



# EU PVSEC 2016

**32nd European  
Photovoltaic Solar Energy  
Conference and Exhibition**

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



## Programme

Co-located with

**inter  
solar**  
connecting solar business | EUROPE

**20 - 24 JUNE 2016  
MUNICH, GERMANY**

**ICM - International  
Congress Center Munich**

**[www.photovoltaic-conference.com](http://www.photovoltaic-conference.com)**

## INSTITUTIONAL SUPPORT



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for Renewable Energy

## COORDINATION OF THE TECHNICAL PROGRAMME



## INSTITUTIONAL PV INDUSTRY COOPERATION



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Conference Programme Outline of the week inside back cover

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

The content represents the status as of 7 June 2016

**Welcome**

**WELCOME**

**Conference Programme**

**PROGRAMME**

**Parallel Events**

**PARALLEL EVENTS**

**Information**

**INFORMATION**

**Acknowledgements**

**ACKNOWLEDGEMENTS**

## CHAIRMAN'S MESSAGE

### Key role of PV forecasted in all major future energy scenarios

The EU PVSEC 2016, the 32nd edition of the European Photovoltaic Energy Conference and Exhibition, offers you an excellent opportunity to absorb, update and discuss the most recent and relevant developments in photovoltaics. We are honoured to host this world class event this year in Munich, Germany, from 20-24 June, 2016, co-located with Intersolar Europe.



Of course it is not just about great conference location and facilities. All major future energy scenarios forecast a key role for photovoltaic solar energy. Further, the COP21's overarching goal from Paris last year to reduce greenhouse gas emissions and to limit the global temperature increase clearly showed that expectations and projections for PV are high. PV has a huge European and global potential, making it an important building block for cost-competitive, secure and sustainable energy systems. PV has just reached 1% of global annual electricity supply but has harnessed only a small fraction of its vast potential. PV deployment could be accelerated by further enhancing light-to-power conversion efficiency, and reducing module and system prices as well as grid-integration bottlenecks. After a difficult period in the PV sector over the past few years, we may expect a strong revival in the coming period. The sense of urgency for innovation is felt more than ever and global market conditions are improving. This also implies a huge challenge for the photovoltaic community.

Once again, the EU PVSEC 2016 continues to be the platform for a unique event to share the latest scientific, technical, financial, policy and market insights and developments. Have a close look to an impressive programme that offers each of you a variety of interesting topics and an opportunity to intensively learn, discuss and network.

I am very pleased to welcome you in Munich. I am sure the 32nd EU PVSEC will energize and inspire you in many ways.

Marko Topič  
Chairman of European Technology & Innovation Platform  
Photovoltaics,  
Conference General Chairman

## MESSAGE FROM THE TECHNICAL PROGRAMME CHAIR

A very warm welcome to EU PVSEC 2016! Again this year we've had a great response from the PV research community, with over 1200 abstracts submitted. Thanks to you all, and to my colleagues on the Scientific Committee who have dedicated considerable time and effort as paper reviewers and as topic organisers to arrive at a really stimulating programme for the week.



We're also pleased to host the award ceremony for the Becquerel prize, given in recognition of an outstanding contribution to the field of photovoltaics and supported by the European Commission.

Photovoltaic solar electricity has emerged as one of the few renewable technologies that can really impact our energy system and help meet the challenge to mitigate climate change. Moreover one of the exciting things about this field is how much technological potential still exists – we have pathways to improve performance and sustainability in all areas, as well as a technology mix that can be developed to meet a broad range consumer requirement and applications.

Against this background, the EU PVSEC programme aims to provide you with insights into cutting edge research both on existing photovoltaic technologies as well as on innovative concepts. I look forward to a stimulating week and count on your active participation to presentations and discussions.

Dr. Nigel Taylor  
EU PVSEC Technical Programme Chair  
European Commission Joint Research Centre



## CONFERENCE PROGRAMME

Plenary, Oral and Visual Sessions

## CONFERENCE PROGRAMME

Please note, that this Programme may be subject to alteration and the organisers reserve the right to do so without giving prior notice. The current version of the Programme is available at [www.photovoltic-conference.com](http://www.photovoltic-conference.com).

(i) = invited

Monday, 20 June 2016

### CONFERENCE OPENING

08:30 - 10:00 Scientific Opening

#### PLENARY SESSION 1AP.1

08:30 - 09:30 New Materials and Concepts for Solar Cells and Modules

#### Welcome:

N. Taylor  
EU PVSEC Technical Programme Chair  
European Commission Joint Research Centre

#### Chairpersons:

A.W. Bett  
Fraunhofer ISE, Germany

M. Rusu  
HZB, Germany

**1AP.1.1 Keynote Presentation**  
**37% Efficient One-Sun Minimodule and over 40% Efficient Concentrator Submodules**

M.A. Green, M.J. Keevers, B. Concha-Ramon & J. Jiang  
UNSW, Sydney, Australia  
P.J. Verlinden, Y. Yang & X. Zhang  
Trina Solar, Changzhou, China

**1AP.1.2 Keynote Presentation:**  
**Innovative Approaches to Interconnect Back-Contact Cells**

J. Govaerts, T. Borgers, E. Voroshazi, S. Jambaldinni,  
B. O'Sullivan, S. Singh, M. Debucquoy, J. Szlufcik &  
J. Poortmans  
imec, Leuven, Belgium

**1AP.1.3 Decarbonisation in the Light of Paris COP 21 – Consequences and urgent first steps**

H. Lehmann  
Federal Environment Agency of Germany, Dessau, Germany

#### 10:00 - 11:00 Opening Addresses

- Professor Marko Topič  
Conference General Chairman  
Chairman European Technology & Innovation Platform Photovoltaics
- Message from the European Commission
- Claude Turmes, Member of the European Parliament; ITRE Committee and EUFORES President, Luxembourg
- Osman Benchikh  
Head of UNESCO's Renewable Energy Programme  
UNESCO Coordinator and Focal Point for UN-Energy

#### 11:00 - 12:15 Moderated Opening Panel

#### Topic:

- Technology and Market Innovations for PV after Paris COP 21.

#### Moderator

- Paolo Frankl, Head of Renewable Energy Division,  
International Energy Agency, France

#### Panelists:

- Marko Topic  
Chairman European Technology & Innovation Platform Photovoltaics
- Claude Turmes  
Member of the European Parliament; ITRE Committee and  
EUFORES President, Luxembourg
- Giovanni De Santi  
Director Institute for Energy and Transport JRC, European  
Commission
- Oliver Schäfer  
President SolarPower Europe, Board member Global Solar Council
- Eicke Weber  
Director Fraunhofer Institute for Solar Energy Systems, President  
EUREC - Association of European Renewable Energy Research  
Centres
- Patrick Hofer-Noser (i)  
CTO, Meyer Burger Technology, Switzerland

#### 12:15 Becquerel Prize Ceremony

For the latest programme details please check  
[www.photovoltic-conference.com](http://www.photovoltic-conference.com) or your  
Personal Programme Planner [www.eupvsec-planner.com](http://www.eupvsec-planner.com).







ORAL PRESENTATIONS 1AO.1

13:30 - 15:00 **Fundamental Characterisation, Theoretical and Modelling Studies**

Chairpersons:

invited

invited

**1AO.1.1 Fast Qualification Method for Thin Film Absorber Materials**

L.W. Veldhuizen, Y. Kuang, D. Koushik & R.E.I. Schropp  
Eindhoven University of Technology, The Netherlands  
G. Adhyaksa & E. Garnett  
FOM Institute AMOLF, Amsterdam, The Netherlands

**1AO.1.2 Transient I-V Measurement Set-Up of Photovoltaic Laser Power Converters under Monochromatic Irradiance**

S.K. Reichmuth, D. Vahle, M. de Boer, M. Mundus,  
G. Siefer, A.W. Bett & H. Helmers  
Fraunhofer ISE, Freiburg, Germany  
C.E. Garza  
Nanoscribe, Eggenstein-Leopoldshafen, Germany

**1AO.1.3 Imaging of Terahertz Emission from Individual Subcells in Multi-Junction Solar Cells**

S. Hamauchi, Y. Sakai, T. Umegaki, I. Kawayama,  
H. Murakami & M. Tonouchi  
Osaka University, Japan  
A. Ito & H. Nakanishi  
SCREEN, Kyoto, Japan

**1AO.1.4 Simulation-Based Optimization for Solar Cells and Modules with Novel Silver Nanowire Transparent Electrodes**

S. Altazin, R. Hiestand & M. Fontenlos  
Fluxim, Winterthur, Switzerland  
F. Pschenitzka  
Cambrios Technologies, Sunnyvale, United States  
B. Ruhstaller  
ZHAW, Winterthur, Switzerland

**1AO.1.5 EU PVSEC Student Award Winner Presentation**

Different Electron and Hole Thermodynamics from Hot Carrier Solar Cell Modeling  
F. Gibelli & J.-F. Guillemoles  
CNRS, Chatou, France

**1AO.1.6 Hot Carrier Solar Cell as Thermoelectric Device**

I. Konovalov & V. Emelianov  
University of Applied Sciences Jena, Germany

ORAL PRESENTATIONS 3AO.4

13:30 - 15:00 **Special Session on CdTe and Kesterites**

Chairpersons:

invited

A. Romeo  
University of Verona, Italy

**3AO.4.1 An Approach to High Efficient CdTe Solar Cells with Wide Spectral Response**

L. Wu, L. Feng, J. Zhang, W. Wang, W. Li, H. Xu, C. Liu,  
B. Li & G. Zeng  
Sichuan University, Chengdu, China

**3AO.4.2 The Impact of Oxygen Inlet during Close-Spaced Sublimation Process on the as-Deposited and Chlorine Treated Microstructure of CdTe Layers**

D. Hirsch, O. Zywitzki, T. Modes, H. Morgner & C. Metzner  
Fraunhofer FEP, Dresden, Germany  
B. Späth & B. Siepchen  
CTF Solar, Dresden, Germany

**3AO.4.3 Sodium Induced Microstructural Changes in MOCVD Grown CdTe Thin Films**

A. Amirkhalil, V. Barrioz, N.S. Beattie & G. Zoppi  
Northumbria University, Newcastle upon Tyne, United Kingdom  
S.J.C. Irvine  
Glyndwr University, St Asaph, United Kingdom

**3AO.4.4 Effects of Surface Etching, Sodium Incorporation and Solar Cell Post-Annealing Treatment on Cu<sub>2</sub>ZnSnS<sub>4</sub> Solar Cells**

G. Altamura, S. Temgoua, N. Naghavi & R. Bodeux  
IPVF, Antony, France

**3AO.4.5 Na and Ge Doping Effect on CZTS Absorber Cells Fabricated by Ink-Jet Printing, Study and Comparison with PVD**

E. Bailo Bobi, B. Medina-Rodríguez, M. Blanes & F.M. Ramos  
FAE, Barcelona, Spain  
M. Colina Brito, I. Becerril-Romero, L. Acebo, M. Placidi & E. Saucedo  
IREC, Barcelona, Spain  
A. Cirera & A. Perez-Rodríguez  
University of Barcelona, Spain

**3AO.4.6 Improved Cu<sub>2</sub>ZnSnSe<sub>4</sub> Solar Cell Properties by Bi-Directional Crystallization Strategy Assisted with Back/Front Ge Nanolayers**

S. Giraldo, M. Neuschitzer, M. Espindola-Rodriguez,  
P. Pistor, F. Oliva, V. Izquierdo-Roca, A. Perez-Rodriguez &  
E. Saucedo  
IREC, Sant Adrià de Besòs, Spain  
T. Thersleff & K. Leifer  
Uppsala University, Sweden

**ORAL PRESENTATIONS 5AO.7**

**13:30 - 15:00 Solar Resource Assessment**

**Chairpersons:**

S. Tselepis  
CRES, Greece

J. Remund  
Meteotest, Switzerland

**5AO.7.1 Performance Assessment of PV Power Plants by Satellite-Derived Solar Radiation and Modelled Meteorological Data**

M. Suri, T. Cebecauer, A. Skoczek, B. Schnierer &  
N. Suriova  
GeoModel Solar, Bratislava, Slovakia

**5AO.7.2 Classifying 1 Minute Temporal Variability in Global and Direct Normal Irradiances within Each Hour from Ground-Based Measurements**

M. Schroedter-Homscheidt, S. Jung & M. Kosmale  
German Aerospace Center, Wessling, Germany

**5AO.7.3 High Resolution Solar Radiation Database. Solar Atlas for South Africa**

A. Gracia Amillo & T. Huld  
European Commission, Ispra, Italy  
L. Ntsangwane  
South African Weather Service, Pretoria, South Africa  
J. Trentmann  
German Meteorological Service, Offenbach, Germany

**5AO.7.4 Fast All-Sky Radiation Model for Solar Applications (FARMS): Mechanisms, Performance, and Applications**

Y. Xie & M. Sengupta  
NREL, Golden, United States

**5AO.7.5 Preliminary Results of the Fifth International Spectroradiometer Comparison for Improved Solar Spectral Irradiance Measurements**

R. Galleano & W. Zaaiman  
European Commission DG JRC, Ispra, Italy  
D. Alonso-Álvarez  
Imperial College London, United Kingdom  
A. Minuto  
RSE, Milan, Italy  
N. Ferretti  
PI Berlin, Germany  
R. Fucci  
ENEA, Portici, Italy  
M. Marzoli & L. Manni  
SUPSI, Canobbio, Switzerland  
M. Halwachs  
AIT, Vienna, Austria  
M. Friederichs  
PV Lab Germany, Potsdam, Germany  
F. Plag & D. Friedrich  
PTB, Braunschweig, Germany  
E.J. Haverkamp  
Radboud University, Nijmegen, France

**5AO.7.6 The Quality of Satellite-Based Irradiation Data for Operations and Asset Management**

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

**VISUAL PRESENTATIONS 2AV.1**

**13:30 - 15:00 Silicon Solar Cell Improvements and Innovation (I)**

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

**VISUAL PRESENTATIONS 6AV.4**

**13:30 - 15:00 Grid and Energy System Integration**

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

**ORAL PRESENTATIONS 1AO.2**

**15:15 - 16:45 Fundamental Materials Studies, their Characterization and Modelling**

**Chairpersons:**

J.A.M. Van Roosmalen  
ECN, The Netherlands

H. Shirai  
Saitama University, Japan

**1AO.2.1 Optical Evaluation of Multi-Wire Modules**

K.R. McIntosh & M.D. Abbott  
PV Lighthouse, Coledale, Australia  
M. Edwards  
UNSW, Sydney, Australia  
R. Evans  
Solingo, Sydney, Australia  
Y. Yao  
Meyer Burger, Gwatt, Switzerland

**1AO.2.2 Influence of Efficient Back Reflectors on the Quantum Efficiency of Solar Cells**

D.N. Micha  
CEFET-RJ, Petrópolis, Brazil  
A. Walker, G. Siefer, A.W. Bett & F. Dimroth  
Fraunhofer ISE, Freiburg, Germany

**1AO.2.3 Impact of Improved Thin Film PV Front Contact and Interconnect Dead-Zone**

J. van Deelen & M. Barink  
TNO, Eindhoven, The Netherlands

**1AO.2.4 Efficient Luminescent Solar Concentrators Based on Self-Absorption Free, Tm<sup>2+</sup> Doped Halides**

O.M. ten Kate, M. De Jong, O.M. ten Kate & E. van der Kolk  
Delft University of Technology, The Netherlands  
K.W. Krämer  
University of Berne, Switzerland

**1AO.2.5 A Three Dimensional Phantom Node Method to Study Complex Crack Patterns in Photovoltaic Solar Cells**

P.R. Budarapu & M. Paggi  
IMT School of Advanced Studies, Lucca, Italy  
J. Reinoso  
University of Seville, Spain

**1AO.2.6 Probing Stress Evolution and Fracture Mechanisms during Solar PV Module Integration/Assembly Using Synchrotron X-Ray Microdiffraction – Enabling Thin Silicon Technologies for Next Generation Solar PV Systems**

A.S. Budiman, S.K. Tippabhatta, I. Radchenko & K.R. Narayanan  
Singapore University of Technology & Design, Singapore  
G. Illya & V. Handara  
Surya University, Tangerang, Indonesia  
M. Kunz & N. Tamura  
ALS, Berkley, United States

**ORAL PRESENTATIONS 3AO.5**

**15:15 - 16:45 Buffer and Contacts for Thin Film Devices**

**Chairpersons:**

T. Walter  
Ulm University of Applied Sciences, Germany

I. Lauermaun  
HZB, Germany

**3AO.5.1 Electrical Passivation of Thin Film Solar Cell Interfaces**

B. Vermang & I. Gordon  
imec, Leuven, Belgium  
R. Kotipalli & D. Flandre  
Catholic University of Louvain, Louvain-la-Neuve, Belgium  
M. Edoff  
Uppsala University, Sweden

**3AO.5.2 Chemical Bath Deposited Zinc Oxide as Transparent Conductive Contact for CIGS Cells**

J. Steinhauser, P. Fuchs, Y.E. Romanyuk & A.N. Tiwari  
EMPA, Dübendorf, Switzerland  
D. Hariskos & W. Wischmann  
ZSW, Stuttgart, Germany  
D. Brémaud  
Flisom, Dübendorf, Switzerland

**3AO.5.3 Characterization of the Back Contact of CIGS Solar Cell as the Origin of “Rollover” Effect**

T. Kato, K. Kitani, K.F. Tai, R. Kamada, H. Hiroi & H. Sugimoto  
Solar Frontier, Atsugi, Japan

**3AO.5.4 Atmospheric Roll-to-Roll Atomic-Layer-Deposition of Zn(O,S) Buffer Layers for Flexible CIGS PV Modules**

P.J. Bolt, C. Frijters, P. Poodt & A. Illiberi  
TNO, Eindhoven, The Netherlands  
D. Brémaud & M. Ruth  
Flisom, Dübendorf, Switzerland  
J. Van den Brink & R. Knaapen  
VDL Enabling Technologies, Eindhoven, The Netherlands

**3AO.5.5 Revealing the Beneficial Effects of Ge Doping on Cu<sub>2</sub>ZnSnSe<sub>4</sub> Thin Film Solar Cells**

M. Neuschitzer, M. Espindola-Rodriguez, M. Guc,  
S. Giraldo, A. Perez-Rodriguez & E. Saucedo  
IREC, Sant Adrià de Besòs, Spain  
J. Marquez & I. Forbes  
Northumbria University, Newcastle upon Tyne,  
United Kingdom  
T. Olar & I. Laueremann  
HZB, Berlin, Germany

**ORAL PRESENTATIONS 5AO.8**

**15:15 - 16:45 Solar Forecasting**

**Chairpersons:**

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

C. Protogeropoulos  
Phoenix Solar, Greece

**55AO.8.1 Multi-Model Ensemble for Day Ahead PV Power Forecasting Improvement**

M. Pierro, F. Bucci & C. Cornaro  
University of Rome, Italy  
M. De Felice  
ENEA, Rome, Italy  
E. Maggioni, A. Perotto & F. Spada  
IDEAM, Cinisello, Italy  
D. Moser  
EURAC, Bolzano, Italy

**5AO.8.2 Dependence of Peer-to-Peer Solar Forecast Skill on Irradiance Variability**

B. Elsinga & W.G.J.H.M. van Sark  
Utrecht University, The Netherlands

**5AO.8.3 Optimal Selection of Training Datasets for Solar Nowcasting Models**

A. Sanfilippo & L. Pomares  
Qatar Foundation, Doha, Qatar  
D. Perez Astudillo, N. Mohandes & D. Bachour  
Qatar Environment and Energy Research Institute, Doha,  
Qatar

**5AO.8.4 Mathematical Parametrisation of Irradiance Transitions Caused by Moving Clouds for PV System Analysis**

K. Lappalainen & S. Valkealahti  
Tampere University of Technology, Finland

**5AO.8.5 Shortest Term Forecasting of DNI for Concentrated Solar Technologies**

S.C. Müller & J. Remund  
Meteotest, Bern, Switzerland

**5AO.8.6 Application of Whole Sky Imagers for Data Selection for Radiometer Calibration**

S. Wilbert, B. Nouri & C. Prah  
German Aerospace Center, Tabernas, Spain  
G. Garcia  
CIEMAT, Tabernas, Spain  
L. Ramirez, L. Zarzalejo, R. Valenzuela & F. Ferrera  
CIEMAT, Madrid, Spain  
N. Kozonek  
German Aerospace Center, Almeria, Spain

