freiburg, Germany
- 7DV.2.5 Impact of PV Power Loss/Gain on PV Power Cost and PV Adoption**  
N. Mohandes, A. Elrayyah, A. Sanfilippo & A. Boumaiza  
QEERI, Doha, Qatar
- 7DV.2.6 Role of Smart Contracts in Photovoltaic Proliferation**  
M. Ray & B. Chakraborty  
IIT Kharagpur, India
- 7DV.2.7 Status of Building Integrated Photovoltaics (BIPV) in Latin America and the Case of Suriname**  
A. Raghoebarsing  
Anton de Kom University of Suriname, Paramaribo, Suriname  
A.H.M.E. Reinders  
University of Twente, Enschede, Netherlands





- 7DV.2.8 Introducing the Super PV Project - Cost Reduction and Enhanced Performance of PV Systems**  
 J. Ulbikas  
 PROTECH, Vilnius, Lithuania  
 J. Denafas  
 Soli "Tek R&D", Vilnius, Lithuania  
 M. Köntges  
 ISFH, Emmerthal, Germany  
 M. Topic  
 University of Ljubljana, Slovenia  
 F. Frontini  
 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, Zwickau, Germany  
 B. Terheiden  
 University of Konstanz, Germany  
 I. Weiss  
 WIP - Renewable Energies, Munich, Germany
- 7DV.2.9 Grid Connected PV Systems in Spain: An Economic Assessment with Sensitivity Analysis**  
 R. Peña, A.M. Diez-Pascual, P. García Díaz & J.A. Luceño Sánchez  
 UAH, Madrid, Spain
- 7DV.2.10 Solar Competitiveness in Technology Neutral Auctions**  
 R. Shrestha  
 GTM Research, Aarhus, Denmark
- 7DV.2.11 Business Conditions Favour Solar Photovoltaic-Thermal Hybrid Module in India**  
 J.N. Malaviya  
 MSEC, Pune, India
- 7DV.2.12 DuraMAT: The Durable Module Materials Consortium**  
 T.M. Barnes, D.S. Ginley, P. Hacke & M. Woodhouse  
 NREL, Golden, United States  
 M. Gordon, K. Leung & B.H. King  
 Sandia National Laboratories, Albuquerque, United States  
 M. Hartney & M.F. Toney  
 SLAC, Palo Alto, United States  
 A. Jain  
 LBNL, Berkeley, United States
- 7DV.2.13 Calculating the Cost of Distribution Grid Upgrades Required to Accommodate Current and Future Levels of PV Deployment in the UK**  
 S. Few, P. Djapic, G. Strbac, J. Nelson & C. Candelise  
 Imperial College London, United Kingdom
- 7DV.2.14 Scenario of Photovoltaics in Power Situation in India**  
 A. Kumar & A.K. Kumar  
 Georgia Institute of Technology, Atlanta, United States
- 7DV.2.15 Solar PV Sector in Turkey: New Trends & Future Plans**  
 N. Faivre & S. Topcu  
 GTC Solar, Istanbul, Turkey

- 7DV.2.16 Building on CrowdFundRES: Crowdfunding the Energy Transition**  
 P. Alonso, S. Caneva & I. Weiss  
 WIP - Renewable Energies, Munich, Germany
- 7DV.2.17 Market Potential of TIPV Applications and Opportunities for the PV Industry**  
 P. Macé, G. Masson & C. Cambiè  
 Becquerel Institute, Brussels, Belgium
- 7DV.2.23 Addressing PV Overvoltage and Backwards Flow Problems with Policy**  
 G.T. Currie, I. Mareels, C. Duffield & R. Evans  
 University of Melbourne, Parkville, Australia
- 7DV.2.25 Patterns of Sectoral Diffusion of Solar Photovoltaics: A Comparative Analysis in UK**  
 A.-M. Bunea  
 IMT Institute for Advanced Studies, Lucca, Italy  
 P. Della Posta & P. Manfredi  
 University of Pisa, Italy
- 7DV.2.26 Impacts of Socio-Economic Policies on Temporal Diffusion of PV-Based Communal Grids in a Rural Developing Community**  
 N. Opiyo  
 University of Southampton, United Kingdom
- 7DV.2.27 20 Years of Successful Experiences of the Project of the Autonomous Photovoltaic Solar Power Plant of the Rural Community "Santa Maria del Loreto"**  
 J.E. Camejo, R. Ramos Heredia, R.A. Proenza Yero & F. Hechavarría Fuentes  
 SERC, Santiago de Cuba, Cuba
- 7DV.2.28 Early Adopters of 24/7 Off-Grid Solar Home Lighting Systems: A Qualitative Exploration of Drivers and Barriers**  
 C. Singh Solanki, J. Venkateswaran & N. Prabhu  
 IIT Bombay, Mumbai, India



- 7DV.2.29 SOLAR-ERA.NET Cofund - European Network of National and Regional Research and Innovation Programmes - Recent Developments of Joint Transnational Calls**  
S. Nowak, M. Gutschner & T. Biel  
NET Nowak Energy & Technology, St. Ursen, Switzerland  
S. Oberholzer  
Swiss Federal Office of Energy, Bern, Switzerland  
C. Hünnekes, H. Bastek & R. Horbelt  
Forschungszentrum Jülich, Germany  
S. Falcón Morales  
MINECO, Madrid, Spain  
L. Gómez  
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  
I. Sergidou-Loizou  
RPF, Lefkosia, Cyprus  
T. Carrere  
ADEME, Paris, France  
K. Karaösz  
TUBITAK, Gebze, Turkey  
A. Goodbrook  
InnovateUK, Swindon, United Kingdom  
J. Osinski  
NCBR, Warsaw, Poland  
E. Lutter  
Climate and Energy Fund, Vienna, Austria  
A. Hipfinger  
FFG, Vienna, Austria  
U. Rohrmeister  
BMVIT, Vienna, Austria
- 7DV.2.30 Policies, Strategies and Economics Review for Solar PV, Storage and Grid Integration for Achieving Global Sustainable Development Goals, and Climate Change Mitigation in India**  
A. Kumar, S. Biswas & A. Sinha  
University of Petroleum and Energy Studies, Dehradun, India  
S. Mittal  
PTCUL, Dehradun, India
- 7DV.2.31 Education for Stand-Alone Photovoltaic System Projects Financed by Governments in Developing Countries: The Case of the Río Ibáñez Commune in the Aysén Region, Patagonia, Chile**  
J.C. Osorio-Aravena  
Austral University of Chile, Coyhaique, Chile  
E. Muñoz-Cerón  
University of Jaén, Spain
- 7DV.2.32 BIPV Courseware for Higher Education and Professionals**  
M. Tabakovic & H. Fechner  
UAS Technikum Wien, Vienna, Austria  
J. van Leeuwen, E. Bontekoe, W.G.J.H.M. van Sark & A. Louwen  
Utrecht University, Netherlands  
I. Weiss & S. Arancón  
WIP - Renewable Energies, Munich, Germany  
G.E. Georghiou, G. Makrides & M. Hadjipanayi  
University of Cyprus, Nicosia, Cyprus  
E. Loucaidou & M. Ioannidou  
Deloitte, Lemassol, Cyprus