**VISUAL PRESENTATIONS 2AV.2**

**15:15 - 16:45 Silicon Solar Cell Improvements and Innovation (II)**

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

**VISUAL PRESENTATIONS 6AV.5**

**15:15 - 16:45 PV in Buildings and the Environment**

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

ORAL PRESENTATIONS 1AO.3

17:00 - 18:30 New Materials and Concepts: Nanostructures

Chairpersons:

A. Martí Vega  
UPM, Spain

invited

1AO.3.1 **Fabrication of Strain-Compensated Heterojunction Ge/Si<sub>1-x</sub>C<sub>x</sub> Quantum Dots Solar Cells**

K. Gotoh  
Tokyo Institute of Technology, Yokohama, Japan  
R. Oshima, T. Tayagaki, T. Sugaya & K. Matsubara  
AIST, Tsukuba, Japan  
M. Kondo  
AIST, Fukushima, Japan

1AO.3.2 **Extended Electron Lifetime in Intermediate-Band Solar Cells Using Dot-in-Well Structure**

S. Asahi  
Kobe University, Japan  
H. Teranishi, S. Watanabe, T. Takada, T. Kaizu & T. Kita  
Kobe University, Japan

1AO.3.3 *EU PVSEC Student Award Winner Presentation*  
**Thin GaAsSb Capping Layers for Improved Performance of InAs/GaAs Quantum Dot Solar Cells**

A.D. Utrilla, A. Gonzalo, I. Artacho, Z. Gacevic, A. Guzmán,  
A. Hierro & J.M. Ulloa  
UPM, Madrid, Spain  
D. Fernández Reyes, T. Ben & D. González  
UCA, Puerto Real, Spain  
J.M. Llorens  
IMM - CSIC, Tres Cantos, Spain

1AO.3.4 **Influence of the Quantum Dot Capping Procedure on the Density of Defects of InAs/GaAs Quantum Dot Intermediate Band Solar Cells**

D.N. Micha  
CEFET/RJ, Petrópolis, Brazil  
E. Weiner, L.D. Pinto & P.L. Souza  
DISSE, Rio de Janeiro, Brazil  
R. Jakomin  
UFRJ, Duque de Caxias, Brazil  
M.P. Pires  
UFRJ, Rio de Janeiro, Brazil

1AO.3.5 **Development of Absorber and Energy Selective Contacts for the Hot Carrier Solar Cell**

S. Shrestha, S. Chung, Y. Liao, W. Cao, H. Xia, N. Gupta,  
X. Wen & G.J. Conibeer  
UNSW Australia, Sydney, Australia

1AO.3.6 **Optimal Utilization of the Optical Field Distribution in RCE a-Ge:H Nanoabsorber Solar Cells**

V. Steenhoff, M. Vehse & C. Agert  
Next Energy, Oldenburg, Germany

ORAL PRESENTATIONS 3AO.6

17:00 - 18:30 Interfaces for Thin Film Devices

Chairpersons:

invited

M.C. Lux-Steiner  
HZB, Germany

3AO.6.1 **Potassium Fluoride Ex-Situ Treatment for Cu-Rich CuInSe<sub>2</sub> Thin Film Solar Cells**

H. ElAnzeery, F. Babbe, M. Melchiorre & S. Siebentritt  
University of Luxembourg, Belvaux, Luxembourg

3AO.6.2 **Effects of Thermal Annealing and KF Post Deposition on Photovoltaic Property of CIGS Solar Cell**

Y. Kamikawa-Shimizu, J. Nishinaga, S. Ishizuka,  
H. Shibata & S. Niki  
AIST, Tsukuba, Japan

3AO.6.3 **Punch-Through Effect in CIGS Thin Film Solar Cells**

T. Ott & H.-J. Fecht  
University of Ulm, Germany  
T. Walter  
Ulm University of Applied Sciences, Germany  
R. Schäffler  
Manz, Schwäbisch Hall, Germany

3AO.6.4 **Nano-Scale Insight into CdS/Cu(In,Ga)Se<sub>2</sub> Interface of Alkali Incorporated Solar Cells**

A. Stokes & A.-J. Mowafak  
NREL, Golden, United States  
B. Gorman  
Colorado School of Mines, Golden, United States



**3AO.6.5 p-n Junction Quality Improvement of Cu<sub>2</sub>ZnSn(S,Se)<sub>4</sub>/CdS Solar Cells: Surface Passivation with Group III-S Compounds by Wet Chemical Treatments**

H. Xie, Y. Sánchez, M. Espindola-Rodriguez,  
S. López-Marino & E. Saucedo  
IREC, Sant Adrià de Besòs - Barcelona, Spain  
L. Calvo-Barrio & A. Perez-Rodriguez  
University of Barcelona, Spain

**ORAL PRESENTATIONS 5AO.9**

**17:00 - 18:30 Balance of System Components**

**Chairpersons:**

G. Graditi  
ENEA, Italy

N.M. Pearsall  
Northumbria University, United Kingdom

**5AO.9.1 Safe PV Plants with Panel Level Electronics?**

J. Laschinski, G. Bettenwort, M. Hopf & H. Knopf  
SMA Solar Technology, Niestetal, Germany

**5AO.9.2 A MPPT Algorithm for Partial Shading Conditions Employing Curve Fitting**

E. Batzelis, G. Kampitsis & S. Papathanassiou  
NTUA, Athens, Greece

**5AO.9.3 Deviations of Results for Energy Yield from Efficiency Rankings of Micro-Inverters**

S. Krauter & J. Bendfeld  
University of Paderborn, Germany

**5AO.9.4 Performance of Recent Inverter Systems under Partial Shading Conditions**

R. Lingel, T. Nordmann & T. Vontobel  
TNC Consulting, Feldmeilen, Switzerland

**5AO.9.5 Performance Evaluation of Household Li-Ion Battery Storage Systems**

N. Munzke & J. Barry  
KIT, Eggenstein-Leopoldshafen, Germany

**5AO.9.6 Photovoltaic Emulator for High-Performance Multi-Substring Simulations**

T.-D. Mai, K. Baert & J. Driesen  
KU Leuven, Heverlee, Belgium  
S. De Breucker & P. van Tichelen  
VITO, Mol, Belgium

**VISUAL PRESENTATIONS 2AV.3**

**17:00 - 18:30 Silicon Solar Cell Improvements and Innovation (III)**

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

**VISUAL PRESENTATIONS 6AV.6**

**17:00 - 18:30 Utility-Scale PV / PV Applications without a Centralised Grid**

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



- 2BO.1.6 Electromagnetic Casting at Emix : a High Rate Purification Process Driven by Numerical Simulations**  
J. Givernaud & F. Boulle  
EMIX, Saint Maurice la Souterraine, France

**ORAL PRESENTATIONS 3BO.5**

**08:30 - 10:00 Amorphous Silicon-Based Thin-Film PV Devices**

**Chairpersons:**

S. Gall  
HZB, Germany

I. Gordon  
imec, Belgium

- 3BO.5.1 Monolithic Interconnection of Micromorph Tandem Thin Film Solar Cells on Flexible and Opaque Substrates Using Laser Ablation**

K. Borzutzki, S. Geißendörfer, O. Siepmann, O. Sergeev,  
M. Vehse & C. Agert  
Next Energy, Oldenburg, Germany  
J. Ohland  
University of Oldenburg, Germany

- 3BO.5.2 High Quality p-a-SiOxCy:H Films Using Additional Trimethylboron for Amorphous Silicon Based Top Cells**

D.-W. Kang  
Cheongju University, Korea South  
P. Sichanugrist & M.A. Khan  
MEXT/FUTURE-PV, Fukushima, Japan  
C. Niikura  
NIMS, Ibaraki, Japan  
M. Konagai  
Tokyo City University, Japan

- 3BO.5.3 Transfer of a Highly Efficient Thin-Film Photovoltaic Device from Its Growth Substrate to a Flexible Plastic Sheet**

S.K. Ram, F. Lyckegaard, B.R. Jeppesen, P.B. Jensen,  
J. Chevallier, A. Nylandsted Larsen & P. Balling  
Aarhus University, Denmark  
R. Rizzoli & M. Bellettato  
CNR, Bologna, Italy  
D. Desta  
University of Aveiro, Portugal

- 3BO.5.4 Development and Validation of a New Model for Degradation and Annealing of a-Si:H Solar Cells under Dynamically Varying Conditions**

M. Görig & B.E. Pieters  
Forschungszentrum Jülich, Germany

- 3BO.5.5 Color Control for a-Si:H Thin Film Solar Cells with Ultrathin Transparent Electrodes**

G. Kim, J.-W. Lim & S.J. Yun  
ETRI, Daejeon, Korea South  
M. Shin  
Korea Aerospace University, Goyang-City, Korea South

- 3BO.5.6 Integration of Graphene as Transparent Conductive Electrode for a-Si:H Solar Cells**

F. Roux, F. Emieux, H. Szabolics, P. Faucherand,  
V. Muffato & E. Quesnel  
CEA, Grenoble, France  
A. Centeno & A. Zurutuza  
Graphenea, San Sebastian, Spain

**ORAL PRESENTATIONS 2BO.9**

**08:30 - 10:00 Industrial Production of High Efficiency c-Si Cells**

**Chairpersons:**

P. Wohlfart  
Singulus Technologies, Germany

D.L. Bätzner  
Meyer Burger Research, Switzerland

- 2BO.9.1 Silicon Heterojunction Solar Cells in Meyer Burger's Demo Line: Results of Pilot Production on Mass Production Tools**

J. Zhao, D. Sontag, M. König, A. Wissen, V. Breus,  
D. Decker, M. Fritzsche, M. Schorch, M. Richter,  
H.J. Nonnenmacher, M. Leonhardt, J. Hausmann,  
A. Waltinger, D. Landgraf, S. Burkhardt, K. Walther,  
S. Frigge, H. Mehlich & E. Vetter  
Meyer Burger, Hohenstein-Ernstthal, Germany  
Y. Yao, T. Söderström, A. Richter & S. Leu  
Meyer Burger, Gwatt, Switzerland  
W. Stein  
Stein Engineering & Consulting, Dresden, Germany  
R. Varache, P. Jeronimo & C. Roux  
CEA, Le Bourget du Lac, France

- 2BO.9.2 How to Deal with Thin Wafers in a Heterojunction Solar Cells Industrial Pilot Line: First Analysis of the Integration of Cells Down to 70µm Thick in Production Mode**

S. Harrison, O. Nos, A. Danel, D. Muñoz, J.P. Rakotoniaina,  
C. Roux & P.J. Ribeyron  
CEA-LITEN, Le Bourget du Lac, France

**2BO.9.3 Mass Production of High Efficiency Silicon Heterojunction Solar Cells: a Low-Cost Approach by Upgrading Gen8.5 Thin Film Solar Line**

L. Li, L. Zhang, Z. Xu, X. Fang, G. Zhao, S. Gu, X. Tian,  
B. Li, R. Yang, Y. Meng & T. Guo  
ENN Solar Energy, Langfang, China

**2BO.9.4 PERC Solar Cells and Its Road to Industry**

J. Wu, X.-S. Wang & G. Xing  
Canadian Solar, Suzhou, China

**2BO.9.5 Cu-Plated Electrodes with Green Nano-Laser Opening Metal Contact on n-Type Silicon Solar Cells**

K.-C. Lai, S.-Y. Liu, Y.L. Lee, M.-S. Lin, Y.-K. Tsao,  
C.-C. Chuang, C.-C. Li & C.-C. Wang  
Motech Industries, Tainan, Taiwan

**2BO.9.6 40 kHz PECVD of AlO<sub>x</sub>/SiN<sub>x</sub> Stacks Demonstrated in Industrial High Efficiency PERC Production**

T. Pernau, J.-U. Fuchs, V.X. Nguyen, A. Nickel,  
U. Walk & W. Jooß  
Centrotherm Photovoltaics, Blaubeuren, Germany  
K. Hsu, J. Chen & S. Wiebecke  
Centrotherm Photovoltaics Asia, Zhubei, Taiwan  
H.-H. Wu, K.-H. Hung, K.-C. Lin & W.K.W. Huang  
Gintech Energy, Miaoli, Taiwan

**VISUAL PRESENTATIONS 5BV.1**

**08:30 - 10:00 PV Cells and Modules (I)**

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

**PLENARY SESSION 2BP.1**

**10:30 - 12:00 Wafer-Based Silicon Technology**

**Chairpersons:**

R. Brendel  
ISFH, Germany

P.J. Verlinden  
Trina Solar Energy, China

**2BP.1.1 *Keynote Presentation:* Current Status of High-Efficiency Q.Antum Technology with New World Record Module Efficiency of 19.5%**

M. Scherff, P. Kowalzik, C. Gerber, K. Duncker,  
M. Junghänel, C. Fahrland, S. Kunath, S. Hörnlein,  
M. Schütze, L. Niebergall, B. Klöter & J.W. Müller  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

**2BP.1.2 New Monosilane Fluid Bed Decomposition Technology for the Production of Solar Quality Silicon Feedstock**

M. Dassel  
SiTec, Augsburg, Germany

**2BP.1.3 *EU PVSEC Student Award Winner Presentation* Calcium Contacts to n-Type Crystalline Silicon Solar Cells**

T.G. Allen, P. Zheng, Y. Wan, C. Samundsett, J. Bullock &  
A. Cuevas  
ANU, Canberra, Australia  
B. Vaughan & M. Barr  
University of Newcastle, Callaghan, Australia

**2BP.1.4 Impact of Solar Cell Architecture on the Temperature Dependency of Electrical Performance**

J.P. Seif, J. Haschke, J. Cattin & S. De Wolf  
EPFL, Neuchâtel, Switzerland  
L. Tous, P. Choulat, M. Aleman, E. Cornagliotti, A. Uruena  
de Castro, R. Russell, F. Duerinckx & J. Szlufcik  
imec, Leuven, Belgium  
L. Barraud, J. Champlaud, J. Levrat, M. Despeisse &  
C. Ballif  
CSEM, Neuchâtel, Switzerland  
A.A. Abdallah, B. Aissa, M.-M. Kivambe & N. Tabet  
Qatar Foundation, Doha, Qatar

ORAL PRESENTATIONS 2BO.2

13:30 - 15:00 Silicon Feedstock and Wafer Technologies

Chairpersons:

K. Hesse  
Wacker Chemie, Germany

B.Y. Jang  
KIER, Korea South

**2BO.2.1 Capture of Agglomerates by Beads in an Experimental System That Simulates a Fluidized Bed Reactor for the Production of Polysilicon**

M. Vazquez Pufleau & M. Yamane  
Washington University in St. Louis, United States

**2BO.2.2 Investigations of Thermal Decomposition of Monosilane in a Free Space Reactor**

G.M. Wyller, T.J. Preston, H. Klette, O. Nordseth,  
T.T. Mongstad & E.S. Marstein  
IFE, Kjeller, Norway  
W.O. Filtvedt  
Dynatec Engineering, Askim, Norway

**2BO.2.3 On the Parameters That Impact the Performance of Diamond Wire in the Production of Silicon Wafers**

K. Sunder & O. Anspach  
PV Crystalox Solar, Erfurt, Germany

**2BO.2.4 The Influence of Surface Quality on Diamond Wire Sawn Multi-Crystalline Silicon Wafer**

T.Y. Wang & W.-J. Lih  
ITRI, Hsinchu, Taiwan  
C.-Y. Cheng, C.-Y. Liu & W.-H. Lin  
Green Energy Technology, Taoyuan, Taiwan

**2BO.2.5 3 Dimensional Direct Wafer Product with Locally-Controlled Thickness**

A. Lorenz, J. Hofstetter, H. Malkasian, L. Sanderson &  
F. van Mierlo  
1366 Technologies, Bedford, United States

**2BO.2.6 Multiple Reuse of the Silicon Substrate in a Porous Silicon Based Layer Transfer Process**

A. Hajjifarassar, K. Van Nieuwenhuysen, I. Sharlandzhiev,  
V. Depauw, H. Sivaramakrishnan Radhakrishnan, T. Bearda,  
I. Gordon, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
Y. Abdulraheem  
Kuwait University, Safat, Kuwait  
L. Magagnin  
Polytechnic University of Milan, Italy

ORAL PRESENTATIONS 3BO.6

13:30 - 15:00 Silicon-Based Thin-Film Materials and Devices

Chairpersons:

P. Delli Veneri  
ENEA, Italy

J. Meier  
PV Consultant, Switzerland

**3BO.6.1 External Quantum Efficiency as Function of Applied Voltage of Multi-Junction Hydrogenated Amorphous Si Based Cell: Performance Optimization After Stabilization**

A. Canino, G. Condorelli & A. Battaglia  
3Sun, Catania, Italy  
C. Gerardi  
Enel Green Power, Catania, Italy

**3BO.6.2 Annealing Effects in Amorphous Silicon Solar Cells Deposited at Low Temperatures for Transparent Flexible Plastic Substrates**

K. Wilken, S. Wang, F. Finger & V. Smirnov  
Forschungszentrum Jülich, Germany

**3BO.6.3 Bifacial Multicrystalline Silicon Thin Film Solar Cells**

G. Jia, A. Gawlik, J. Plentz, M. Vetter & G. Andrä  
IPHT, Jena, Germany

**3BO.6.4 1- $\mu$ m-Thin Crystalline Silicon Solar Cells with Pseudo-Ordered Nanotextures**

V. Depauw, T. Bearda, I. Gordon & J. Poortmans  
imec, Leuven, Belgium  
I. Massiot & A. Dmitriev  
Chalmers University of Technology, Goteborg, Sweden  
W. Chen & P. Roca i Cabarrocas  
CNRS, Palaiseau, France  
C. Trompoukis  
KU Leuven, Heverlee, Belgium

**3BO.6.5 Passivation at the Interface between Liquid-Phase Crystallized Silicon and Silicon Oxynitride in Thin Film Solar Cells**

N. Preissler, J.A. Töfflinger, O. Gabriel, D. Amkreutz,  
B. Stannowski, R. Schlatmann & B. Rech  
HZB, Berlin, Germany

**3BO.6.6 Analysis of Carrier Lifetime in Liquid-Phase Crystallized Silicon on Glass**

M. Vetter, A. Gawlik, J. Plentz & G. Andrä  
IPHT, Jena, Germany



## ORAL PRESENTATIONS 5BO.10

13:30 - 15:00 **Backsheet and Encapsulant Materials**

### Chairpersons:

C. Monokroussos  
TÜV Rheinland, China

R. Gottschalg  
Loughborough University, United Kingdom

### 5BO.10.1 Yellowing of PV Backsheets in Accelerated Tests Can Be Used as a Realistic Indication of Possible Field Failures – Fact or Fiction?