- 7DV.2.34 Enhancing Solar Research by Using ICT and Explorative Web-Based Methods for Communication, Education and Training**  
C.S. Polo López, F. Frontini & P. Bonomo  
SUPSI, Canobbio, Switzerland
- 7DV.2.35 Education and Awareness Can Brand PV Technology Beautiful before Turning It Invisible**  
S. Ray  
Swami Vivekananda Seva Samity for Girls, Kolkata, India  
M. Ray  
IITKGP, Kharagpur, India  
T. Ram  
HPTDC, Manali, India
- 7DV.2.36 The Potential of Webinars as a Dissemination and Training Tools in Photovoltaics Among Communities of Scientists, Students, Professionals, Stakeholders**  
F. Roca, D. Casaburi, F. Ammirati & F. Beone  
ENEA, Portici, Italy  
K. Bittkau  
Forschungszentrum Jülich, Germany  
C. del Cañizo  
UPM, Madrid, Spain  
E. Simonot  
KIC InnoEnergy Iberia, Barcelona, Spain
- 7DV.2.37 Trends in Employment Factors for the PV Value Chain and Implications for EU Jobs**  
N. Taylor, P. Ruiz Castillo, V. Czako & A. Jäger-Walldau  
European Commission JRC, Petten, Netherlands
- 7DV.2.38 Human Capital for the Global PV Revolution: Experiences with Online BSc and MSc Education in Solar Energy Engineering**  
A.H.M. Smets  
Delft University of Technology, Netherlands
- 7DV.2.39 Photovoltaic Generation in the Spanish Electrical System and Its Impact on Agriculture of Irrigation. Regulations, Current Situation and Limitations**  
J.P. Chazarra Zapata, A. Ruíz Canales & F.J. López Peñalver  
University Miguel Hernandez, Alicante, Spain  
R. Egea Pérez  
Alicante University, Spain  
F.J. Pérez de la Cruz  
Polytechnic University of Cartagena, Murcia, Spain
- 7DV.2.40 Energy and Climate Change**  
M.I. Rabiou  
CODDAE, Niamey, Niger
- 7DV.2.41 Enterprise Europe Network Sector Group Intelligent Energy and Sustainable Constructions Helping Companies in Photovoltaics Innovate and Grow Internationally**  
S. Angloher-Reichelt  
Bayern Innovativ, Nuremberg, Germany  
K. Tzitzinou  
FING, Thessaloniki, Greece  
F. Roca  
ENEA, Portici, Italy



## VISUAL PRESENTATIONS 2DV.3

17:00 - 18:30 Thin Film and Foil-Based Si Solar Cells / Characterisation & Simulation Methods for Si Cells / Manufacturing & Production of Si Cells

- 2DV.3.1 Homogeneous Deposition of High Purity Silicon Thin Films with Highest Rates above 30  $\mu\text{m}/\text{min}$**   
S. Saager & B. Scheffel  
Fraunhofer FEP, Dresden, Germany
- 2DV.3.2 Large Area Deposition of P, I and N Single Layer of Amorphous Silicon Thin Films Solar Cells Prepared by PECVD**  
K. Belrhiti Alaoui, S. Laalioui & B. Ikken  
IRESEN, Rabat, Morocco  
A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco
- 2DV.3.3 High-Performing Photonic-Structured ARCs Enabling Pronounced Efficiency Enhancement in a-Si Thin Film Solar Cells**  
O. Sanchez-Sobrado, M.J. Mendes, S. Haque, T. Mateus, H. Águas, E. Fortunato & R. Martins  
New University of Lisbon, Caparica, Portugal
- 2DV.3.4 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. Ech-Chamikh & Y. Ijdyaou  
Cadi Ayyad University, Marrakech, Morocco
- 2DV.3.5 PEDOT:PSS Window Layer for a-Si:H Thin Film Solar Cells on Flexible Substrates**  
Y. Lee, M. Shin & J. Lee  
Korea Aerospace University, Goyang, Korea South  
S.J. Yun, G. Kim & J.W. Lim  
ETRI, Daejeon, Korea South
- 2DV.3.6 Optimizing the Transparent Electrode Structure in a-Si:H Solar Cells for Low Angular Dependence of Incident Light for BIPV Windows**  
G. Kim & J.W. Lim  
ETRI, Daejeon, Korea South  
Y. Lee & M. Shin  
Korea Aerospace University, Goyang, Korea South
- 2DV.3.7 Enhanced Efficiency of Crystalline Si Solar Cells Based on Kerfless-Thin Wafers with Nanohole Arrays**  
H.-S. Lee, J. Suk, H. Kim, J. Kim, J. Song, D.S. Jeong, J.-K. Park, W.M. Kim, D.-K. Lee, T.S. Lee & I. Kim  
KIST, Seoul, Korea South  
K.J. Choi  
UNIST, Ulsan, Korea South  
B.-K. Ju  
Korea University, Seoul, Korea South
- 2DV.3.13 Validity Analysis of the Textbook Lumped Series Resistance Approach for Solar Cells**  
A.S.H. van der Heide  
imec, Leuven, Belgium
- 2DV.3.14 Capacitive Effects in High-Efficiency Solar Cells During IV-Curve Measurement: Considerations on Error of Correction and Extraction of Minority Carrier Lifetime**  
H. Vahlman  
Aalto University, Espoo, Finland  
J. Hyvärinen, A. Tolvanen & S. Hyvärinen  
Endeas, Espoo, Finland