E. Parnham, A. Seaman, A. Whitehead, W. Brennan & M. Peevor  
DuPont Teijin Films, Redcar, United Kingdom

### 5BO.10.2 Acetic Acid Permeation through PV-Backsheets: Dependence of the Composition on the Permeation Rate

G. Oreski & A. Mihaljevic  
PCCL, Leoben, Austria  
Y. Voronko & G.C. Eder  
OFI, Vienna, Austria

### 5BO.10.3 Method to Measure Light Recovery Factor Enabling 20.2% Module Efficiency with Passivated Emitter and Rear Solar Cells

M. Köntges, H. Schulte-Huxel, S. Blankemeyer, M.R. Vogt, R. Witteck, S. Spätlich, D. Hinken, H. Holst, U. Sonntag, T. Brendemühl, I. Ahrens, T. Neubert, K. Bothe & R. Brendel  
ISFH, Emmerthal, Germany

### 5BO.10.4 Development of Adhesive and Cohesive Failures in EVA-Backsheet Structures in Environmental Testing

J. Zhu, D. Montiel-Chicharro, T.R. Betts & R. Gottschalg  
Loughborough University, United Kingdom

### 5BO.10.5 Investigation of the EVA Degradation Mechanism and Prediction of Reliability by the Raman Spectroscopy

M.A. Islam, K. Noguchi & Y. Ishikawa  
NAIST, Ikoma, Japan  
H. Nakahama  
Nisshinbo Mechatronics, Tsukuba, Japan

### 5BO.10.6 Direct Evidence for Hot-Cell-Induced Modifications in PV Module Encapsulants

C. Camus, C. Buerhop-Lutz, S. Wrana, J. Adams, T. Pickel, H. Scheuerpflug & J. Hauch  
ZAE Bayern, Erlangen, Germany  
C. Zetzmann  
Rauschert, Pressig, Germany  
E. Malguth  
LayTec in-line, Berlin, Germany  
C.J. Brabec  
University of Erlangen, Germany

## VISUAL PRESENTATIONS 5BV.2

13:30 - 15:00 **Operation of PV Systems**

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

## VISUAL PRESENTATIONS 1BV.5

13:30 - 15:00 **Fundamental Studies / New Materials and Concepts for Modules**

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

## ORAL PRESENTATIONS 2BO.3

15:15 - 16:45 **Heterojunction Solar Cell Concepts**

### Chairpersons:

P.J. Ribeyron  
CEA, France

C. Ballif  
EPFL&CSEM, Switzerland

### 2BO.3.1 Impact of High-Temperature Processes on Bulk Carrier Lifetime of n-Type Cz Silicon

S. Werner, A. Wolf, S. Mack & E. Lohmüller  
Fraunhofer ISE, Freiburg, Germany  
R.C.G. Naber  
Tempres, Vaassen, The Netherlands

**2BO.3.2 Implementation of n+ and p+ Poly-Si/c-Si Junctions on Front and Rear Side of Double-Side Contacted Industrial Silicon Solar Cells**

R. Peibst, Y. Larionova, S. Reiter, M. Turcu & R. Brendel  
ISFH, Emmerthal, Germany  
D. Tetzlaff, J. Krügener & T. Wietler  
Leibniz University Hannover, Germany  
U. Höhne & J.-D. Kähler  
centrotherm, Hannover, Germany  
H. Mehlich & S. Frigge  
Meyer Burger, Hohenstein-Ernstthal, Germany

**2BO.3.3 Process Development of Silicon Heterojunction Interdigitated Back-Contacted (SHJ-IBC) Solar Cells Bonded to Glass**

M. Xu, T. Bearda, H. Sivaramakrishnan Radhakrishnan,  
S. Kiran Jonnak, V. Depauw, K. Van Nieuwenhuysen,  
M. Filipic, I. Gordon, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
Y. Abdulraheem  
Kuwait University, Safat, Kuwait

**2BO.3.4 Enhancing the Efficiency of Silicon Heterojunction Solar Cells Using Effectively Transparent Contacts**

R. Saive, A.M. Borsuk, H.S. Emmer, C. Bukowsky,  
J.V. Lloyd, S. Yalamanchili & H.A. Atwater  
Caltech, Pasadena, United States

**2BO.3.5 Silicon Heterojunction Solar Cells Using Aluminum Doped Zinc Oxide as Back Contact: Sputtering and ALD**

G. Christmann, D. Sacchetto, L. Sansonnens, L. Barraud,  
A. Descoeurdes, B. Paviet-Salomon, N. Badel, M.  
Despeisse, S. Nicolay & C. Ballif  
CSEM, Neuchâtel, Switzerland  
L.A.A. Duval, M. Creatore & W.M.M. Kessels  
Eindhoven University of Technology, The Netherlands  
G. Wahli & B. Strahm  
Meyer Burger Research, Hauterive, Switzerland

**2BO.3.6 Status of the EU FP7 HERCULES Project: What Is the Potential of n-Type Silicon Solar Cells in Europe?**

D. Muñoz, P.J. Ribeyron & S. Harrison  
CEA, Le Bourget du Lac, France  
C. Allebé, A. Descoeurdes & M. Despeisse  
CSEM, Neuchâtel, Switzerland  
C. Reichel & S.W. Glunz  
Fraunhofer ISE, Freiburg, Germany  
R. Peibst & A. Merkle  
ISFH, Emmerthal, Germany  
O. Nielsen  
NorSun, Oslo, Norway  
I. Martín  
UPC, Barcelona, Spain

V. Mihailetschi  
ISC Konstanz, Germany  
T. Söderström & B. Demareux  
Meyer Burger, Gwatt (Thun), Switzerland  
S. De Wolf  
EPFL, Neuchâtel, Switzerland  
H. Mehlich & J. Zhao  
Meyer Burger, Hohenstein-Ernstthal, Germany  
J. Alvarez  
CNRS, Paris, France  
J. Dupuis  
EDF R&D - IRDEP, Chatou, France  
E. Macron  
Alma Consulting Group, Lyon, France  
B. de Gier  
Eurotron, Bleskensgraaf, The Netherlands  
M. Tallián & F. Korsós  
Semilab, Budapest, Hungary  
L. Korte  
HZB, Berlin, Germany

**ORAL PRESENTATIONS 3BO.7**

**15:15 - 16:45 Perovskite Solar Cells and Modules: Performance**

**Chairpersons:**

R. Gehlhaar  
imec, Belgium

S. Berson  
CEA, France

**3BO.7.1 Air-Blade Deposition of Large Area Perovskite Modules with Efficiency Exceeding 9%**

S. Razza, L. Cinà, M. Dianetti, S. Casaluci, A. Agresti,  
F. Matteocci, A. d'Epifanio, S. Licoccia, A. Reale,  
F. Brunetti & A. di Carlo  
University of Rome, Italy

**3BO.7.2 Flexible Perovskite/Cu(In, Ga)Se<sub>2</sub> Tandem Thin Film Solar Cell**

S. Pisoni, F. Fu, T. Feurer, S. Buecheler & A.N. Tiwari  
EMPA, Dübendorf, Switzerland

**3BO.7.3 Spatially Resolved Current Generation in the Sub-Cells of Monolithic Perovskite/Silicon Tandem Solar Cells**

Z. Song, A.B. Phillips, R.J. Ellingson & M.J. Heben  
University of Toledo, United States  
J. Werner, S. De Wolf & B. Niesen  
EPFL, Neuchâtel, Switzerland  
C. Ballif  
CSEM, Neuchâtel, Switzerland

**3BO.7.4 Interface Architecture between TiO<sub>2</sub>/Perovskite, Perovskite/Hole Transport Layer, and Perovskite Grain Boundary**

D. Hirotani, M. Moriya, Y. Ogomi & S. Hayase  
Institute of Technology, Kitakyushu, Japan  
Q. Shen & T. Toyoda  
University of Electro-Communication, Chofu, Japan  
K. Yoshino  
University of Miyazaki, Japan

**3BO.7.5 Tin(IV)-Based Iodide Perovskite Materials for Photovoltaic Application**

Y. Chen, T. Krishnamoorthy, T. Baikie, N. Mathews,  
L.H. Wong & S.G. Mhaisalkar  
Nanyang Technological University, Singapore, Singapore

**3BO.7.6 Dependence of the Transport Length in CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub> Powders on Light Soaking: a Surface Photovoltage Study**

T. Dittrich, O. Shargaieva, F. Lang, N.H. Nickel,  
B. Rech & J. Rappich  
HZB, Berlin, Germany

**ORAL PRESENTATIONS 5BO.11**

**15:15 - 16:45 Potential Induced Degradation (PID), Soiling and Glass of PV Modules**

**Chairpersons:**

H. Nagel  
Germany

A.R. Lagunas  
CENER, Spain

**5BO.11.1 Regeneration of Potential Induced Degradation Affected Modules**

C. Hinz, S. Koch & J. Berghold  
PI Berlin, Germany

**5BO.11.2 Modeling the Lifetime and Performance Prediction of PV Solar Plants: the Role of PID and Moisture Ingress in Crystalline Modules**

E. Annigoni, F. Galliano & F. Sculati-Meillaud  
EPFL, Neuchâtel, Switzerland  
M. Jankovec & M. Topic  
University of Ljubljana, Slovenia  
H.Y. Li, L.-E. Perret-Aebi & C. Ballif  
CSEM, Neuchâtel, Switzerland

**5BO.11.3 Potential-Induced Degradation: an Improved Understanding of Mechanism and Influence Factors**

C. Taubitz & M.B. Köntopp  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany  
A. Schulze  
Rosenheim University of Applied Sciences, Germany

**5BO.11.4 PV Module Test for Arid Climates Including Sand Storm and Dust Testing**

G. Mathiak, M. Hansen, M. Schweiger, L. Rimmelspacher,  
W. Herrmann, F. Reil & J. Althaus  
TÜV Rheinland, Cologne, Germany

**5BO.11.5 Advances in the Development of “AtaMo”: Solar Modules Adapted for the Climate Conditions of the Atacama Desert in Chile- the Impact of Soiling and Abrasion**

E. Cabrera, A. Schneider, E. Wefringhaus,  
D. Thaller & R. Kopecek  
ISC Konstanz, Germany  
J. Rabanal-Arabach  
ISC Konstanz, Antofagasta, Chile  
P. Ferrada, F. Araya, A. Marzo, M. Trigo,  
D. Olivares & E. Fuentealba  
University of Antofagasta, Chile  
J. Haas  
University of Santiago de Chile, Chile

**5BO.11.6 Investigation of Damp Heat Aging on Soda-Lime Glass for Photovoltaic Applications**

V. Guiheneuf, F. Delaleux, O. Riou, P.-O. Logerais &  
J.-F. Durastanti  
University of Paris-Est, Lieusaint, France

**VISUAL PRESENTATIONS 5BV.3**

**15:15 - 16:45 Balance of System Components**

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

## VISUAL PRESENTATIONS 1BV.6

15:15 - 16:45 **New Materials and Concepts for Cells**

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

## ORAL PRESENTATIONS 2BO.4

17:00 - 18:30 **p-Type PERC Solar Cell Concepts and Surface Passivation**

### Chairpersons:

R. Preu  
Fraunhofer ISE, Germany

J. John  
imec, Belgium

**2BO.4.1 Emitter Saturation Currents of 22 fA/cm<sup>2</sup> Applied to Industrial PERC Cells Approaching 22% Conversion Efficiency**

T. Dullweber, H. Hannebauer, S. Dorn, S. Schimanke,  
A. Merkle, C. Hampe & R. Brendel  
ISFH, Emmerthal, Germany

**2BO.4.2 Recent 22% Efficient Fully Screen Printed Industrial PERC Silicon Solar Cells – the Q.ANTUM Technology Platform Applied to Mono Cz p-Type to Maintain Constant Efficiency Increase per Year in Production Environment**

M. Schaper, J. Cieslak, K. Duncker, C. Fahrland, S.  
Geissler, S. Hörnlein, C. Klenke, R. Lantzsch, A. Mohr,  
L. Niebergall, A. Schönmann, M. Schütze, J.W. Müller &  
D.J.W. Jeong  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

**2BO.4.3 Towards a 300wp p-Type HIP-MWT-Module – Simulation, Experimental Results and Costs**

A. Spribille, A. Kraft, D. Eberlein, M. Ebert & F. Clement  
Fraunhofer ISE, Freiburg, Germany  
T. Savisalo & H. Pantsar  
Valoe, Mikkeli, Finland

**2BO.4.4 Plasma Process Analysis of ICP-PECVD of AlO<sub>x</sub> Layers for c-Si Surface Passivation**

M. Hofmann & M. Jäcklein  
Fraunhofer ISE, Freiburg, Germany

B. Cord  
Singulus Technologies, Kahl am Main, Germany  
T. Schütte  
Plasus, Mering, Germany  
M. Siemers  
Fraunhofer IST, Braunschweig, Germany

**2BO.4.5 Al<sub>2</sub>O<sub>3</sub> Passivation for Cu Plated 15.6x15.6 cm<sup>2</sup> IBC Cells**

S. Jambaldinni, B. O'Sullivan, S. Singh, E. Cornagliotti,  
B. Zielinski, M. Debucquoy, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
M. Kyuzo  
Kyocera, Shiga, Japan

**2BO.4.6 Formation and Evolution of the SiO<sub>x</sub>F<sub>y</sub> Masking Layer Caused by Plasma Texturing**

M. Gaudig, J. Hirsch & N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany  
V. Naumann, C. Hagendorf & D. Lausch  
Fraunhofer CSP, Halle, Germany

## ORAL PRESENTATIONS 3BO.8

17:00 - 18:30 **CIGS Manufacturing**

### Chairpersons:

M. Powalla  
ZSW, Germany

A.N. Tiwari  
EMPA, Switzerland

**3BO.8.1 Improved CIGS Modules by KF Post Deposition Treatment and Reduced Cell-to-Module Losses**

N. Kaihovirta, O. Lundberg, E. Wallin, V. Gusak,  
S. Södergren, S. Chen, S. Lotfi, F. Chalvet, U. Malm,  
J. Joel, M. Skupinski, P. Lindberg, T. Jarmar, J. Lundberg,  
J. Mathiasson & L. Stolt  
Solibro Research, Uppsala, Sweden  
P. Mende, G. Jaschke & P. Kratzert  
Solibro, Bitterfeld-Wolfen, Germany

**3BO.8.2 Efficiency Improvement of CIGSSe/Cd-Free Solar Module by Optimized Cell and Interconnect Design**

P. Eraerds, C. Schubbert, T. Kwast, M. Grave, F. Braun,  
M. Algasinger, R. Lechner, T. Dalibor & J. Palm  
AVANCIS, Munich, Germany

**3BO.8.3 High Efficiency Solution Coated Cu(In,Ga)(Se,S)<sub>2</sub> Thin Film Solar Cells**

T. Aramoto & Y. Kawaguchi  
Solar Frontier, Atsugi, Japan  
Y.-C. Liao, Y. Kikuchi, T. Ohashi, H. Iida & A. Nakamura  
Tokyo Ohka Kogyo, Koza-Gun, Japan

**3BO.8.4 Recrystallization of Printed Cu(In,Ga)S Nanoparticle Absorber Layers**

S.K. Stubbs, C.G. Allen, P. Kirkham, Z. Liu, A. Whiteside,  
C. Newman, O. Masala & S. Whitelegg  
Nanoco Technologies, Manchester, United Kingdom  
A. Abbas, A. Eeles, J. Bowers & M. Walls  
Loughborough University, United Kingdom

**3BO.8.5 Revealing Laser-Induced Damages in CIGSe Based Solar Cells by Means of Photoluminescence and Thermography**

G. Farias, C. Schultz & B. Stegemann  
Berlin University of Applied Sciences, Germany  
C. Wolf, C.A. Kaufmann, B. Rau & R. Schlatmann  
HZB, Berlin, Germany

**ORAL PRESENTATIONS 1BO.12**

**17:00 - 18:30 Advanced Concepts for Modules**

**Chairpersons:**

U. Eitner  
Fraunhofer ISE, Germany

G. Beaucarne  
Dow Corning, Belgium

**1BO.12.1 Universal External Light Trap for Photovoltaic Modules**

L. van Dijk & M. Di Vece  
Utrecht University, The Netherlands  
J. van de Groep & A. Polman  
AMOLF, Amsterdam, The Netherlands  
R.E.I. Schropp  
Eindhoven University of Technology, The Netherlands

**1BO.12.2 White Bifacial Modules – Improved STC Performance Combined with Bifacial Energy Yield**

B.B. Van Aken, L.A.G. Okel, J. Liu & J.A.M. Van Roosmalen  
ECN, Petten, The Netherlands

**1BO.12.3 Enabling Solderability of PVD Al Rear Contacts on High-Efficiency Crystalline Silicon Solar Cells by Wet Chemical Treatment**

H. Nagel, M. Kamp, D. Eberlein, J. Bartsch, M. Glatthaar & S.W. Glunz  
Fraunhofer ISE, Freiburg, Germany

**1BO.12.4 Results on Module Integration of IBC Solar Cells Based on the Conductive Backsheet Approach**

A. Halm, A. Schneider, V.D. Mihailetchi, L.J. Koduvelikulathu, G. Galbiati, H. Chu, R. Roescu,  
J. Libal & R. Kopecek  
ISC Konstanz, Germany  
B. de Gier & N. van Ommen  
Eurotron, Bleskensgraaf, The Netherlands

**1BO.12.5 Small Unit Compound Modules: a New Approach for Light Weight PV Modules**

H. Nussbaumer, M. Klenk & N. Keller  
Zurich University of Applied Sciences, Winterthur,  
Switzerland

**1BO.12.6 Reconfigurable Topologies for Smarter PV Modules: Simulation, Evaluation and Implementation**

P. Bauwens & J. Doutreloigne  
Ghent University, Belgium  
J. Govaerts, F. Catthoor, H. Goverde & J. Poortmans  
imec, Leuven, Belgium  
M. Baka & D. Anagnostos  
NTUA, Athens, Greece  
K. Baert & G. Vandenbroeck  
KU Leuven, Heverlee, Belgium

**VISUAL PRESENTATIONS 5BV.4**

**17:00 - 18:30 PV Cells and Modules (II)**

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

**VISUAL PRESENTATIONS 2BV.7**

**17:00 - 18:30 Silicon Solar Cell Characterisation and Modelling / Manufacturing and Processing**

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





ORAL PRESENTATIONS 3CO.5

08:30 - 09:30 Characterisation and Simulation for Thin Film Devices

Chairpersons:

J.R. Sites  
Colorado State University, United States

P. Pistor  
IREC, Spain

**3CO.5.1 Spatially Resolved Determination of the Absolute Collected Photocurrent from Solar Cells Using Electro-Modulated Luminescence**

V. Huhn, A. Gerber, B.E. Pieters, Y. Augarten & U. Rau  
Forschungszentrum Jülich, Germany

**3CO.5.2 EU PVSEC Student Award Winner Presentation**

**Quantitative Mapping of Interface Defects in Cu(In,Ga)Se<sub>2</sub> Solar Cells Using Photoluminescence-Based Methods**

G. El Hajje, D. Ory, J.F. Guillemoles & L. Lombez  
CNRS, Chatou, France

**3CO.5.3 Reverse-Bias Induced Shunt Formation in Cu(In,Ga)Se<sub>2</sub> Thin Film Solar Cells: an Approach with Three-Dimensional Electro-Thermal Simulations**

M. Richter, J. Neerken & J. Parisi  
University of Oldenburg, Germany

**3CO.5.4 Chalcogenides CIGS Thin Films: a Novel Cross Strategy Approach of Surface and Volume Characterizations**

A. Loubat, M. Bouttemy, D. Aureau, J. Vigneron & A. Etcheberry  
CNRS, Versailles, France  
F. Mollica, N. Naghavi & D. Lincot  
CNRS, Chatou, France  
C. Eypert  
HORIBA, Palaiseau, France  
S. Gaiaschi & P. Chapon  
HORIBA, Longjumeau, France  
M. Jubault & F. Donsanti  
EDF, Chatou, France

ORAL PRESENTATIONS 1CO.9

08:30 - 09:30 New Light Management Concepts

Chairpersons:

invited

I. Kononov  
Ernst Abbe University of Applied Science Jena, Germany

**1CO.9.1 Enhanced Solar Cell Current and Voltage by Nanostructuring**

D. van Dam, Y. Cui, N.J.J. van Hoof, R.P.J. van Veldhoven, E.P.A.M. Bakkers & J.E.M. Haverkort  
Eindhoven University of Technology, The Netherlands  
S.A. Mann & E.C. Garnett  
AMOLF, Amsterdam, The Netherlands

**1CO.9.2 Photovoltaic-Performance-Enhancing Patch with Combined Light Trapping and Spectral Upconverting Effect**

D. Desta  
University of Aveiro, Portugal  
E. Eriksen, B.R. Jeppesen, P.B. Jensen, S.P. Madsen, A. Nylandsted Larsen, P. Balling & S.K. Ram  
Aarhus University, Denmark  
M. Bellettato, R. Rizzoli & C. Summonte  
CNR, Bologna, Italy

**1CO.9.3 Electrical and Optical Performances of Silicon Solar Cells Modulated by Plasmonics Scattering of Silver and Indium Nanoparticles**

S.-H. Weng, W.-J. Ho, Y.-Y. Lee, C.-H. Hu, W.-L. Wang & Y.-J. Deng  
NTUT, Taipei, Taiwan  
H.-P. Shiao  
Win Semiconductor, Taoyuan, Taiwan

**1CO.9.4 Graphene Quantum Dot Layers with Down-Conversion Effect on Crystalline Silicon Solar Cells**

K.D. Lee, D.-Y. Kim, S.M. Kim, S. Kim, H. Kim, H. Park, H.-S. Lee, Y. Kang, S.S. Yoon & D. Kim  
Korea University, Seoul, Korea South  
M.J. Park & B.H. Hong  
Seoul National University, Korea South

**ORAL PRESENTATIONS 5CO.13**

**08:30 - 09:30 Interconnects and Cell Cracking**

**Chairpersons:**

M. Köntges  
ISFH, Germany

D. Jordan (*i*)  
NREL, USA

**5CO.13.1 Impact of Ribbon Specification and Handling during PV Module Manufacturing to Module Reliability**

A. Schneider, R. Fernada, J. Schmauder & R. Harney  
ISC Konstanz, Germany  
T. Link  
SI Module, Freiburg, Germany

**5CO.13.2 Fatigue Analysis of Solar Cell Interconnectors due to Cyclic Mechanical Loading**

M. Pander, R. Meier, S. Dietrich & M. Ebert  
Fraunhofer CSP, Halle (Saale), Germany

**5CO.13.3 Extended Thermal Cycling Lifetime Testing on Crystalline Silicon Solar Modules with Artificially Introduced Defects**