- 2DV.3.15 Cross-Sectional Workfunction Measurements on Solar Cell Structures Under Light-Controlled Conditions**  
F. Yamada, T. Kamioka, Y. Ohshita & I. Kamiya  
Toyota Technological Institute, Nagoya, Japan
- 2DV.3.16 A Simulation Study of LID Loss in p-Type Monocrystalline Silicon Solar Cells**  
C.-M. Wei, Y.-C. Lai & C.-C. Li  
Motech Industries, Tainan City, Taiwan
- 2DV.3.17 Measurement of Doping Profiles by a Contactless Method of IR Reflectance under Grazing Incidence**  
J. Holovsky, Z. Remes & A. Poruba  
ASCR, Prague, Czech Republic  
D. Franta  
Masaryk University, Brno, Czech Republic  
B. Conrad, L. Abelová & D. Bušek  
CTU, Prague, Czech Republic
- 2DV.3.18 Theoretical Simulation of Carbon Nanotubes – Amorphous Silicon Hybrid Solar Cells**  
H. Meddeb, O.V. Sergeev, M. Vehse & C. Agert  
DLR, Oldenburg, Germany  
P.M. Rajanna & A.G. Nasibulin  
Skoltech, Moscow, Russia
- 2DV.3.19 Fundamental and Technological Limits to Low-Light Efficiency of Crystalline Silicon Solar Cells**  
B. Conrad & A.P. Amalathas  
CTU, Prague, Czech Republic  
J. Holovsky  
ASCR, Prague, Czech Republic
- 2DV.3.20 Silicon Failure under Complex Loadings**  
M. Fourmeau, M. Wang & D. Nelias  
INSA Lyon, Villeurbanne, France
- 2DV.3.21 Series Resistance Breakdown of Silicon Heterojunction Solar Cells Produced on CEA-INES Pilot Line**  
L. Basset, W. Favre & R. Varache  
CEA, Le Bourget du Lac, France  
J.-P. Vilcot  
IEMN, Villeneuve d'Ascq, France
- 2DV.3.22 A New Analysing Approach for Periodically Textured c-Si Solar Cells**  
S.H. Altinoluk  
Mugla University, Turkey  
H.E. Çiftçinar, O. Demircioğlu & R. Turan  
METU, Ankara, Turkey
- 2DV.3.23 Electrical and Optical Characterization of e-Beam Evaporated Poly-Si Films as an Alternative Emitter Layer for Solar Cell Applications**  
S.H. Sedani, O.F. Erdem & R. Turan  
METU, Ankara, Turkey
- 2DV.3.24 Evaluation of the Lateral Homogeneity of the Light Field of Solar Simulators**  
M. Turek & S. Eiternick  
Fraunhofer CSP, Halle (Saale), Germany