J. Schmauder, K. Kurz & A. Schneider  
ISC Konstanz, Germany

**5CO.13.4 Reliability of Low Temperature Conductive Film Interconnection Process for PV Modules**

S. Zhang, Y. Xie, H. Jiao, J. Xu, Z. Feng & P.J. Verlinden  
Trina Solar Energy, Changzhou, China

**VISUAL PRESENTATIONS 4CV.1**

**08:30 - 09:30 III-V-based Devices for Terrestrial and Space Applications / Concentrator and Space Systems**

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

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

**09:50 - 12:10 Thin Film Solar Cells and Modules // Concentrator and Space Applications**

**Chairpersons:**

J. Cárabe  
CIEMAT, Spain

C. Signorini  
ESA-ESTEC, The Netherlands

**3CP.1.1 Advanced Si Epi-Foil-Based PV Devices**

J. Poortmans  
imec, Leuven, Belgium

**3CP.1.2 Progress on Making Perovskite Solar Cells Viable Products**

A. Hagfeldt  
Uppsala University, Sweden

**3CP.1.3 Advances and Opportunities in CIGS Thin Film Photovoltaics R&D**

A.N. Tiwari  
EMPA, Dübendorf, Switzerland

**3CP.1.4 Delivering on the Promise of Thin-Film PV**

D. Weiss  
First Solar, Santa Clara, USA

**3CP.1.5 The Future of CIGS Technology: Production Standardization and Product Differentiation**

J. Palm  
AVANCIS, Munich, Germany

**4CP.2.1 invited**

**ORAL PRESENTATIONS 2CO.2**

**13:30 - 15:00 Metallisation Technologies for Si Solar Cells**

**Chairpersons:**

J. Horzel  
CSEM - Centre Suisse d'Electronique et de Microtechnique  
SA, Switzerland

J. Libal  
ISC Konstanz, Germany

**2CO.2.1 22.77% Efficient n-Type PERT Solar Cell with Plating Metallization Process**

W. Duan, S. Yuan, Y. Sheng, W. Cai, Z. Zhang, Y. Chen,  
Y. Yang, P.P. Altermatt, P.J. Verlinden & Z. Feng  
Trina Solar Energy, Changzhou, China

**2CO.2.2 High Speed Dispensing – a High-Throughput Metallization Technology for >21% PERC Type Solar Cells**

M. Pospischil, M. Klawitter, M. Kuchler, M. Linse,  
S. Gutscher, A. Brand, F. Clement & D. Biro  
Fraunhofer ISE, Freiburg, Germany  
M. König  
Heraeus, Hanau, Germany  
L. Wende  
ASYS, Dornstadt, Germany

**2CO.2.3 Flip-Flop Cell Interconnection Enabled by an Extremely High Bifaciality of Screen-Printed Ion Implanted n-PERT Si Solar Cells**

H. Schulte-Huxel, F. Kiefer, S. Blankemeyer, R. Witteck,  
M. Vogt, M. Köntges, R. Brendel & R. Peibst  
ISFH, Emmerthal, Germany  
J. Krügener  
Leibniz University, Hanover, Germany

**2CO.2.4 High-Throughput Front Side Metallization of Busbarless Solar Cells Using Rotational Flexographic Printing**

A. Lorenz, C. Gredy & F. Clement  
Fraunhofer ISE, Freiburg, Germany  
S. Beyer & J. Ufheil  
SOMONT, Umkirch, Germany  
Y. Yao  
Meyer Burger Technology, Gwatt, Switzerland  
A. Senne  
ContiTech, Northeim, Germany  
H. Reinecke  
University of Freiburg, Germany

**2CO.2.5 Bifacial n-PERT Cells (BiPERT) with Plated Contacts for Smart-Wire Interconnection**

E. Cornagliotti, L. Tous, A. Uruena de Castro, R. Russell,  
M. Aleman, P. Choulat, A. Sharma, J. John, F. Duerinckx &  
J. Szlufcik  
imec, Leuven, Belgium

**2CO.2.6 Laser Formed Anchor Points for Copper Plating Adhesion on Al-BSF and PERC Cells**

A. Wenham, C.M. Chong, S. Wang, J. Ji, Z. Shi, L. Mai,  
A. Sugianto, S. Wenham, A. Barnett & M. Green  
UNSW Australia, Sydney, Australia

**ORAL PRESENTATIONS 4CO.6**

**13:30 - 15:00 III-V-based Devices for Terrestrial and Space Applications / Concentrator and Space Systems**

**Chairpersons:**

M.C. Casale  
CESI, Italy

A.D. Johnson  
IQE, United Kingdom

**4CO.6.1 III-V Multi-Junction Metal-Wrap-through (MWT) Concentrator Solar Cells**

E. Oliva, H. Helmers, M. Steiner, M. Schachtner,  
V. Klinger & F. Dimroth  
Fraunhofer ISE, Freiburg, Germany  
T. Salvetat, C. Jany, R. Thibon & J.-S. Moulet  
CEA, Le Bourget du Lac, France

**4CO.6.2 Group-V in-Diffusion and Si(100) Surface Preparation for Single-Domain III/V-on-Si Tandem Absorbers**

A. Paszuk, O. Supplie, S. Brückner, A. Dobrich, M.M. May,  
C. Koppka, M. Duda, A. Nägelein, P. Kleinschmidt &  
T. Hannappel  
Ilmenau University of Technology, Germany

**4CO.6.3 Improved Performance of III-V Multi-Junction Solar Cells Fabricated with Indium-Tin-Oxide Electrodes**

R.-H. Horng, Y.-C. Kao, F.-L. Wu & S.-H. Shi  
NCTU, Taichung, Taiwan  
S.-L. Ou  
Da-Yeh University, Changhua, Taiwan

**4CO.6.4 Luminescent Solar Noise Barrier – Large Scale Testing and Modeling**

L.H. Slooff  
ECN, Petten, The Netherlands  
S. Verkuilen  
Heijmans Wegen, Rosmalen, The Netherlands  
M.M. de Jong & M.N. van den Donker  
SEAC, Eindhoven, The Netherlands  
M. Kanellis & M.G. Debije  
Eindhoven University of Technology, The Netherlands

**4CO.6.5 Developing a Low Concentration Module Using PV Assembly Processes and Suitable for Both Terrestrial and Space Applications**

C. Weick, P. García-Linares, P. Voarino & M. Baudrit  
CEA, Le Bourget Du Lac, France

**4CO.6.6 Performance Analysis of Ecosole HCPV System**

C. Cancro, G. Graditi, G. Ciniglio, G. Leanza, A. Borriello,  
A. Merola, S. Ferlito & F. Pascarella  
ENEA, Portici, Italy  
M. Carpanelli, G. Borelli, D. Verdilio, D. De Nardis & V. Gilioli  
Bezar, Monteveglio, Italy

**ORAL PRESENTATIONS 1CO.10**

**13:30 - 15:00 New Solar Cell Concepts**

**Chairpersons:**

invited

invited

**1CO.10.1 Al-Back Surface Field-Type Crystalline Si-Based Smart Stack Triple-Junction (InGaP/GaAs/Si) Cells**

H. Mizuno, K. Makita, T. Tayagaki, T. Mochizuki, Y. Kida,  
T. Sugaya & H. Takato  
AIST, Koriyama, Japan

**1CO.10.2 Photoresponse Properties of BaSi<sub>2</sub> Film Grown on Si (100) by Vacuum Evaporation**

C.T. Trinh, Y. Nakagawa & N. Usami  
Nagoya University, Japan  
K.O. Hara  
University of Yamanashi, Japan  
R. Takabe & T. Suemasu  
University of Tsukuba, Japan

**1CO.10.3 Organometallic Halide Perovskite / Barium Di-Silicide Thin-Film Double-Junction Solar Cells**

O. Isabella, R. Vismara & M. Zeman  
Delft University of Technology, The Netherlands

**1CO.10.4 Solar Grade III-V Substrates for Cost Effective High Efficiency Photovoltaics**

Y.-T. Sun, G. Omanakuttan, C. Reuterskiöld Hedlund,  
M. Hammar & S. Lourduoss  
KTH Royal Institute of Technology, Kista, Sweden

**1CO.10.5 Back-Contacted Thin-Film GaAs Solar Cells**

C.-Y. Hong, Y.-C. Lin, K.-Y. Ho, J.-L. Tsai, T.-C. Zhan,  
Y.-R. Wu, A. Lin, W.-Y. Uen, G.-C. Chi & P. Yu  
NCTU, Hsinchu, Taiwan

**1CO.10.6 Recent Advances in Polymer/Silicon Heterojunction Solar Cells**

J. Schmidt, D. Zielke & R. Gogolin  
ISFH, Emmerthal, Germany  
R. Sauer & W. Lövenich  
Heraeus Deutschland, Leverkusen, Germany

**ORAL PRESENTATIONS 5CO.14**

**13:30 - 15:00 Bifacial Performance and Yield Measurement**

**Chairpersons:**

K. Peter  
ISC Konstanz, Germany

M. Grottko  
WIP - Renewable Energies, Germany

**5CO.14.1 Geographical Mapping of the Performance of Vertically Installed Bifacial Modules**

M. Ito  
Waseda University, Tokyo, Japan  
E. Gerritsen  
CEA, Le Bourget du Lac, France

**5CO.14.2 Modelling of Single-Axis Tracking Gain for Bifacial PV Systems**

A. Lindsay, M. Chiodetti, D. Binesti & P. Dupeyrat  
EDF R&D, Moret-sur-Loing, France  
S. Mousel, E. Lutun & K. Radouane  
EDF EN, Paris, France



**5CO.14.3 Performance Analysis of PV Green Roof Systems**

T. Baumann, D. Schär, F. Carigiet & F. Baumgartner  
Zurich University of Applied Sciences, Winterthur,  
Switzerland  
A. Dreisiebner  
Solarspar, Sissach, Switzerland

**5CO.14.4 Performance Monitoring of Different Module Technologies and Design Configurations of PV Systems in South Africa**

T. Serameng, K. Cunden & S. Myeni  
Eskom, Johannesburg, South Africa  
K.T. Roro, M.B. Ayanna & S. Koopman  
CSIR, Pretoria, South Africa

**5CO.14.5 The Need of Frameless Mounting Structures for Vertical Mounting of Bifacial PV Modules**

J. Rabanal-Arabach, A. Schneider & R. Kopecek  
ISC Konstanz, Germany  
M. Mrcarica  
DSM Innovation Center, Sittard, The Netherlands

**5CO.14.6 Performance Analysis of Photovoltaics Systems Installed at Different Sites in the Atacama Desert**

F. Araya, P. Ferrada, A. Marzo & E. Fuentealba  
University of Antofagasta, Chile  
J. Rabanal-Arabach  
ISC Konstanz, Germany

**VISUAL PRESENTATIONS 3CV.2**

**13:30 - 15:00 CdTe, CIS and Related Thin Film Solar Cells and Modules (I)**

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

**ORAL PRESENTATIONS 2CO.3**

**15:15 - 16:45 n-Type PERT Solar Cell Concepts**

**Chairpersons:**

A.W. Weeber  
ECN, The Netherlands

J. Bagdahn  
Fraunhofer CSP, Germany

**2CO.3.1 Oxygen Vacancies in Tungsten Oxide and Their Influence on Tungsten Oxide/Silicon Heterojunction Solar Cells**

M. Mews, L. Korte & B. Rech  
HZB, Berlin, Germany

**2CO.3.2 n-PERT Solar Cells with Passivated Contact Technology Based on LPCVD Polysilicon and Fire-through Contact Metallization**

R.C.G. Naber, M. Lenes, A.H.G. Vlooswijk & J.R.M. Luchies  
Tempress, Vaassen, The Netherlands  
Z. Qian, F. Zheng, J. Lin & Z. Zhang  
Shanghai ShenZhou New Energy Development, China

**2CO.3.3 20% n-PERT Solar Device in Only 7 Steps: the Solenna(3) Concept**

R. Cabal, B. Grange, R. Monna, Y. Veschetti & S. Dubois  
CEA, Le Bourget du Lac, France

**2CO.3.4 21.3% Large Area n-PERT Silicon Solar Cells Using Screen-Printed Aluminium with Open Circuit Voltage above 680mV**

J. Chen, F. Duerinckx, E. Cornagliotti, A. Uruena de Castro, L. Tous, M. Aleman, R. Russell, P. Choulat, S. Singh, J. Cho, J. John, I. Kuzma Filipek, M. Haslinger, I. Gordon, J. Poortmans & J. Szlufcik  
imec, Leuven, Belgium

**2CO.3.5 n-PERC c-Si Solar Cell Architecture with Front and Rear Ion-Implanted Carrier-Selective Contacts**

A. Ingenito, H. Dijkslag, G. Yang, O. Isabella & M. Zeman  
Delft University of Technology, The Netherlands

**2CO.3.6 Industrial n-Type Bifacial Co-Diffused Rear Emitter Solar Cells with Boron Silicate Glass as Diffusion Source and Passivation**

N. Wehmeier, S. Kajari-Schröder, T. Brendemühl, A. Nowack, R. Brendel & T. Dullweber  
ISFH, Emmerthal, Germany

ORAL PRESENTATIONS 3CO.7

15:15 - 16:45 Perovskite Solar Cells and Modules: Processing

Chairpersons:

Y. Chen  
Nanyang Technological University, Singapore

S. Hayase  
Institute of Technology, Japan

3CO.7.1 **Special Introductory Presentation  
Towards Roll-to-Roll Manufacturing of Perovskite Based  
PV Modules**

R. Andriessen & P. Poodt  
TNO, Eindhoven, The Netherlands

T. Aernouts  
imec, Leuven, Belgium

S. Veenstra  
ECN, Eindhoven, The Netherlands

R. Janssen & A. Createore  
TU/e, Eindhoven, The Netherlands

D. Vanderezand  
University of Hasselt, Diepenbeek, Belgium

T. Kirchartz  
Forschungszentrum Jülich, Germany

3CO.7.2 **High-Efficiency Planar-Structure Perovskite Solar Cells  
from Low Temperature Proximity Evaporation Technique**

S.-P. Lin, H.-C. Lee, P.-T. Guo & C.-F. Lin  
NTU, Taipei, Taiwan

3CO.7.3 **Perovskite-Based Solar Cells: towards Large & Flexible  
Devices**

L. Wagner, M. Manceau, F. Ardiaca & S. Berson  
CEA, Le Bourget du Lac, France

3CO.7.4 **A Fast Spray Deposition Approach for High Efficient Planar  
Heterojunction Solar Cells**

Z. Bi, Z. Liang, X. Xu, J. Li & G. Xu  
Chinese Academy of Science, Guangzhou, China

N. Yuan & J. Ding  
Changzhou University, Jiangsu, China

3CO.7.5 **Loss Analysis and Optimization for High Efficiency  
Perovskite Photovoltaic Modules**

R. Gehlhaar, T. Merckx, C. Masse de la Huerta,  
L. Rakocevic, W. Qiu & M. Jaysankar  
imec, Leuven, Belgium

ORAL PRESENTATIONS 1CO.11

15:15 - 16:45 New Materials for Modules

Chairpersons:

J. Poortmans  
imec, Belgium

B.B. Van Aken  
ECN, The Netherlands

1CO.11.1 **Back in the PV Galaxy: the Return of the Silicone Module**

G. Beaucarne  
Dow Corning, Seneffe, Belgium  
S. Wang, X. Sun, Y. Wu & Y. Huang  
BYD, Shenzhen, China  
N. Shephard  
Dow Corning, Midland, United States

1CO.11.2 **Investigation of Thermomechanical Stress in Solar Cells  
with Multi Busbar Interconnection by Finite Element  
Modeling**

L.C. Rendler, A. Kraft & U. Eitner  
Fraunhofer ISE, Freiburg, Germany  
C. Ebert  
Gebr. Schmid, Freudenstadt, Germany  
S. Wiese  
Saarland University, Saarbrücken, Germany

1CO.11.3 **Production of Cheap Back Contact Based PV Modules**

M.J.A.A. Goris, A. Biesbroek, B.W.J. Kikkert & J.M. Kroon  
ECN, Petten, The Netherlands  
K. Rozema  
Dycomet Europe, Akkrum, The Netherlands  
I.J. Bennett  
DSM Innovation Center, Sittard, The Netherlands  
J. Verlaak  
DSM Coating Resins, Zwolle, The Netherlands

1CO.11.4 **Novel Conductive Adhesive Concept for Solar Module  
Manufacturing**

S. Helland, T. Helland & E. Kalland  
Mosaic Solutions, Skjetten, Norway  
H. Kristiansen & K. Redford  
Conpart, Skjetten, Norway

1CO.11.5 **DSM Light Trapping Technology for Bifacial PV Modules**

P. Pasmans  
DSM, Geleen, The Netherlands  
M. Mrcarica & K. Du-Mong  
DSM, Sittard, The Netherlands  
A. Schneider & J. Rabanal-Arabach  
ISC Konstanz, Germany

**1CO.11.6 Novel High Performance, Highly Durable, Anti-Reflective Coating for Photovoltaic Glass**

B. Brophy, S. Maghsoodi & P. Gonsalves  
Enki Technology, San Jose, United States  
M. Terry, J. Dee & C. Alcantara  
DuPont, Sunnyvale, United States  
Y. Wang, J. Qi & D. Hu  
Lerri Solar Technology, Xi'an, China

**ORAL PRESENTATIONS 5CO.15**

**15:15 - 16:45 MPP, Inverter and Grid Services**

**Chairpersons:**

C. Wittwer  
Fraunhofer ISE, Germany

H. Te Heesen  
Tier University of Applied Science, Germany

**5CO.15.1 Low Cost Maximum Power Point Tracker Replaces Bypass-Diode**

T. Czarnecki, A. Schneck & R. Merz  
University of Applied Sciences Karlsruhe, Germany

**5CO.15.2 Power Balance Control for a Two-Stage Solar Inverter with Low Voltage Ride through Capability**

G. Kampitsis, E. Batzelis & S. Papathanassiou  
NTUA, Athens, Greece

**5CO.15.3 Module-Level Power Electronics: the Business Case from an End-User Perspective**

M.N. van den Donker, G. Verberne, K. Sinapis & W. Folkerts  
ECN, Eindhoven, The Netherlands

**5CO.15.4 Field and Laboratory Performance Characterisation of Microinverter and Power Optimizer Systems**

D. Stellbogen, P. Lechner & M. Senger  
ZSW, Stuttgart, Germany

**5CO.15.5 Genetic Algorithm Selection of Optimal Values for 4-Bit Active Power Control of Solar Inverters**

A. El Hassani El Alaoui, B. Ikken, Z. Naimi,  
K. Belrhiti Alaoui, A. Benlarabi & A. Benazzouz  
IRESEN, Rabat, Morocco  
M. Taalabi & K. Lefrouni  
EMI, Rabat, Morocco

**5CO.15.6 Lessons Learned from the Design and Operation of a 300 kWp PV System with Full Self-Consumption of the Energy Produced**

B. Gaidon & M. Joos  
Hespul, Lyon, France  
A. Thebault & C. Derobert  
Enercoop, Paris, France  
N. Debray  
Enercoop Bretagne, Rennes, France  
M. Dupret & B. Rozel  
Enertech, Felines, France

**VISUAL PRESENTATIONS 5CV.3**

**15:15 - 16:45 Solar Resource and Forecasting / Sustainability and Recycling**

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

**ORAL PRESENTATIONS 2CO.4**

**17:00 - 18:30 Solar Cell Concepts Based on Passivating Contacts**

**Chairpersons:**

S.W. Glunz  
Fraunhofer ISE, Germany

S. De Wolf  
EPFL, Switzerland

**2CO.4.1 A Quantitative Measure for the Carrier Selectivity of Contacts to Solar Cells**

R. Brendel & R. Peibst  
ISFH, Emmerthal, Germany

**2CO.4.2 Titanium Dioxide: a Promising Candidate Material as Electron-Selective Passivating Contact for Crystalline Silicon Solar Cells?**

J. Melskens, B.W.H. van de Loo, B. Macco,  
R.W.H.S. Scheerder & W.M.M. Kessels  
Eindhoven University of Technology, The Netherlands

**2CO.4.3 Optimization of p+ Poly-Si / c-Si Junctions on Wet-Chemically Grown Interfacial Oxides and on Different Wafer Morphologies**

Y. Larionova, R. Peibst, M. Turcu, S. Reiter & R. Brendel  
ISFH, Emmerthal, Germany  
D. Tetzlaff & J. Krügener  
Leibniz University of Hannover, Germany  
T. Wietler  
Leibniz Universität Hannover, Germany  
U. Höhne & J.-D. Köhler  
centrotherm, Hannover, Germany

**2CO.4.4 High Efficiency Tunnel Oxide Junction Solar Cell Enabling Record 22% Efficiency Solar Module**

J.B. Heng, Z. Xie, A. Reddy, B. Yang, P. Nguyen, J. Fu, K. Lam, C. Erben, Z. Huang, Y. Kang & Z. Xu  
Silevo, Fremont, United States

**2CO.4.5 High Volume Manufacturing of High Efficiency Crystalline Silicon Solar Cells with Shielded Metal Contacts**

O. Schultz-Wittmann, D. de Ceuster, A. Turner, B. Eggleston, D. Suwito, V. Prajapati & S. Baker-Finch  
First Solar, Santa Clara, United States

**2CO.4.6 n-Type Polysilicon Passivating Contacts for Industrial Bifacial n-PERT Cells**

M.K. Stodolny, Y. Wu, G.J.M. Janssen, I. Romijn & L.J. Geerligs  
ECN, Petten, The Netherlands  
M. Lenès & J.R.M. Luchies  
Tempress Systems, Vaassen, The Netherlands

**ORAL PRESENTATIONS 3CO.8**

**17:00 - 18:30 Organic Photovoltaic Devices**

**Chairpersons:**

invited

R. Dunbar  
CSIRO Energy Technology, Australia

**3CO.8.1 Special Introductory Presentation Industrialization of OPV**

S. Wieder  
Merck, Darmstadt, Germany

**3CO.8.2 invited**

**3CO.8.3 Organic Photovoltaics for Energy Harvester of Wireless Sensor Network**

Y. Aoki  
Rohm, Kyoto, Japan

**3CO.8.4 Digital Processing and Lifetime Study of Flexible Organic Photovoltaic Modules**

M. Manceau, A. Barbot, F. Ardiaca, N. Nguyen, M. Matheron & S. Berson  
CEA, Le Bourget du Lac, France

**3CO.8.5 EU PVSEC Student Award Winner Presentation Highly Efficient, All-Solution Processed, Mechanically Flexible, Semi-Transparent Organic Solar Modules**

J. Czolk, D. Landerer, M. Koppitz, C. Sprau & A. Colmann  
Karlsruhe Institute of Technology, Germany

**ORAL PRESENTATIONS 6CO.12**

**17:00 - 18:30 Grid and Energy System Integration (III) - Technology Solutions**

**Chairpersons:**

H. Nussbaumer  
Zurich University of Applied Sciences, Switzerland

S. Caneva  
WIP - Renewable Energies, Germany

**6CO.12.1 Efficiency and Effectiveness of PV Battery Energy Storage Systems for Residential Applications - Experience from Laboratory Tests of Commercial Products**

C. Messner, R. Bründlinger, J. Kathan & J. Mayr  
AIT, Vienna, Austria

**6CO.12.2 Characterising the Prevalence and Persistence of Solar Energy Fluctuations for Successful PV Integration Using Battery Storage Systems**

J. Barry, N. Munzke & J. Thomas  
Karlsruhe Institute of Technology,  
Eggenstein-Leopoldshafen, Germany

**6CO.12.3 PV Battery Learning Curve and Future Market Penetration**

F.P. Baumgartner  
Zurich University of Applied Sciences, Winterthur,  
Switzerland

**6CO.12.4 Assessing the Potential of Hybrid PV-Battery Systems to Cover HVAC Loads under Southern European Climate Conditions**

J.C. Solano, L. Olivieri, E. Caamaño-Martín & G. Almeida Dávi  
UPM, Madrid, Spain

**6CO.12.5 Combined PV Solar Compression Cooling and Free Cooling System**

P. Gantenbein, L. Omlin & D. Notter  
Institut für Solartechnik, Rapperswil, Switzerland  
A. Snegirjovs  
Technical University, Riga, Latvia

**6CO.12.6 Optimized Demand Side Management and Minimized Battery Storage for High Self-Consumption with PV Driven Low-Part-Load Heat Pumps or Compression Chillers**

M. Spinnler, J. Shen, B. Heithorst, F. Kiefer, A. Kastl,  
A. Präbst & T. Sattelmayer  
Munich University of Technology, Garching, Germany

**ORAL PRESENTATIONS 5CO.16**

**17:00 - 18:30 Meteorology, Improved Yield Estimation and Soiling Effects**

**Chairpersons:**

E. Lorenz  
Fraunhofer ISE, Germany

C. Nyman  
Soleco, Finland

**5CO.16.1 EU PVSEC Student Award Winner Presentation Combining Solar Irradiance Databases and PV Performance Model for PV System Performance Analysis**

B. Kirn & M. Topic  
University of Ljubljana, Slovenia

**5CO.16.2 Impact of Wind on Intra-Module Energy Yield Variations**

H. Goverde, J. Govaerts, E. Voroshazi, F. Cattthoor & J. Poortmans  
imec, Leuven, Belgium  
G. Van den Broeck, B. Herteleer, D. Goossens,  
K. Baert & J. Driesen  
KU Leuven, Belgium  
D. Anagnostos  
NTUA, Athens, Greece

**5CO.16.3 Quantification of Losses Caused by Dynamically Changing Shadows in Multi-MW PV Plants Based on Advanced Monitoring Data Analysis**

G. Mütter & B. Eizinger  
Alternative Energy Solutions, Vienna, Austria  
M. Edelbacher  
Greentec Services, Diepoldsau, Switzerland

**5CO.16.4 Snow Cover Mapping Improved and Updated for Site Assessment, Yield Forecast and Photovoltaic System Design**

F. Kaiser & M. Zehner  
Rosenheim University of Applied Sciences, Germany  
G. Wirth  
Cronimet Mining Power Solutions, Unterhaching, Germany  
R. Gottschalg  
Loughborough University, United Kingdom  
G. Becker & F. Flade  
SeV Bavaria, Munich, Germany  
M. Schroedter-Homscheidt  
German Aerospace Center, Wessling, Germany

**5CO.16.5 Advanced Analyses of Loss Mechanisms for PV Systems in Delhi, India**

A.M. Nobre, D. Dave, A. Khor, R. Malhotra & S. Karthik  
Cleantech Energy, Singapore, Singapore  
M. Peters  
MIT, Cambridge, United States  
T. Reindl  
SERIS, Singapore, Singapore

**5CO.16.6 Performance of Photovoltaic Panels under Soiling in Capital City of Chile**

E. Urrejola, P. Ayala, M. Salgado, G. Ramírez-Sagner,  
C. Cortés & A. Pino  
Fraunhofer Chile, Santiago, Chile  
J. Antonanzas  
University of La Rioja, Logrono, Spain  
R. Escobar  
Pontifical Catholic University of Chile, Santiago, Chile

**VISUAL PRESENTATIONS 3CV.4**

**17:00 - 18:30 CdTe, CIS and Related Thin Film Solar Cells and Modules (II)**

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

**EU PVSEC Dinner**





## ORAL PRESENTATIONS 6DO.5

08:30 - 09:30 **Grid and Energy System Integration (I) / Utility-Scale PV**

### Chairpersons:

I. Weiss  
WIP - Renewable Energies, Germany

F. Bonemazzi  
ENEL, Italy

### 6DO.5.1 **Simulation of Local Energy Surplus Usage in Hybrid Grids with a High PV Penetration Rate**

D. Stacic, G. Heilscher, H. Ruf, K. Ditz & D. Funk  
Ulm University of Applied Sciences, Germany  
F. Meier  
Stadtwerke Ulm, Germany

### 6DO.5.2 **Solar PV Resource for Higher Penetration through a Combined Spatial Aggregation with Wind**

T. Bischof-Niemz & C. Mushwana  
CSIR, Pretoria, South Africa

### 6DO.5.3 **Techno-Economic Optimization of Photovoltaic Plant Layout by Using Design of Experiments Techniques**

S.N. Ringlstetter, L. Haack, L. Sommer & R. Meyer  
Suntrace, Hamburg, Germany  
F. Dildey  
Hamburg University of Applied Sciences, Germany

### 6DO.5.4 **New Design Challenges in Large Scale PV Installations in Tough Contexts**

F. Montanari  
ENEL Green Power, Rome, Italy

## ORAL PRESENTATIONS 3DO.9

08:30 - 09:30 **Characterisation, Standards and Applications of Organic and Hybrid PV Devices**

### Chairpersons:

invited

Y. Aoki  
Rohm, Japan

### 3DO.9.1 **Progress in Standardization for OPV**

J. Hauch  
ZAE Bayern, Erlangen, Germany

### 3DO.9.2 **Long-Term Outdoor Performance Evaluation of Organic PV Modules**

R. Gehlhaar, E. Vandenplas, K. Cnops, D. Cheyns & T. Aernouts  
imec, Leuven, Belgium  
A.-F. Vaessen, H. Grandjean & S. Scheerlinck  
Laborelec, Linkebeek, Belgium

### 3DO.9.3 **Device Pre-Conditioning and Steady-State Temperature Dependence of Perovskite Solar Cells**

R. Dunbar, W. Moustafa, T.W. Jones, K.F. Anderson, C. Fell & G.J. Wilson  
CSIRO Energy Technology, Mayfield West, Australia  
A. Pascoe & Y.-B. Cheng  
ANU, Canberra, Australia

### 3DO.9.4 **Calibration Procedure for the Accurate Power Measurements of Slow Responding PV Devices (Hetero-Junction, Dye-Sensitized and Perovskite Solar Cells)**

G. Bardizza, D. Pavanello, R. Galleano, T. Sample & H. Müllejans  
European Commission, Ispra, Italy

## ORAL PRESENTATIONS 7DO.13

08:30 - 09:30 **Contribution of PV to the Energy Transition**

### Chairpersons:

D. Stickelberger  
Swissolar, Switzerland

M. Getsiou  
European Commission DG RTD, Belgium

### 7DO.13.1 **On the Role of Solar Photovoltaics in Global Energy Transition Scenarios**

C. Breyer, D. Bogdanov, O. Koskinen, M. Baraza, U. Caldera, S. Afanasyeva, M. Child & J. Farfan  
Lappeenranta University of Technology, Finland  
A. Gulagi & A. Aghahosseini  
Lappeenranta University of Technology (LUT), Finland  
L.S.N.S. Barbosa  
University of São Paulo, São Carlos, Brazil  
P. Vainikka  
VTT, Lappeenranta, Finland

**7DO.13.2 Market4RES- Post-2020 Framework for a Liberalised Electricity Market with a Large Share of Renewable Energy Sources**

T. Döring  
SolarPower Europe, Brussels, Belgium  
L. Olmos, P. Rodilla & C. Fernandes  
Comillas, Madrid, Spain  
A. Fontaine  
RTE, La Defense, France  
B. Caetano & R. Loureiro  
FOSG, Brussels, Belgium  
Y. Langer & H. Right  
APX Group, Amsterdam, The Netherlands  
S. Dourlens  
Technofi, Sophia-Antipolis, France  
W. Ove  
SINTEF, Trondheim, Norway  
B. Burgholzer  
EEG, Vienna, Austria

**7DO.13.3 The Relevance of PV in the Optimisation of Synergies Among Hybrid Energy Grids in Smart Cities – the Orpheus Project**

S. Caneva, I. Weiss & S. Betz  
WIP - Renewable Energies, Munich, Germany  
G. Heilscher, H. Ruf, D. Stacic, K. Ditz & D. Funk  
Ulm University of Applied Sciences, Germany  
F. Meier  
SWU Netz, Ulm, Germany  
A. Schülke, T.G. Noh, A. Papageorgiou, S. Nicolas & S. Nicolas  
NEC Laboratories, Cambridge, United Kingdom

**7DO.13.4 Interactive Web-Service for Environmental Multi-Criteria LCA of Photovoltaic Systems Worldwide**

P. Perez-Lopez, I. Blanc, B. Gschwind, P. Blanc & L. Menard  
MINES ParisTech, Sophia-Antipolis, France  
R. Frischknecht & P. Stolz  
Treeze, Zurich, Switzerland  
Y. Durand  
ADEME, Valbonne, France  
G. Heath  
NREL, Golden, United States

**VISUAL PRESENTATIONS 3DV.1**

**08:30 - 09:30 Silicon-based Thin Film Solar Cells and Modules II**

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

**PLENARY SESSION 5DP.1 / 6DP.2**

**09:50 - 12:10 Operation, Performance, Reliability and Sustainability of Photovoltaics // PV as Part of Our Built Environment: Solutions for Integration into Building Envelopes and Energy Systems**

**Chairpersons:**

M. Perrin  
CEA, France

F.P. Baumgartner  
Zurich University of Applied Sciences, Switzerland

**5DP.1.1 Keynote Presentation: Identification of Technical Risks in the PV Value Chain and Quantification of the Economic Impact on the Business Model**

D. Moser & M. Del Buono  
Eurac Research, Bolzano, Italy  
U. Jahn & M. Herz  
TÜV Rheinland, Cologne, Germany  
M. Richter & K. de Brabandere  
3E, Brussels, Belgium

**5DP.1.2 Mean Degradation Rates in PV Systems for Various Kinds of PV Module Failures**

M. Köntges & S. Altmann  
ISFH, Emmerthal, Germany  
U. Jahn  
TÜV Rheinland, Cologne, Germany

**5DP.1.3 Forecasting and Observability: Critical Technologies for System Operations with High PV Penetration**

P.-J. Alet  
CSEM, Neuchâtel, Switzerland  
V. Efthymiou  
University of Cyprus, Nicosia, Cyprus  
G. Graditi  
ENEA, Portici, Italy  
N. Henze  
Fraunhofer IWES, Kassel, Germany  
M. Juel  
SINTEF, Trondheim, Norway  
D. Moser & M. Pierro  
EURAC, Bolzano, Italy  
F. Nematic  
ApE, Ljubljana, Slovenia  
E. Rikos & S. Tselepis  
CRES, Athens, Greece  
G. Yang  
Technical University of Denmark, Lyngby, Denmark

- 5DP.1.4 PV Bifacial Yield Simulation with a Variable Albedo Model**  
M. Chiodetti, A. Lindsay, P. Dupeyrat & D. Binesti  
EDF R&D, Moret-sur-Loing, France  
E. Lutun, K. Radouane & S. Mousel  
EDF EN, Paris, France
- 6DP.2.1 *Keynote Presentation:* Emerging Performance Issues of Photovoltaic Battery Systems**  
J. Weniger, T. Tjaden, J. Bergner & V. Quaschnig  
Berlin University of Applied Sciences, Germany
- 6DP.2.2 BIPV – Getting the Technology and Integration Balance Right**  
A. Scognamiglio  
ENEA, Portici, Italy

#### ORAL PRESENTATIONS 2DO.2

13:30 - 15:00 **Minority Carrier Lifetime Degradation and Regeneration**

#### Chairpersons:

G. Hahn  
University of Konstanz, Germany

J.W. Müller  
Hanwha Q CELLS, Germany

- 2DO.2.1 Of Apples and Oranges: Why Comparing BO Regeneration Rates Requires Injection Level Correction**  
S. Wilking, S. Ebert, C. Beckh, A. Herguth & G. Hahn  
University of Konstanz, Germany
- 2DO.2.2 The Development of In-Line Regeneration Tool for the Effective Suppression of Light-Induced-Degradation on p-Type Silicon Solar Cells**  
K.-Y. Yen, J.-R. Huang, Y.-F. Lin, S.-P. Su, S.H.T. Chen & L.-W. Cheng  
Motech Industries, Taoyuan County, Taiwan
- 2DO.2.3 Degradation and Regeneration in mc Si After Different Gettering Steps**  
A. Zuschlag, D. Skorcka & G. Hahn  
University of Konstanz, Germany

- 2DO.2.4 Solutions for Preventing Carrier-Induced Degradation in Industrially Produced Multi-Crystalline PERC Cells**  
C. Chan, D. Payne, A. Wenham, T.H. Fung, B. Hallam, M. Abbott & S. Wenham  
UNSW Australia, Sydney, Australia
- 2DO.2.5 Measures for Eliminating Light-Induced Lifetime Degradation in Multicrystalline Silicon**  
D. Bredemeier, D.C. Walter, S. Herlufsen & J. Schmidt  
ISFH, Emmerthal, Germany
- 2DO.2.6 Impact of Al<sub>2</sub>O<sub>3</sub>/SiNx Passivation Layers on LeTID**  
F. Kersten & J.W. Müller  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany  
J. Heitmann  
Freiberg University of Technology, Germany

#### ORAL PRESENTATIONS 6DO.6

13:30 - 15:00 **Grid and Energy System Integration (II) - Case Studies**

#### Chairpersons:

W.C. Sinke  
ECN, The Netherlands

G. Masson  
Becquerel Institute, Belgium

- 6DO.6.1 Integration of PV to Industrial Consumers with Multiple Grid Supply and Energy Management in Lebanon and Palestine**  
M. Anzizu & X. Vallvé  
Trama TecnoAmbiental, Barcelona, Spain  
G. Velasco-Quesada  
CEIB, Barcelona, Spain  
H. Harajli  
UNDP, Beirut, Lebanon
- 6DO.6.2 Photovoltaic and Battery Energy Storage Systems in Shopping Malls: Energy and Cost Analysis of an Italian Case Study**  
G. Barchi, R. Lollini & D. Moser  
Eurac Research, Bolzano, Italy
- 6DO.6.3 PV Application and Energy Management in Near-Zero Energy Buildings with Heat Pump and E-Mobility – Case Study of the Nexushaus**  
J. Shen, S. Salfner, C. Hemmerle, F. Kiefer & W. Lang  
TUM, Munich, Germany

**6DO.6.4 Analysis of Stationary Electrical Storage Solutions for Residential Districts with High Photovoltaic Penetration**  
R. Völker, F. Schuldt, T. Kilper & K. von Maydell  
Next Energy, Oldenburg, Germany

**6DO.6.5 Advanced Simulation Platform for the Integration of Photovoltaics into Power Systems: SPIDER**  
F. Bourry & T.L. Phan  
CEA, Le Bourget du Lac, France  
B. Guinot, C. Bourasseau & S. Revol  
CEA, Grenoble, France

**6DO.6.6 Probabilistic Evaluation of UK Domestic Solar Photovoltaic Systems: An Integrated Geographical Information System PV Estimation Tool**  
P.A. Leicester, N. Doylend & P. Rowley  
Loughborough University, United Kingdom

#### ORAL PRESENTATIONS 5DO.10

13:30 - 15:00 **Failure Modes and Accelerated Testing**

##### Chairpersons:

U. Jahn  
TÜV Rheinland Energy, Germany

W. Knaupp  
PV-Plan, Germany

**5DO.10.1 *Special Introductory Presentation:* PV Degradation Curves: Non-Linearities and Failure Modes**  
D.C. Jordan, T.J. Silverman, B. Sekulic & S.R. Kurtz  
NREL, Golden, United States

**5DO.10.2 Acceleration Factors for Moisture Induced Degradation of Flexible PV Modules and Prediction of Field Performance**  
K. Hardikar, T. Krajewski & K. Toivola  
MiaSolé, Santa Clara, United States

**5DO.10.3 Bias and Irradiation Dependencies of CIGS Module Reliability during Heat Tests**  
K. Sakurai, K. Ogawa & H. Shibata  
AIST, Tsukuba, Japan  
A. Masuda  
AIST, Tosu, Japan  
H. Tomita, D. Schmitz & S. Tokuda  
Solar Frontier, Atsugi, Japan

**5DO.10.4 PV Module Damages Caused by Hail Impact and Non-Uniform Snow Load**  
G. Mathiak, J. Sommer, K. Kämmer, W. Herrmann, F. Reil & M. Hansen  
TÜV Rheinland, Cologne, Germany

**5DO.10.5 Investigation on the Impact of Module Cleaning on the Antireflection Coating**  
N. Ferretti, A. Sönmez & J. Berghold  
PI Berlin, Germany  
I. Ilse & C. Hagendorf  
Fraunhofer CSP, Halle, Germany

#### ORAL PRESENTATIONS 7DO.14

13:30 - 15:00 **PV Economics and Markets**

##### Chairpersons:

T. Nordmann  
TNC Consulting, Switzerland

C. Breyer  
Lappeenranta University of Technology, Finland

**7DO.14.1 Trends in Photovoltaic Applications the Latest Survey Results on PV Markets and Policies from the IEA PVPS Programme**  
G. Masson  
IEA PVPS, Brussels, Belgium  
P. Hüsler  
Nova Energie, Aarau, Switzerland  
I. Kaizuka  
RTS, Tokyo, Japan