- 2DV.3.25 Simulations of Optimal Solar Cell Architecture and Material Parameters for Silicon Heterojunction Cells on Quasi-Mono Substrate: Strategies for Obtaining Efficiencies over 20%**  
Y. Smirnov, V.N. Verbitskiy, I. Nyapshaev, D. Andronikov, A. Abramov & E.I. Terukov  
R&D Center TFTE, St. Petersburg, Russia
- 2DV.3.26 Physical Device Simulation of Dopant-Free Silicon Solar Cell Based on Hole-Selective Molybdenum Oxide and Electron-Selective Titanium Oxide**  
H. Mehmood  
NUST, Islamabad, Pakistan  
T. Tauqeer  
ITU, Lahore, Pakistan  
H. Nasser & R. Turan  
METU, Ankara, Turkey
- 2DV.3.27 Inline Wafer Identification Using Optical Character Recognition (OCR)**  
S. Al-Hajjawi, T. Hammer & J. Haunschild  
Fraunhofer ISE, Freiburg, Germany
- 2DV.3.28 Optical and Electrical Behaviour of Dislocations in Monolike Silicon Solar Cells**  
D. Ory  
EDF R&D, Palaiseau, France  
O. Lafont & L. Lombez  
IPVF, Palaiseau, France
- 2DV.3.29 Image Recognition of Etch Pits on As-Sliced Surface of Multicrystalline Silicon Using Machine Learning**  
T. Kojima, K. Onishi & A. Ogura  
Meiji University, Kawasaki, Japan  
K. Fukui, M. Komoda & J. Atobe  
Kyocera, Higashiomi, Japan
- 2DV.3.30 Spectral Optical Characteristics of Silicon Nanowire System: Simulative Prediction Followed by Experiments**  
M.K. Hossain, A. Wajeesh & B. Salhi  
KFUPM, Dhahran, Saudi Arabia
- 2DV.3.31 Study of Inhibition Amorphous Incubation Layer in n an p Doped  $\mu$ -Si:H Thin Films by Optical Methods and Electron Microscopy**  
F.E. Rojas Tarazona  
Pontifical Xavierian University, Bogotá, Colombia  
F. Villar Lopez, J.M. Asensi & J. Bertomeu  
UB, Barcelona, Spain
- 2DV.3.32 Application of Genetic Algorithm Parameter Optimization on Current-Voltage Data of Multi-Crystalline Silicon Solar Cells**  
R. Dix-Peek, E.E. van Dyk, F.J. Vorster & C.J. Pretorius  
Nelson Mandela University, Port Elizabeth, South Africa
- 2DV.3.33 Silver Nanoparticles on Substrate and Superstrate: Fabrication and Numerical Analysis for Solar Cell Applications**  
M.K. Hossain & A. Wajeesh  
KFUPM, Dhahran, Saudi Arabia
- 2DV.3.34 Spectral Characterization of Temperature Increase in Encapsulated Crystalline Silicon Solar Cells**  
J. Bengoechea, I. Urrea, E. Zugasti & A.R. Lagunas  
CENER, Navarra, Spain

- 2DV.3.35 Light Trapping Impact on SiGe Solar Cell Performance: Analytical Modeling and Global Optimization**  
H. Bencherif & A. Yousfi  
University Mostefa Benboulaïd, Batna, Algeria  
L. Dehimi  
University of Biskra, Algeria  
F. Pezzimenti  
UNIRC, Reggio Calabria, Italy
- 2DV.3.36 Electroluminescence Imaging and Light-Beam Induced Current as Characterization Techniques of Multi-Crystalline Si Solar Cells**  
L.A. Sánchez, A. Moretón, S. Rodríguez-Conde, M. Guada, O. Martínez & J. Jiménez  
UVa, Valladolid, Spain
- 2DV.3.37 Usage of Low Cost Digital Camera for Detecting of Silicon Solar Cell Electroluminescence**  
P. Lepik & J. Vanek  
Brno University of Technology, Czech Republic
- 2DV.3.43 GÜNAM Photovoltaic Line (GPVL) - A Pilot Research Line for PERC/PERL/PERT Concepts**  
F. Es, E. Semiz & R. Turan  
METU, Ankara, Turkey
- 2DV.3.44 Over 22.0% Efficiency for the p-Type Mono Silicon PERC Solar Cells by Industrial Mass Production Technology**  
C.-W. Kuo, T.-M. Kuan, W.-L. Chueh, C.-J. Li, L.-G. Wu, C.-C. Huang & C.-Y. Yu  
TSEC, Hsinchu, Taiwan
- 2DV.3.45 Optimization of Rear Pattern for p-Type Mono Bifacial PERC Cells in Mass Production**  
H. Li, Z. Zhang, T. Jia, C. Yu, Q. Ma & Q. Xu  
Dongfang Huansheng Photovoltaic, Yixing, China
- 2DV.3.46 70% Bifaciality Industrial p-Type mc-Si Bifacial PERC Solar Cell**  
J. Dong, X. Chen, Y. Zhang, J. Lv, Z. Shen, J. Li, Q. Ye, W. Wei, W. Wang, S. Yuan, J. Sheng, X. Zhou & C. Zhang  
GCL System Integration Technology, Suzhou, China
- 2DV.3.47 Nanocrystalline n-Type Silicon and Silicon Oxide Front Surface Field Layers: Transfer and Optimization of Research Process in Industrial Scale HJT Cell Production**  
D. Decker, D. Sontag & D. Sontag  
Meyer Burger, Hohenstein-Ernstthal, Germany  
A.B. Morales-Vilches, L. Mazzarella, R. Schlatmann & B. Stannowski  
HZB, Berlin, Germany
- 2DV.3.48 Magnetron Sputtered TCO-Layers for Industrial Production of Heterojunction Silicon Solar Cells**  
R. Korn, S. Hübner, M. Huber & P. Wohlfart  
Singulus Technologies, Kahl am Main, Germany
- 2DV.3.49 Atmospheric Pressure Chemical Vapor Deposition of in-Situ Doped Amorphous Silicon Layers for Passivating Contacts**  
A. Merkle, B. Min, R. Brendel & R. Peibst  
ISFH, Emmerthal, Germany  
S. Seren, H. Knauss & R. Nissler  
SCHMID Group, Freudenstadt, Germany  
J. Steffens & B. Terheiden  
University of Konstanz, Germany
- 2DV.3.50 Printed Dopant Sources for Locally-Doped SiO<sub>x</sub>/Poly-Si Passivating Contacts**  
Z. Kiaee, C. Reichel, M. Jahn, F. Feldmann, R. Keding, M. Hermle & F. Clement  
Fraunhofer ISE, Freiburg, Germany