**7DO.14.2 Global Photovoltaics in 2015 – Analysis of Current Solar Energy Markets and Hidden Growth Regions**  
C. Werner  
Chris Werner Energy Consulting, Dessau, Germany  
A. Gerlach  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany  
C. Breyer  
Lappeenranta University of Technology, Finland  
G. Masson  
Becquerel Institute, Brussels, Belgium

**7DO.14.3 Impact of FIT on the Cost of PV Systems in Japan**  
I. Kaizuka, H. Matsukawa, H. Yamaya, T. Ohigashi & O. Ikki  
RTS, Tokyo, Japan

**7DO.14.4 Technical Assumptions Used in PV Financial Models: Review and Analysis**

J. Vedde  
SiCon, Birkerød, Denmark  
M. Richter & C. Tjendgdrawira  
3E, Brussels, Belgium  
B. Herteleer  
KU Leuven, Belgium  
M. Herz & U. Jahn  
TÜV Rheinland, Cologne, Germany  
B. Stridh  
ABB Corporate Research, Västerås, Sweden  
L. Frearson  
CAT Projects, Alice Springs, Australia

**7DO.14.5 Impact of Energy Storage in Conjunction With Solar PV on Wholesale Electricity Prices**

F. Sanches, H. Gouzerh & N. Gourvitch  
Green Graffe Energy, Paris, France  
A. El Gammal, G. Masson & T.M.N. Ngo  
Becquerel Institute, Brussels, Belgium

**7DO.14.6 Electric Vehicles Powered with PV Electricity as a New Driver for Photovoltaic**

U. Muntwyler  
BUAS, Burgdorf, Switzerland

**VISUAL PRESENTATIONS 3DV.2**

**13:30 - 15:00 Perovskite, Organic and Hybrid Devices**

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

**ORAL PRESENTATIONS 2DO.3**

**15:15 - 16:45 Silicon Solar Cell Characterisation and Modelling (I)**

**Chairpersons:**

E. Cornagliotti  
imec, Belgium

D.C. Walter  
ISFH, Germany

**2DO.3.1 Evaluation of Passivated Surface of Silicon with Laser Terahertz Emission Microscope (LTEM)**

T. Mochizuki, J. Mitchell, K. Tanahashi, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan  
A. Ito & H. Nakanishi  
SCREEN, Kyoto, Japan  
I. Kawayama & M. Tonouchi  
Osaka University, Japan

**2DO.3.2 Investigation of Al<sub>2</sub>O<sub>3</sub> Passivation Layers by Photoluminescence Imaging under Applied Voltage**

H. Haug & E.S. Marstein  
Institute for Energy Technology, Kjeller, Norway  
H. Savin  
Aalto University, Espoo, Finland

**2DO.3.3 Advanced Optical Characterization of Industrial PECVD Silicon Nitride Layers**

N. Borojevic & Z. Hameiri  
UNSW, Sydney, Australia  
S. Winderbaum  
Shamash, Mount Barker, Australia

**2DO.3.4 On the Stability of Dielectric Passivation Subjected to Illumination and Temperature Treatments**

D. Sperber, A. Herguth & G. Hahn  
University of Konstanz, Germany

**2DO.3.5 Two-Dimensional Characterization of Phosphorus-Implanted Emitter and Phosphorus-Diffused Emitter of Silicon Solar Cell Using Super-Higher-Order Scanning Nonlinear Dielectric Microscopy**

K. Hirose, N. Chinone & Y. Cho  
Tohoku University, Sendai, Japan  
K. Tanahashi & H. Takato  
AIST, Koriyama, Japan

**2DO.3.6 A Simulation Study of Resistive Effect of Rear Tunneling Oxide Passivated Contacts in Bifacial n-PERT Silicon Solar Cell**

C.-M. Wei, Y.-H. Lin, C.-C. Li & C.-C. Chuang  
Motech Industries, Tainan, Taiwan

**ORAL PRESENTATIONS 6DO.7**

**15:15 - 16:45 PV in Buildings and in the Environment: Focus on Product Design and Integration**

**Chairpersons:**

A. Scognamiglio  
ENEA, Italy

F. Frontini  
SUPSI, Switzerland

**6DO.7.1 Hikari : a Positive Energy Building with an Architecturally Integrated PV Facade and a PV Roof-Top System (190 kWp)**

B. Gaiddon  
Hespul, Lyon, France  
M. Valentin  
SPL Lyon-Confluence, France  
L. Alfonsi  
Bouygues Immobilier, Lyon, France  
M.-L. Laquerriere  
Tecsol, Lyon, France  
G. Gouranton  
Terre Ciel Energies, Bidart, France  
D. Corgier  
Manaslu, Le Bourget du Lac, France

**6DO.7.2 Visual Design of PV-Modules – a Crucial Factor for Façade Application Acceptance**

A. Geissler  
FHNW Switzerland, Muttenz, Switzerland  
P. Fornaro & A. Bianco  
University of Basel, Switzerland

**6DO.7.3 Integration of Trackless Holographic CPV Modules in Buildings and Urban Furniture**

H.-J. Rodríguez San Segundo, A.M. Villamarín Villegas & A. Calo López  
IHT, El Puerto de Santa Maria, Spain  
F.J. Pérez López  
IHT, El Puerto de Santa María, Spain

**6DO.7.4 Electrical Design and Layout Optimization of Flexible Thin-Film Photovoltaic Modules**

J. Hofer, Z. Nagy & A. Schlueter  
ETH Zurich, Switzerland

**6DO.7.5 ZigZag Structure in Façade Optimizes PV Yield While Aesthetics Are Preserved**

R.M.E. Valckenborg & W. Folkerts  
SEAC, Eindhoven, The Netherlands  
W. van der Wall  
Wallvision, Heeze, The Netherlands  
J.L.M. Hensen  
Eindhoven University of Technology, The Netherlands  
A. De Vries  
Holland Solar, Utrecht, The Netherlands

**6DO.7.6 Designing Agrivoltaico Solutions for Conventional Cereal Cropping Systems**

S. Amaducci & M. Colauzzi  
UCSC, Piacenza, Italy  
A. Reboldi  
REM TEC, Casalromano, Italy

**ORAL PRESENTATIONS 5DO.11**

**15:15 - 16:45 Electrical Characterisation of PV Modules**

**Chairpersons:**

T. Sample  
European Commission DG JRC, Italy

T.R. Betts  
Loughborough University, United Kingdom

**5DO.11.1 Accurate Determination of Photovoltaic Cells and Modules Peak-Power from Their Current-Voltage Characteristics**

B. Paviet-Salomon, J. Levrat, M. Despeisse & C. Ballif  
CSEM, Neuchâtel, Switzerland  
V. Fakhfour, Y. Pelet & N. Rebeaud  
Pasan, Neuchâtel, Switzerland



**5DO.11.2 Electrical Performance Characterisation Intercomparison of High Efficiency c-Si PV Modules within European and Asian Laboratories**

C. Monokroussos & D. Etienne  
TÜV Rheinland, Shanghai, China  
J. Ha  
TÜV Rheinland, Shanghai, Japan  
S. Dittmann  
SUPSI, Canobbio, Switzerland  
K. Morita  
TÜV Rheinland, Yokohama, Japan  
J. Stang & T. Herbrecht  
TÜV Rheinland, Cologne, Germany  
V. Fakhfour & N. Rebeaud  
Pasan, Neuchâtel, Switzerland  
E. Salis, D. Pavanello & H. Müllejans  
European Commission, Ispra, Italy

**5DO.11.3 Comprehensive Characterized Solar Cells: Impact of Angular, Spectral, and Nonlinear Effects**

T. Fey, I. Kröger, F. Witt & S. Winter  
PTB, Braunschweig, Germany

**5DO.11.4 Precise Determination of the STC I-V Curves by Wide-Range Linear Extrapolation of Outdoor I-V Curves on Partly Sunny Days**

Y. Hishikawa, T. Doi, M. Higa, H. Ohshima & K. Yamagoe  
AIST, Tsukuba, Japan

**5DO.11.5 Uncertainty Analysis in the Power Rating Measurement of Solar Cell as Per IEC 61853-1**

R. Singh, B. Bora, O.S. Sastry, S. Rai, M. Bangar & R. Dahiya  
NISE, Gurgaon, India

**5DO.11.6 Characterisation of n-Type Bifacial Silicon PV Modules**

J. Lopez-Garcia, A. Pozza, D. Pavanello, B. Haile & T. Sample  
European Commission, Ispra, Italy

**ORAL PRESENTATIONS 5DO.15**

**15:15 - 16:45 Sustainability and Recycling**

**Chairpersons:**

K. Wambach  
bifa Environmental Institute, Germany

A. Wade  
First Solar, Germany

**5DO.15.1 Eco-Solar Factory: 40%plus Eco-Efficiency Gains in the Photovoltaic Value Chain with Minimised Resource and Energy Consumption by Closed Loop Systems**

M.P. Bellmann  
SINTEF, Trondheim, Norway  
R. Roligheten  
Steuler Solar Technology, Porsgrunn, Norway  
G.S. Park  
NorSun, Oslo, Norway  
J. Denafas  
Soli Tek R&D, Vilnius, Lithuania  
F. Buchholz  
ISC Konstanz, Germany  
R. Einhaus  
Apollon Solar, Lyon, France  
I. Lombardi  
Garbo, Cerano, Italy  
B. Ehlen  
Boukje.com Consulting, Bleiswijk, The Netherlands  
K. Wambach  
bifa Environmental Institute, Augsburg, Germany  
P. Romero  
AIMEN, Porrino, Spain  
A. Bollar  
INGESEA, Elgoibar, Spain

**5DO.15.2 Status Quo of Emerging Photovoltaics from an Environmental Perspective**

S. Weyand & L. Schebek  
Technical University of Darmstadt, Germany

**5DO.15.3 LCA and Data Monitoring for an Innovative Ready to Plug BIPV Roofing Steel Envelope**

L. Samain & L. Fourdrinier  
CRM Group, Liège, Belgium  
R. Turconi, A.-L. Hettinger & R. Vignal  
Arcelor Mittal, Maizières-lès-Metz, France

**5DO.15.4 New Findings in Fire Prevention and Fire Fighting of PV Installations**

U. Muntwyler, C. Renken & L. von Ballmoos  
BUAS, Burgdorf, Switzerland

**5DO.15.5 Recycling of Broken Si Based Structures and Solar Cells**

M. Syvertsen & B. Rynningen  
SINTEF, Trondheim, Norway  
M. Di Sabatino  
NTNU, Trondheim, Norway  
W. Palitzsch  
Loser Chemie, Langenweißbach, Germany  
M. Schumann  
Fraunhofer ISE, Freiburg, Germany  
H.J. Möller  
Fraunhofer ISE, Freiberg, Germany  
C. Audoin, M. Serasset & D. Pelletier  
CEA, Le Bourget du Lac, France  
J. Diéguez  
Silicio FerroSolar, Arteixo, Spain  
A. Souto  
Ferroatlantica, Arteixo, Spain  
J. Denafas, L. Petreniene, M. Pranaitis, V. Cyras & R. Zolubas  
Soli Tek R&D, Vilnius, Lithuania  
A. Ulyashin  
SINTEF, Oslo, Norway

**5DO.15.6 FRELP 2 Project - Full Recovery End of Life Photovoltaic**

L. Ramon  
SASIL, Brusnengo, Italy  
S. Ceola & S. Hreglich  
Stazione Sperimentale del Vetro - SSV, Venice, Italy

**VISUAL PRESENTATIONS 2DV.3**

**15:15 - 16:45 Silicon Feedstock, Crystallisation and Wafering**

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

**ORAL PRESENTATIONS 2DO.4**

**17:00 - 18:30 Silicon Solar Cell Characterisation and Modelling (II)**

**Chairpersons:**

M.C. Schubert  
Fraunhofer ISE, Germany

L.H. Slooff  
ECN, The Netherlands

**2DO.4.1 EU PVSEC Student Award Winner Presentation Modelling and Characterization of Multicrystalline Silicon Blocks by Quasi-Steady-State Photoconductance**

M. Goodarzi & D. Macdonald  
ANU, Canberra, Australia  
D. Chung & B. Mitchell  
UNSW Australia, Sydney, Australia  
T. Trupke  
UNSW Australia, Kensington, Australia  
R.A. Sinton  
Sinton Instruments, Boulder, United States

**2DO.4.2 Fourier Optical Measurement System: Enabling Ultrafast External Quantum Efficiency Measurements on Crystalline Silicon Solar Cells**

J. Melskens, S.G.M. Heirman, M.A.A. Elshinawy,  
R. Koornneef & M. Schouten  
Delft Spectral Technologies, The Netherlands

**2DO.4.3 Genuine Bifacial Simulation and Optimization of an mc-Silicon PERC Solar Cell**

N. Wöhrle, A. Alapont Sabater & J. Greulich  
Fraunhofer ISE, Freiburg, Germany

**2DO.4.4 Light Induced Degradation in PERC Solar Cells**

J. Arumughan & R. Kopecek  
ISC Konstanz, Germany  
B. Martel & G. Raymond  
CEA, Le Bourget du Lac, France  
X. Brun  
AET-Technologies, Meylan, France

**2DO.4.5 Why Multi Busbars and Future Emitters Require Further Shrinking of Finger Line Width**

L.J. Koduvelikulathu, J. Lossen & D. Rudolph  
ISC Konstanz, Germany  
M. Matusovsky & G. Dishon  
Utilight, Yavne, Israel

**2DO.4.6 Modelling The Long-Term Behaviour of Boron-Oxygen Defect Passivation in the Field Using Real Weather Data**

B. Hallam, J. Bilbao, D. Payne, C. Chan, M. Kim, D. Chen,  
N. Gorman, M. Abbott & S. Wenham  
UNSW Australia, Sydney, Australia

**ORAL PRESENTATIONS 6DO.8**

**17:00 - 18:30 PV in Buildings and in the Environment: Focus on Characterisation and Evaluation**

**Chairpersons:**

M. Topic  
University of Ljubljana, Slovenia

H. Ossenbrink (*i*)  
European Commission DG JRC, Italy

**6DO.8.1 Bifacial PV Integrated on Building Balconies**

S.R. Teixeira Freitas & M.C. Brito  
University of Lisbon, Portugal

**6DO.8.2 Indoor and Outdoor Characterization of Innovative Colored BIPV Modules for Façade Application**

F. Frontini, P. Bonomo & E. Saretta  
SUPSI, Canobbio, Switzerland  
T. Weber & J. Berghold  
PI Berlin, Germany  
R. Karoblis & M. Pikutis  
Viasolis, Vilnius, Lithuania  
T. Lenkimas  
GLASSBEL, Klaipeda, Lithuania

**6DO.8.3 Quantification of Glare from Sunlight Reflected on Solar Installations**

F. Ruesch, A. Bohren, M. Battaglia & S. Brunold  
Institut für Solartechnik, Rapperswil, Switzerland

**6DO.8.4 Integration of PV Modules in Energy Yield Optimized Carbon Concrete Composite Facades**

S. Schindler & J. Schneider  
Fraunhofer CSP, Halle, Germany  
A. Heller  
Leipzig University of Applied Sciences, Germany  
M. Gorges  
Technical University of Dresden, Germany  
C. Rudolf  
Solar Valley, Erfurt, Germany  
L. Dämmig  
SGB Steuerungstechnik, Leipzig, Germany

**6DO.8.5 invited**

**6DO.8.6 Technical Evaluation of BIPV Power Generation Potential in EU-28**

A. El Gammal  
Becquerel Institute, Brussels, Belgium  
D. Mueller & H. Bürckstümmer  
Merck, Munich, Germany  
R. Vignal  
Arcelor Mittal, Luxembourg, France

**ORAL PRESENTATIONS 5DO.12**

**17:00 - 18:30 Electroluminescence, Thermography, Failure Modes and Degradation Estimation**

**Chairpersons:**

A. Metz  
h.a.l.m. elektronik, Germany

P. Lechner  
ZSW, Germany

**5DO.12.1 Implementation of Aerial Thermography Inspection of PV Modules in the O&M Activities in Large PV Plants**

J. Coello, L. Perez, A. Velasco & V. Parra  
Enertis Solar, San Sebastián de los Reyes, Spain  
M. Rosa & A. Cristobal  
Aerotoools-UAV, Alcobendas, Spain

**5DO.12.2 Outdoor Electroluminescence Imaging of Crystalline Photovoltaic Modules: Comparative Study between Manual Ground-Level Inspections and Drone-Based Aerial Surveys**

S. Koch, T. Weber & J. Berghold  
PI Berlin, Germany  
A. Fladung  
Solartechnik-Fladung, Aachen, Germany  
P. Clemens  
SafeTwork, Saarbrücken, Germany

**5DO.12.3 Outdoor Non-Destructive Infrared Thermography of Photovoltaic Modules and Plants for Inspection: IEC 62446-3**

B. Jaeckel  
UL International, Neu-Isenburg, Germany  
B. Weinreich  
HaWe Engineering, Gauting-Hausen, Germany  
C. Buerhop-Lutz  
ZAE Bayern, Erlangen, Germany  
U. Jahn  
TÜV Rheinland, Cologne, Germany

**5DO.12.4 Data Mining Methods for Failure Classification on PV-Modules Monitored under Field-Conditions**

G. Behrens, A. Dercho, H. Quakernack & T. Wächter  
University of Applied Sciences Bielefeld, Minden, Germany  
S. Hempelmann & I. Kruse  
STORM Energy, Nuremberg, Germany

**5DO.12.5 Assessment for IR Inspection Cycles and Efforts Related to System Design**

A. Häring & T. Henne  
SolarEdge Technologies, München, Germany  
S. Dobler  
Dosol, Regensburg, Germany

**5DO.12.6 Estimation of the Degradation Rate of Fielded Photovoltaic Arrays in the Presence of Measurement Outages**

A. Phinikarides, G. Makrides & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus

**ORAL PRESENTATIONS 2DO.16**

**17:00 - 18:30 Advanced c-Si Solar Cell Architectures**

**Chairpersons:**

B. Terheiden  
University of Konstanz, Germany

D. Muñoz  
CEA, France

**2DO.16.1 22.3% n-PERT Solar Cells on Epitaxially Grown Silicon Wafers**

I. Kuzma-Filipek, M. Récaman-Payo, F. Duerinckx,  
E. Cornagliotti, P. Choulat, A. Sharma, M. Aleman,  
R. Russell, A. Uruena de Castro, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
R. Hao & T.S. Ravi  
Crystal Solar, Santa Clara, United States

**2DO.16.2 Co-Diffusion for p-Type PERT Solar Cells Using APCVD BSG Layers as Boron-Doping Source**

S. Meier, S. Wiesnet, S. Maier, S. Mack, S. Unmüßig,  
S. Werner, P. Saint-Cast, D. Biro & A. Wolf  
Fraunhofer ISE, Freiburg, Germany  
C. Demberger & H. Knauss  
Gebr. SCHMID, Freudenstadt, Germany

**2DO.16.3 Pilot Production of 6inch IBC Solar Cells Yielding an Average Efficiency of 23% with a Low-Cost Industrial Process**

Z. Li, Y. Yang, X. Zhang, W. Liu, Y. Chen, G. Xu, X. Shu,  
Y. Chen, P.P. Altermatt, Z. Feng & P.J. Verlinden  
Trina Solar Energy, Changzhou, China

**2DO.16.4 Co-Diffused Back-Contact Back-Junction Silicon Solar Cells with a Novel Screen-Printing Including Rear Innovation Technology**

J.D. Huyeng, R. Efinger, A. Spribille, R. Keding, A. Wolf &  
F. Clement  
Fraunhofer ISE, Freiburg, Germany  
O. Doll  
Merck, Darmstadt, Germany

**2DO.16.5 5" Laser-IBC Solar Cells with 22.0% Efficiency**

E. Hoffmann, M. Dahlinger, K. Carstens,  
R. Zapf-Gottwick & J.H. Werner  
University of Stuttgart, Germany

**2DO.16.6 Silicon Solar Cells with Passivated Contacts and Their Application in High-Efficiency Perovskite/c-Si Tandem Solar Cells**

C. Ballif, J. Werner, G. Nogay, A. Walter, J. Geissbühler,  
J.P. Seif, F.-J. Haug, S. De Wolf & B. Niesen  
EPFL, Neuchâtel, Switzerland  
C. Allebé, D. Sacchetto, M. Despeisse, S.-J. Moon,  
S. Nicolay & J. Bailat  
CSEM, Neuchâtel, Switzerland

**VISUAL PRESENTATIONS 7DV.4**

**17:00 - 18:30 PV Economics and Markets / PV Global Issues, Policies and Strategies**

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



**6EO.1.5 Industrial Hybrid Systems with High PV Penetration – Performance Analysis and Key Success Factors**

J.A. Notholt Vergara, V. Wachenfeld & M. Mostafa  
SMA Solar Technology, Niestetal, Germany

**6EO.1.6 Energy Forecast for Mobile Photovoltaic Systems with Focus on Trucks for Cooling Applications**

M. Kühnel, B. Hanke, S. Geißendörfer, K. von Maydell & C. Agert  
Next Energy, Oldenburg, Germany

**ORAL PRESENTATIONS 7EO.2**

**08:30 - 10:00 From Global Assessment to Local Deployment**

**Chairpersons:**

E. Perezagua  
Consultores de Energía Fotovoltaica, Spain

W. Hoffmann (i)  
ASE, Germany

**7EO.2.1 Gamifying the Energy Transition**

B. O'Donnell  
Helio-centric Solutions, London, United Kingdom  
D. Pfahl & J. Mehling  
Prometeruse Foundation, Berlin, Germany

**7EO.2.2 Photovoltaic Development Standardizing Based on Roadmaps and Technology Readiness Levels**

P. Baliozian  
Freiburg, Germany  
S. Murad, S. Kim, R. Preu & F. Lorenz  
Fraunhofer ISE, Freiburg, Germany  
D. Morse  
March, Germany

**7EO.2.3 Rooftop PV Potential Estimations: Automated Orthographic Satellite Image Recognition Based on Publicly Available Data**

K. Mainzer, D. Schlund, R. Mckenna & W. Fichtner  
KIT, Karlsruhe, Germany  
S. Killinger  
Fraunhofer ISE, Freiburg, Germany

**7EO.2.4 Contribution of PV to the Energy Transition: the Case of Switzerland during the Next 15 Years**

A.V. Shah, Y.S. Riesen & N. Wyrsh  
EPFL, Neuchâtel, Switzerland  
J. Remund  
Meteotest, Bern, Switzerland  
A. von Kaenel  
Meyer Burger, Gwatt, Switzerland  
C. Ballif  
CSEM, Neuchâtel, Switzerland

**7EO.2.5 Pro-PV Local Building Policy – State of Progress of the Lyon-Confluence Solar City Project**

B. Gaidon & M. de l'Epine  
Hespul, Lyon, France  
M. Valentin & E. Vignali  
SPL Lyon-Confluence, France  
K. Lapray & O. Zanni  
TRIBU, Lyon, France

**7EO.2.6 Progress of Solar Photovoltaic Systems in India**

S. Vasudevan & A. Murugesan  
Arunai Engineering College, Tiruvannamalai, India

**ORAL PRESENTATIONS 5EO.3**

**08:30 - 10:00 Economics, O&M and Reliability**

**Session Chair:**

J. Binder  
ZSW, Germany

K. Radouane  
EDF EN, France

**5EO.3.1 Analysis of the Energy and Economic Influence of the O&M Annual Cost in the Profitability of PV Systems**

J.C. Lomas Monzón  
Gerión Ingeniería, Granada, Spain  
E. Muñoz-Cerón, G. Nofuentes Garrido & J. De la Casa  
University of Jaén, Spain

**5EO.3.2 Reliability of Photovoltaic Solar Systems through Real O&M Follow-Up Data**

I. Lillo Bravo, A. Palomo & M. Silva Pérez  
University of Seville, Spain  
J. Guasumba  
University of Fuerzas Armadas, Quito, Ecuador



**5EO.3.3 Weather Sensitivity Analyses in Layout Planning**

M. Bischoff & M. Dehler  
Siemens, München, Germany  
J. Leitner, K. Plociennik & T. Fleuren  
Fraunhofer ITWM, Kaiserslautern, Germany

**5EO.3.4 3D Solar Potential Modelling and Analysis: a Case Study for the City of Utrecht**

B. Kausika & W. van Sark  
Utrecht University, The Netherlands  
M. Moshrefzadeh & T.H. Kolbe  
Munich University of Technology, Germany

**5EO.3.5 New Approach to Analyzing Longterm Performance of Large Populations of PV Systems in Feed in Tarif Markets with Minimal Efforts and Costs**

T. Vontobel, T. Nordmann & R. Lingel  
TNC Consulting, Feldmeilen, Switzerland

**5EO.3.6 A Fast and Effective Approach to Modelling PV System Performance in Complex Shading Environments**

I.R. Cole, D. Palmer, E. Koumpli (a.k.a Koubli), T.R. Betts & R. Gottschalg  
Loughborough University, United Kingdom

**PLENARY SESSION 7EP.1**

**10:30 - 11:30 PV Economics, Markets and Policies**

**Chairpersons:**

S. Nowak (*i*)  
NET Nowak Energy & Technology, Switzerland

P. Menna  
European Commission DG Energy, Belgium

**7EP.1.1 True Competitiveness of Solar PV - a European Case Study**

E. Vartiainen  
Fortum, Finland  
G. Masson  
Becquerel Institute, Brussels, Belgium  
C. Breyer  
Lappeenranta University of Technology, Finland

**7EP.1.2 PV Financing**

G. Agostinelli  
IFC, Washington, United States

**7EP.1.3 Value of PV and Wind in the Energy Market**

P. Frankl, S. Müller  
IEA, Paris, France

**11:30 – 12:30 CONFERENCE CLOSING**

**Chaired by:**

Marko Topič  
Conference General Chairman  
Chairman of European Technology & Innovation Platform  
Photovoltaics

**Key note presentation**

**The Highlights of the Conference**

**Ceremony of Poster Awards**

**Winners of Student Awards**

**Conclusions and Farewell**

At the time of printing the detailed Programme of the Closing Event is under final preparation. Please visit [www.photovoltaic-conference.com](http://www.photovoltaic-conference.com) for all information.



**2AV.1.8 Optical Reflection Spectra of Silicon Surface with Nanowires Produced by Special Electrochemical Etching**

M. Treideris, V. Strazdienė, I. Šimkiene, V. Bukauskas, A. Reza, S. Indrišūnas, M. Kamarauskas & A. Setkus  
Center for Physical Sciences and Technology, Vilnius, Lithuania

**2AV.1.9 Advances in Si Heterojunction Solar Cells on p-Type Wafers with Sputtered ZnO:Al as Transparent Conductive Oxide**

L.V. Mercaldo, I. Usatii, E. Bobeico, M. Della Noce, L. Lancellotti & P. Delli Veneri  
ENEA, Portici, Italy  
M. Izzi & M. Tucci  
ENEA, Rome, Italy

**2AV.1.10 High Efficient n-Type and p-Type PERT Solar Cells by Industrially Feasible Processes**

C.-C. Wang, C.-L. Lin, Y.-T. Cheng, Y.-H. Huang, C.-P. Tsao, C.-C. Chen & J.-W. Chien  
Inventec Solar Energy, Taoyuan, Taiwan

**2AV.1.11 Combination of Plasma-Damage-Less Cat-CVD with a New Low Temperature Impurity Doping Method, Cat-Doping, for Improvement of Solar Cell Performance**

T.C.T. Huynh, S. Terashima, K. Koyama, C.T. Nguyen & H. Matsumura  
JAIST, Ishikawa, Japan

**2AV.1.13 Micro-Patterned (111) Silicon for Thin Film Solar Cells**

R. Champory, F. Mandorlo, A. Fave, R. Orobtschouk & E. Fourmond  
INSA Lyon, Villeurbanne, France  
E. Drouard & C. Seassal  
Ecole Centrale de Lyon, Ecully, France

**2AV.1.14 Pilot Production of Bifacial Multicrystalline PERCT Cells Achieving 18.5% Efficiency and Singlefacial More Than 19%**

A. Teppe, C. Gong, O. Voigt, I. Melnyk, F. Binaie Masouleh & P. Fath  
RCT-Solutions, Konstanz, Germany  
E. Wang & W. Guo  
Lu'an Photovoltaic Technology, Changzhi, China

**2AV.1.15 Investigation of Laser Ablation Process for High Efficiency Solar Cells**

M.-S. Lin, S.-Y. Liu, Y.-L. Lee, K.-C. Lai, Y.-K. Tsao, C.-C. Chuang & C.-C. Li  
Motech Industries, Tainan City, Taiwan

**2AV.1.16 Effective SiNy Capping Layers on High-Power-Plasma PECVD AlOx for High Efficiency (21%) Industrial p-Type Mono PERC Solar Cells**

C.-J. Hung, W.-C. Kao, K.-W. Tsai, C.-C. Chen, L.-Y. Wu, K.-Y. Ting, C.-Y. Kuo, K.-T. Chu & L.-W. Cheng  
Motech Industries, Taoyuan, Taiwan

**2AV.1.17 Rear Passivation and Point Contacts Formation by Laser Process through Stacks of a-Si:H(l) and a-Si:B/Sb for High Efficiency Silicon Solar Cell**

Y. Han, E. Franklin, X. Zhang, A. Thomson & M. Ernst  
ANU, Canberra, Australia

**2AV.1.18 Effect of Laser Ablation on Electroplated-Metallization Crystalline Silicon Solar Cells**

Y.-L. Lee, M.-S. Lin, S.-Y. Liu, K.-C. Lai, C.-C. Chuang & C.C. Li  
Motech Industries, Tainan, Taiwan

**2AV.1.19 Nanostructured Silicon Nitride (Si-N) Antireflection Coating for c-Si Solar Cells**

H. Ghosh, S. Mitra, C. Banerjee, H. Saha & S.K. Datta  
IEST, Howrah, India

**2AV.1.20 Black Silicon Solar Cells with Black Bus-Bar Strings**

R. Schmidt Davidsen, S. Thorsteinsson, P. Behrendorff Poulsen & O. Hansen  
Technical University of Denmark, Lyngby, Denmark  
P. Torben Tang & I. Mizushima  
IPU, Lyngby, Denmark  
J. Frausig  
Gaia Solar, Hvidovre, Denmark  
O. Nordseth  
Institute for Energy Technology, Kjeller, Norway

**2AV.1.21 Investigating Effects of p-n Junction Area and Geometry on IV Characteristics of High Efficiency Silicon Solar Cells**

X. An, P. Teng, B. Hoex, C. Johnson, H. Mehrvarz, A. To, H. Li & A. Barnett  
UNSW Australia, Sydney, Australia

**2AV.1.22 Influence of c-Si Cell Architectures on 4-Terminal Perovskite/c-Si Hybrid Tandem Devices**

D. Zhang, W. Verhees, M. Dörenkämper, S. Veenstra, Y. Wu, B. Geerligs & W. Söppe  
ECN, Eindhoven, The Netherlands  
W. Qiu, U. Paetzold & T. Aernouts  
imec, Leuven, Belgium

**2AV.1.23 Bifacial p-Type Solar Cells Exhibiting Low Temperature Coefficients: Heterojunction Technology**

D.L. Bätzner, R. Kramer, L. Andreetta, D. Lachenal,  
W. Frammelsberger, B. Legradic, J. Meixenberger, P. Papet,  
B. Strahm & G. Wahl  
Meyer Burger, Hauterive, Switzerland

**2AV.1.24 Influence of the Regeneration Kinetics of Bo Complexes by the Composition of Silicon Nitride Layers**

M. Gläser, S. Jafari, S. Krause & D. Lausch  
Fraunhofer CSP, Halle (Saale), Germany

**2AV.1.25 HIT Cell with p+ Epi/poly-Silicon Intentionally Doped Emitter in Crystalline Silicon Substrate**

M.Y. Ghannam, Y. Abdulraheem & A. Hajjiah  
Kuwait University, Safat, Kuwait  
J. Poortmans  
imec, Leuven, Belgium

**2AV.1.26 Spatially Resolved Degradation and Regeneration Kinetics in mc-Si**

A. Zuschlag, D. Skorka & G. Hahn  
University of Konstanz, Germany

**2AV.1.27 Influence of Hydrogen Incorporation on the AlN Grown by RF Sputtering**

A. Ben Or  
Tel Aviv University, Ramat Aviv, Israel  
L. Korte  
HZB, Berlin, Germany  
L.M. Montañez Huamán & R. Weingärtner  
PUCP, Lima, Peru

**2AV.1.28 22.6% Simplified Back-Contacted Silicon Heterojunction Solar Cell**

A. Tomasi, M.J. Lehmann, J. Geissbühler, J.P. Seif &  
S. De Wolf  
EPFL, Neuchâtel, Switzerland  
B. Paviet-Salomon, L. Barraud, A. Descoedres,  
G. Christmann, N. Badel, H. Watanabe, A. Faes, S. Nicolay,  
M. Despeisse & C. Ballif  
CSEM, Neuchâtel, Switzerland  
D. Lachenal & B. Strahm  
Meyer Burger Research, Hauterive, Switzerland

**2AV.1.29 Contact Formation on p-Doped Si by Screen-Printing Pure Ag Pastes for Bifacial n-Type Si Solar Cells**

J. Engelhardt, S. Fritz, E. Emre & G. Hahn  
University of Konstanz, Germany

**2AV.1.30 Optimal Thermal Annealing of a-SiO<sub>x</sub> Layer Obtained by PECVD for Heterojunction Solar Cell Application**

L. Martini, L. Serenelli, F. Menchini, M. Izzi & M. Tucci  
ENEA, Rome, Italy  
L. Imbimbo & R. Asquini  
University of Rome, Italy

**2AV.1.31 A New Type Back Contact Solar Cells Based on Si Wafer and Combined with the Multilayer MoO<sub>x</sub>/Ag/MoO<sub>x</sub> and Cesium Carbonate Films**

W. Wu, J. Bao & H. Shen  
Sun Yat-sen University, Guangzhou, China

**2AV.1.32 Wet Oxidation Effects on the Electrical and Interface Properties of ALD Al<sub>2</sub>O<sub>3</sub> and ALD-AIO<sub>x</sub>/SiN<sub>x</sub> Passivation Stacks for PERC Solar Cells**

S. Joonwichien, K. Shirasawa, S. Simayi, K. Tanahashi,  
T. Mochizuki & H. Takato  
AIST, Koriyama, Japan

**2AV.1.33 Investigation on the Anti-PID Method of mc-Si Solar Cell for Mass Production**

J. Lu, Q. Wei, W. Lian & Z. Ni  
Talesun Solar, Suzhou, China

**2AV.1.34 Chemistry of Mist Deposition of Organic Polymer PEDOT:PSS on Crystalline Si**

H. Shirai, T. Ohki, Q. Liu & K. Ichikawa  
Saitama University, Japan

**2AV.1.37 Field-Effect Surface Passivation Paste by Screen-Printing for High Efficiency PERC**

T. Hayasaka, S. Kodama, M. Shimizu, M. Hamada,  
N. Tanaka & T. Nojiri  
Hitachi Chemical, Ibaraki, Japan

**2AV.1.38 Ultra-Short Pulse Laser for Patterning High Quality Graphene Electrodes in Photovoltaic Applications**

E.-M. Pechlivani, E. Mekeridis, S. Tsimikli & V. Matskos  
Organic Electronic Technologies, Thessaloniki, Greece  
A. Laskarakis & S. Logothetidis  
Aristotle University - LAB LTFN, Thessaloniki, Greece

**VISUAL PRESENTATIONS 6AV.4**

**13:30 - 15:00 Grid and Energy System Integration**

**6AV.4.4 Managing the Quality of Electricity Supply under High Penetration of Photovoltaic Generation with Load Shifting and Inverter Control**

W. Martin, P.-J. Alet, L.-E. Perret-Aebi & C. Ballif  
CSEM, Neuchâtel, Switzerland  
A. Ghasem Azar & R. Hylsberg Jacobsen  
Aarhus University, Denmark

**6AV.4.6 Full Spectrum Hybrid Photovoltaics and Thermal Engine Utilizing High Concentration Solar Energy**

J. Grandidier, B.J. Nesmith, T.J. Hendricks, J. Cepeda-Rizo, J. Paredes Garcia & M.E. Devost  
NASA, Pasadena, United States  
M.B. Petach, E. Tward, S.A. Whitney & D.E. Lee  
Northrop Grumman Aerospace Systems, Redondo Beach, United States  
H. Hayden, N. Fette & T. Beeney  
SST, Tempe, United States

**6AV.4.7 Optimizing the Integration of Solar Power in the National Electricity System – a Case Study of South Africa**

N. Hartmann, C. Friebertshäuser & C. Kost  
Fraunhofer ISE, Freiburg, Germany

**6AV.4.8 Integration of Reverse Osmosis Seawater Desalination in the Power Sector, Based on PV and Wind Energy, for the Kingdom of Saudi Arabia**

U. Caldera, D. Bogdanov, S. Afanasyeva & C. Breyer  
Lappeenranta University of Technology, Finland

**6AV.4.9 A Cost Optimal Resolution for Sub-Saharan Africa Powered by 100 Percent of Renewables by the Year 2030**

M. Baraza, D. Bogdanov, S. Oyewo & C. Breyer  
Lappeenranta University of Technology, Finland

**6AV.4.10 Solar Photovoltaics – a Driving Force towards a 100% Renewable Energy System for India and the Saarc Region**

A. Gulagi, D. Bogdanov & C. Breyer  
LUT, Lappeenranta, Finland

**6AV.4.11 Nationwide Photovoltaic Hosting Capacity in the Finnish Electricity Distribution System**

J. Lassila, V. Tikka, J. Haapaniemi, M. Child, C. Breyer & J. Partanen  
Lappeenranta University of Technology, Finland

**6AV.4.12 GIS Based Assessment of Storage Impact on PV Integration into UK Electricity Network**

C. Candelise & P. Westacott  
Imperial College London, United Kingdom

**6AV.4.16 Performance Analysis and Yield Assessment of Several Uncovered Photovoltaic-Thermal Collectors: Results of Field Measurements and System Simulations**

C. de Keizer, M. de Jong & W. Folkerts  
SEAC, Eindhoven, The Netherlands  
M. Katiyar, C. Rindt & H. Zondag  
Eindhoven University of Technology, The Netherlands

**6AV.4.17 Simulation of the Load Flow at the Transformer in Low Voltage Distribution Grids with a Significant Number of PV Systems Using Satellite-Derived Solar Irradiance**

H. Ruf & G. Heilscher  
Ulm University of Applied Sciences, Germany  
M. Schroedter-Homscheidt  
German Aerospace Center, Wessling, Germany  
F. Meier  
Stadtwerke Ulm, Germany  
H.G. Beyer  
University of Agder, Grimstad, Norway

**6AV.4.18 Challenges of PV Generation in Polar Regions. Case Study: the Norwegian Research Station “Troll” in Antarctica**

S. Merlet & B. Thorud  
Multiconsult, Oslo, Norway  
T. Thiis & E. Olsen  
UMB, Ås, Norway

**6AV.4.19 Study on Optimal Installed Capacity of Photovoltaic Generation and Battery to Minimize Total Cost in Factory**

Y. Minamishima, S. Takayama & A. Ishigame  
Osaka Prefecture University, Sakai, Japan  
M. Takeuchi  
NISSHIN ELECTRIC, Kyoto, Japan

**6AV.4.20 The Utility of Power-to-Gas Concept for Integration of Increased Photovoltaic Generation into the Distribution Grid**

F. Bigler, C. Park & P. Korba  
ZHAW, Winterthur, Switzerland

**6AV.4.21 PV Integration and Price-Based Demand Side Management: Optimum Time-of-Use Tariffs**

N. Philippou, G. Makrides, M. Hadjipanayi, V. Efthymiou & G.E. Georgiou  
University of Cyprus, Nicosia, Cyprus

- 6AV.4.22 Large-Scale Integration of Renewable Energy Sources: Technical and Economical Analysis for the Italian Case**  
M.G. Prina, G. Garegnani, R. Vaccaro & D. Moser  
EURAC, Bolzano, Italy  
D. Kleinhans  
Next Energy, Oldenburg, Germany  
G. Manzolini  
Polytechnic University of Milan, Italy  
S. Weitemeyer  
University of Oldenburg, Germany
- 6AV.4.23 Conditions in Which a Photovoltaic System Is More Viable Than a Low-Temperature Solar Thermal System**  
I. Lillo Bravo, M. Silva Pérez & S. Moreno  
University of Seville, Spain  
E. Pérez  
AICIA, Sevilla, Spain
- 6AV.4.25 Effective Integration of PV Source by Means of DC Micro-Grids**  
V. Musolino, P.-J. Alet, L.-E. Perret-Aebi & C. Ballif  
CSEM, Neuchâtel, Switzerland
- 6AV.4.26 Photovoltaic Plant Orientation Strategies to Minimize Grid Exchange in Free Field and Building Integrated Setups**  
P. Ingenhoven, G. Barchi, M. Lovati & D. Moser  
Eurac Research, Bolzano, Italy
- 6AV.4.27 PV Plant Repowering: Optimization of the Energy Which Can Be Fed into the Grid by Increasing the Installed PV Power. A Challenging Application for an Intelligent Active Power Curtailment with Additional Grid Protection Devices**  
R. Estrella Navarro  
Skytron-Energy, Berlin, Germany  
M. Kammerer & K. Albers  
Parabel, Berlin, Germany
- 6AV.4.28 Evaporating Pure Rainwater to Increase the Yield of Commercial-Size PV Arrays**  
N. Cristi, A. Macq, L. Martin-Carron & D. Ugarte  
SUNIBRAIN, Toulouse, France
- 6AV.4.29 Optimizing the Self-Consumption of Solar-Powered Smart Microgrids**  
A. Mahran, A. Minde, M. Noebels, K. Peter & J. Glatz-Reichenbach  
ISC Konstanz, Germany