- 2DV.3.51 19.2% Efficiency of Industrial Multi-Crystalline Silicon Solar Cell with MCCE Textured**  
H. Wang, Z. Xu, F. Lang, Y. Wang, J. Liu, F. Li, J. Shi & D. Song  
Yingli Green Energy, Baoding, China
- 2DV.3.52 Metal-Free Texturing for Diamond-Wire-Sawn Multi-Crystalline Silicon (DWS-mc)**  
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- 2DV.3.53 MCCE Textured Multicrystalline and Monocrystalline Silicon Solar Cells**  
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- 2DV.3.54 Anisotropic Etching of Monocrystalline Silicon Wafer without Formation of Hydrogen**  
A. Stapf, K. Halbfaß, P. Nattrodt, B. Neubert & E. Kroke  
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- 2DV.3.55 Improvement of Emitter Characterization for Industrial PERC Solar Cell**  
C.-S. Park, N.R. Oh, D.K. Kim, J.-M. Yeon, K. Hong, E.-J. Lee & D.-S. Kim  
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- 2DV.3.56 Phosphorus and Boron Co-Diffusion in Silicon for p-PERT Solar Cells Application**  
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- 2DV.3.57 Gentle and Damage Free Ablation of Dielectric Layers Using a Femtosecond Laser Source for High Efficiency Silicon Wafer Solar Cells**  
J.M. Yacob Ali, V. Shanmugam, A.G. Aberle & T. Mueller  
SERIS, Singapore, Singapore
- 2DV.3.58 Improvement of Solar Cell Efficiencies for Ultrashort-Pulse Laser Contact Opening with Ni-Cu Plated Contacts by Optimized LCO-FFO Processing Order**  
V. Arya, S. Kluska, S. Gutscher, G. Cimiotti, J.-F. Nekarda & A.A. Brand  
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- 2DV.3.59 Low Temperature Silver-Copper Paste Printed on Bus-Bar Electrodes of Passivated Emitter and Rear Cell**  
K.-Y. Wu, C.-H. Chen, H.W. Lu, C.-H. Chen, X.-W. Wu & C.-H. Du  
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- 2DV.3.60 Effect of Current-Injection on Fire-Through Mechanism of SiNx/p-Doped Emitter/p-Type Silicon Solar Cell with Low Temperature Firing Process**  
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- 2DV.3.61 PVD Metallization for High-Efficiency c-Si Solar Cells: Scenario for Implementation in Production**  
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- 2DV.3.62 Deep Learning Approach to Inline Quality Rating and Mapping of Multi-Crystalline Si-Wafers**  
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- 2DV.3.63 Ultrafast In-Line Regeneration for Cz-Si PERC Solar Cells and Stability Testing**  
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- 2DV.3.64 Temperature Dependence and Low Light Performance of Various Types of Silicon Solar Cells**  
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- 2DV.3.65 Screen Printed Thick Film Metallization of Silicon Solar Cells - Recent Developments and Future Perspectives**  
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- 2DV.3.66 Results of the Project "AdmMo" – Cell and Module Development towards a 318 W Module**  
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**2DV.3.67 Optimizing Yield of High Efficiency Solar Cells by Correlating Final Cell I-V Test Data with Upstream Process Variation in Real Time – The Opportunity for Close-Loop Control**

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