- 6AV.4.31 Evaluation of Load Matching and Grid Interaction Parameters of a Net Plus-Energy House in Brazil with a Hybrid Grid-Connected Photovoltaic System and Demand-Side Management**  
G. Almeida Dávi, M. Castillo-Cagigal, E. Caamaño-Martín & J. Solano  
UPM, Madrid, Spain
- 6AV.4.32 Multi Agent System in a Smart Rail Microgrid: Application to a Tramway System**  
S. Boudoudouh, M. Ouassaid & M. Maaroufi  
University Mohammed V-Agdal, Rabat, Morocco
- 6AV.4.33 Electromobility, the Heritage Clean Energy and the Utilization of Wasted Energy from Cars Toward the Sustainable Future**  
L. Barrera Aguilar  
UPTIax, Tlaxcala, Mexico  
H. Lima Gutierrez  
UPT, Tlaxcala, Mexico  
J.C. Roldán Maldonado & U. Becerril Franco  
UPAEP, Puebla, Mexico
- 6AV.4.34 Advanced PV Inverter Functions: Survey and Verification Test**  
J. Freis, M. Cosic & B. Jaeckel  
UL International, Neu-Isenburg, Germany
- 6AV.4.35 Stochastic Generation Scheduling with Solar PV and Storage Integration**  
C. Shang, D. Srinivasan & T. Reindl  
NUS, Singapore, Singapore
- 6AV.4.37 Smart PV Home : Experimental Investigations**  
P. Dupeyrat, A.-S. Coince, C. Gachot, Y. Pollet, S. Bernasconi, C. Le Sueur & G. Kwiatkowski  
EDF, Moret-sur-Loing, France
- 6AV.4.38 Definition of a Desalination-Refrigeration Unit Powered by a Solar Photovoltaic Thermal Collectors PVT: a Case Study for Dakhla Morocco**  
M. Ibrahim, A. Arbaoui & Y. Aoura  
National School of Arts and Trades, Bouarfa, Morocco  
E.M. Elkhatabi  
USMBA, Fez, Morocco
- 6AV.4.39 Energy Flow Optimization of a Grid Connected PV System with Electrical Storage Based on Predictive Data**  
M. Bressan & C. Alonso  
LAAS CNRS, Toulouse, France  
M. Rabarijoelina & T. Sanchez  
Solveo Energie, Fenouillet, France



**6AV.4.40 Demand Side Power Management of a Grid Connected Solar PV System with Vanadium Redox Flow Battery Storage**

A. Bhattacharjee & H. Saha  
IEST, Howrah, India

**6AV.4.41 Towards a Novel Proposal of a Solar Polygeneration System for Morocco's Public Hospitals**

L. Souad  
University Mohammed V-Agdal, Rabat, Morocco

**6AV.4.42 Energy Storage System Management in Grid Connected PV Systems: From Simulation to Experiment on Field**

F. De Lia, S. Castello, M. Tucci & R. Schioppo  
ENEA, Rome, Italy

**VISUAL PRESENTATIONS 2AV.2**

**15:15 - 16:45 Silicon Solar Cell Improvements and Innovation (II)**

**2AV.2.1 SiC Layer as Mechanical Enhancement for Solar Module**

C.-L. Wang, C.-C. Hsieh & H.-C. Tseng  
WINAICO, Hsinchu, Taiwan  
H.-H. Hsieh, Y.-H. Lee, M.-A. Tsai, W.-L. Yang, S.-H. Chen,  
M.-F. Lin, K.-W. Lu & S.-J. Wu  
ITRI, Hsinchu, Taiwan

**2AV.2.2 Universal Nano-Texture Process For Diamond- And Slurry-Wire Sawn Mono/Poly-Crystalline Silicon Solar Cells**

K. Chen, J. Zha, F. Hu, X. Ye, S. Zou & X. Su  
Soochow University, Suzhou, China

**2AV.2.3 Solution Processed Crystalline-Si/PEDOT:PSS Heterojunction Solar Cell Module**

H. Shirai, T. Ohki, Q. Liu & K. Ichikawa  
Saitama University, Japan

**2AV.2.4 E-Ton's Printed-AIOx PERC Cells: Efficiencies Beyond 21 % with a Next-Generation AIOx Paste**

T.-C. Chen, Y.-S. Lin, C.-F. Lin, C.-H. Ku, C.-S. Hu & C.-C. Wen  
E-TON Solar Tech, Tainan, Taiwan  
J.Y. Hung  
New E Materials, Kaohsiung, Taiwan  
J.-C. Wang & S.-W. Chen  
Eternal Chemical, Kaohsiung, Taiwan

**2AV.2.5 Wet Chemical Metallization of Silicon Solar Cells: Status and Perspective of Industrial Application**

A. Letize, B. Lee & D. Cullen  
MacDermid, Waterbury, United States

**2AV.2.6 Investigation of Plasmonic and Transparent Conductive Oxide Work Function Effect with Different Metal Doping for Amorphous/Crystalline Silicon Heterojunction Solar Cells**

P.K. Parashar, R.P. Sharma, R. Kapoor & V.K. Komarala  
IIT Delhi, New Delhi, India  
V. Bharadwaj & S.P. Singh  
Bharat Heavy Electricals, New Delhi, India

**2AV.2.7 Performance Enhancement of Textured and Planar Silicon Solar Cells Using Luminescent Down-Shifting Eu<sup>2+</sup>-Phosphor Silica-Layer**

Y.-J. Deng, W.-J. Ho, S.-K. Feng, G.-Y. Li & S.-H. Weng  
NTUT, Taipei, Taiwan

**2AV.2.8 The Application of Multilayer SiNx Anti-Reflection Films in Polycrystalline Silicon Solar Cell Production**

H.N. Ma, Z. Li, L. Pang & D. Zhang  
Yingli Green Energy, Baoding, China

**2AV.2.9 Study of One-Step Annealing for Plated Nickel-Copper Contacts on n-Type Monocrystalline Silicon Solar Cells**

J. Couderc, J. Dupuis & P.P. Grand  
EDF, Chatou, France  
H. El Belghiti & E. Delbos  
KMG Ultra Pure Chemicals, Saint-Fromond, France  
D. Aureau, A. Etcheberry & D. Lincot  
CNRS-IRDEP, Chatou, France

**2AV.2.10 A Solar Module Prototype Assembled from Silicon Heterojunction Solar Cells Manufactured in Gen5 Kai PECVD Reactors**

D. Andronikov  
RAS/ Ioffe, St-Petersburg, Russia  
A. Abramov, S. Abolmasov, K. Emtsev, G. Ivanov,  
I. Nyapshaev, A. Semenov, G. Shelopin & E. Terukov  
RAS/ Ioffe, St. Petersburg, Russia  
D. Orekhov & E. Terukova  
RAS / Ioffe, St-Petersburg, Russia  
I. Shakhrai  
Hevel Solar, Moscow, Russia  
M. Joanny, A. Jouini & C. Roux  
CEA, Le Bourget du Lac, France  
F. Quesnel & R. Turchet  
CEA LITEN - INES, Le Bourget du Lac, France  
Y. Trouillot & N.J. Matsapey  
ECM Greentech, Grenoble, France  
G. Bubnov & G. Kekelidze  
Moscow Technological Institute, Russia

- 2AV.2.11 Fabrication of Black Multicrystalline Silicon and Solar Cell by Cu and Ag Co-Assisted Chemical Etching**  
H. Shen, C. Zheng, T. Pu & Y. Jiang  
NUAA, Nanjing, China
- 2AV.2.12 Optimized Single Side Doped Layer Removal of PERT Solar Cells**  
S. Simayi, Y. Kida & H. Takato  
AIST, Koriyama, Japan  
K. Shirasawa  
AIST, Tsukuba, Japan  
T. Suzuki  
Nippon Kasei Chemical, Fukushima, Japan
- 2AV.2.13 Lowest Surface Recombination in n-Type Oxidised Crystalline Silicon by Means of Extrinsic Field Effect Passivation**  
S. Bonilla, P. Hamer & P.R. Wilshaw  
University of Oxford, United Kingdom
- 2AV.2.17 Effective Surface Recombination of p+-Layer in p-Type Silicon PERT Bifacial Cell**  
Y. Eisenberg, L. Kreinin, N. Bordin & N. Eisenberg  
Jerusalem College of Technology, Israel  
G. Grigorieva & M. Kagan  
OJSC RPE „KVANT“, Moscow, Russia  
S. Hava  
BGU, Beer-Sheva, Israel
- 2AV.2.18 23% Metal Wrap through Silicon Heterojunction Solar Cells - A Simple Technology Integrating High Performance Cell and Module Technologies**  
G. Coletti, Y. Wu, E.E. Bende, G.J.M. Janssen & B.B. Van Aken  
ECN, Petten, The Netherlands  
F. Ishimura, K. Hashimoto & Y. Watabe  
Choshu Industry, Sanyo Onoda, Japan
- 2AV.2.19 Novel Low Cost Wet Chemical Cleaning Processes for Industrial Large Area n-Type Silicon Solar Cells with 22% Efficiency**  
J. John, M. Haslinger, M. Aleman, A. Uruena de Castro, E. Cornagliotti, L. Tous, R. Russell, F. Duerinckx, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
A. Hajjiah  
Kuwait University, Safat, Kuwait

- 2AV.2.20 Saw Damage Removal and Texturing of Crystalline Silicon by Maskless Inductively Coupled Plasma (ICP) Processes with SF6 and O2**  
J. Hirsch, M. Gaudig & N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany  
M. Gläser, M. Werner, S. Großer & D. Lausch  
Fraunhofer CSP, Halle, Germany
- 2AV.2.21 Surface Photovoltage Studies of n- and p-Type Crystalline Silicon Passivated by Thermal-ALD Aluminium Oxide**  
Y. Sun, R. Jia, B. Sun, X. Dou, K. Tao, Z. Jin & X. Liu  
CAS, Beijing, China
- 2AV.2.23 Surface Passivation by Al2O3 Deposited on an Industrial Low Frequency PECVD Equipment**  
R. Monna & S. Dubois  
CEA, Le Bourget du Lac, France  
L. Crampette, C. Bourcheix, G. Lazzarelli & R. de Munnik  
SEMCO Engineering, Montpellier, France
- 2AV.2.24 Surface Passivation of c-Si Using Silicon Oxynitride - Accentuating the Thermal Stability by Silicon Nitride Capping Layer**  
A. Soman & A. Antony  
IIT Bombay, Mumbai, India
- 2AV.2.25 Low Temperature PECVD Formation of Boron-Doped Epitaxial Emitters for Crystalline Silicon Solar Cells**  
R. Leal & G. Poulain  
TOTAL, Paris La Défense, France  
F. Haddad, F. Silva, J.-L. Maurice & P. Roca i Cabarrocas  
CNRS, Palaiseau, France
- 2AV.2.26 Hydrogen Plasma Treatment to Enhance a-Si/c-Si Interface Passivation**  
A. Soman & A. Antony  
IIT Bombay, Mumbai, India
- 2AV.2.27 Softly Doped and Deep Emitters for P/Al Solar Cell Structure**  
M.A. Rasool, V. Fano, A. Otaegi, J.R. Gutiérrez, J.C. Jimeno, N. Azkona & E. Cereceda  
University of the Basque Country, Zamudio, Spain  
A. Habib  
Mansoura University, Egypt
- 2AV.2.28 Surface Passivation of Crystalline Silicon by Hydrogenated Amorphous Silicon/Sub-nm Al2O3 Stack**  
A.S.A. Ali  
Zewail City of Science and Technology, Giza, Egypt  
O. Tobail  
Cairo University, Giza, Egypt

- 2AV.2.29 Process Development for Silicon Heterojunction Solar Cells**  
M. Hendrichs, A. Morales, L. Mazzearella, S. Kirner, M. Zelt, L. Korte, B. Stannowski & R. Schlatmann  
HZB, Berlin, Germany
- 2AV.2.30 Laser Lithography for Interdigitated Back-Contacted Silicon Heterojunction Solar Cells**  
A. Singh, B. Turan & K. Ding  
Forschungszentrum Jülich, Germany
- 2AV.2.31 Improved Silicon Heterojunction Photo-Conversion Efficiency Using In<sub>2</sub>O<sub>3</sub>:Sn Front Electrodes Grown from Sputter Targets with an SnO<sub>2</sub> Content below 10 Wt. %**  
S. Calnan, L. Mazzearella, M.-S. Hendrichs, S. Kirner, M. Wittig, L. Korte, B. Stannowski & R. Schlatmann  
HZB, Berlin, Germany  
M. Dimer, W. Thom, U. Graupner & M. Thumsch  
VON ARDENNE, Dresden, Germany
- 2AV.2.32 Silicon Oxynitride–Silicon Nitride Surface Passivation of p-Type c-Si Solar Cells with Laser Fired Rear Contacts**  
A. Soman, S. Mondal, S. Bhatia, B. Arunachalam, S. Kumbhar, S. Somasundaram, P. Nair & A. Antony  
IIT Bombay, Mumbai, India
- 2AV.2.33 Emitter and Contact Optimization for High-Efficiency IBC Mercury Cells**  
A.A. Mewe, P. Spinelli, A.R. Burgers, N. Guillevin, E.J. Kossen & I. Cesar  
ECN, Petten, The Netherlands  
A.H.G. Vlooswijk  
Tempress, Vaassen, The Netherlands
- 2AV.2.34 Optimized Lifetime of Black Silicon Nanostructures for Photovoltaic Applications**  
M. Plakhotnyuk, R. Schmidt Davidsen, M. Stenbæk Schmidt, R. Malureanu, E. Stamate & O. Hansen  
Technical University of Denmark, Kongens Lyngby, Denmark
- 2AV.2.35 Analysis of Device Interface Properties on Mono-Crystalline Silicon Using Plasma Etching Process**  
C.Y. Yoo, K. Hong, J. Kim, E. Lee & Y.H. Cho  
Shinsung Solar Energy, Seongnam-si, Korea South
- 2AV.2.36 Anti-Reflective Coating Made by Solution Based Deposition of TiO<sub>2</sub> Nanoparticles**  
G. Peharz, B. Feketeföldi, C. Prietl, C. Auer & G. Jakopic  
JOANNEUM RESEARCH, Weiz, Austria

- 2AV.2.38 Investigation of Deep Levels in Solar Cell Structure Based on HIT**  
V.G. Litvinov, N.V. Vishnyakov, V.V. Gudzev, A.V. Ermachikhin & S.P. Vikhrov  
Ryazan State Radio Engineering University, Russia  
E.I. Terukov, D.L. Orekhov, A.S. Abramov & S.N. Abolmasov  
RAS/ Ioffe, St. Petersburg, Russia

## VISUAL PRESENTATIONS 6AV.5

15:15 - 16:45 PV in Buildings and the Environment

- 6AV.5.1 The Electric Mondrian Toolbox Concept - a Luminescent Solar Concentrator Design Study**  
P. Moraitis & W.G.J.H.M. van Sark  
Utrecht University, The Netherlands
- 6AV.5.2 Leaf Roof – Designing Luminescent Solar Concentrating PV Roof Tiles**  
G. Doudart de la Grée, A. Papadopoulos, A. Rosemann, M.G. Debije & M. Cox  
Eindhoven University of Technology, The Netherlands  
Z. Krumer & A.H.M.E. Reinders  
University of Twente, Enschede, The Netherlands
- 6AV.5.4 Tunable Shade Windows with Integrated Luminescent Solar Concentrators and High Efficiency Lighting**  
P. Bernardoni, M. Tonezzer, D. Vincenzi, S. Baricordi, S. Fugattini & V. Guidi  
University of Ferrara, Italy
- 6AV.5.5 Self-Shading in Bifacial Photovoltaic Noise Barriers**  
M.M. de Jong, M.N. van den Donker & W. Folkerts  
SEAC, Eindhoven, The Netherlands  
S. Verkuilen  
Heijmans Wegen, Rosmalen, The Netherlands
- 6AV.5.7 Invited**
- 6AV.5.8 Thermal Model of Building Integrated Air Type Photovoltaic-Thermal System under Varying Conditions**  
A. Jagomägi  
Tallinn University of Technology, Estonia
- 6AV.5.9 Thermal Analysis of a BIPV/T Prototype for Fodder Drying**  
Y.B. Assoa  
CEA, Le Bourget du Lac, France  
S. Boddaert  
CSTB, Sophia Antipolis, France

- 6AV.5.10 Opportunities for Thermal / Photovoltaic Hybrid Building-Integrated Systems in Hong Kong**  
B. Stobbe, O. Isabella & M. Zeman  
Delft University of Technology, The Netherlands  
L.F.N. Moses  
Hong Kong University of Science and Technology, Hong Kong
- 6AV.5.11 Energy Performance of PV Modules as Adaptive Building Shading Systems**  
J. Jayathissa, J. Schmidli, J. Hofer & A. Schlueter  
ETH Zurich, Switzerland
- 6AV.5.13 Experimental Analysis of the Performance of Façade-Integrated BIPV in Different Configurations**  
G. Van den Broeck, W. Parys, H. Goverde, J. Poortmans, J. Driesen, K. Baert & D. Saelens  
EnergyVille, Genk, Belgium
- 6AV.5.14 Semi-Transparent Photovoltaic Windows Performance Modelling: on the Prediction of Cell Operating Temperatures**  
K. Kapsis & A. Athienitis  
Concordia University, Montreal, Canada
- 6AV.5.15 A Multi Criteria Optimization Tool for BIPV Overhangs**  
M. Lovati, J. Adami, G. Demichele, L. Maturi & D. Moser  
EURAC, Bolzano, Italy
- 6AV.5.16 Effective Positioning of Photovoltaic Modules in Solar Plants in the Urban Environment**  
R. Herrero Alonso, S. Shimura, R. Silva Simplício, C. Biasi de Moura & M. Knörich Zuffo  
University of São Paulo, Brazil
- 6AV.5.18 Obstruction Surveying Methods for PV Application in Urban Environments**  
S.R. Teixeira Freitas, A.R. Cristovão, R. Amaro e Silva & M.C. Brito  
University of Lisbon, Portugal
- 6AV.5.19 Impact of Different Architectural Parking Lot Layouts on Photovoltaic System Performance**  
C. Biasi de Moura, S. Shimura, R. Silva Simplício, R. Herrero Alonso & M. Knörich Zuffo  
University of São Paulo, Brazil
- 6AV.5.20 Simulation of Mismatch Losses for Parallel Connection of CIGS Module Strings with Different Orientations in BIPV Systems**  
R. Wächter, A. Jenninger & T. Repmann  
Manz CIGS Technology, Schwäbisch Hall, Germany

- 6AV.5.21 Building Integrated Photovoltaics from Design Concepts to Real Buildings in Different Stakeholders' Visions in the European Funded Project Construct PV**  
A. Scognamiglio  
ENEA, Portici, Italy  
F. Frontini  
SUPSI, Canobbio, Switzerland  
C. Erban  
Meyer Burger, Gwatt, Switzerland  
K. Fath & R. Hecker  
Zueblin, Stuttgart, Germany  
G. Gijzen & T. Minderhoud  
UNStudio, Amsterdam, The Netherlands  
T.E. Kuhn  
Fraunhofer ISE, Freiburg, Germany
- 6AV.5.22 Integration of Photovoltaic Module into Building Facade**  
G. Cattaneo  
CSEM, Neuchâtel, Switzerland  
P. Heinstejn, K. Söderström, C. Ballif & L.-E. Perret-Aebi  
CSEM, Neuchâtel, Switzerland  
A. Clua Longas, S. Lufkin & E. Rey  
EPFL, Lausanne, Switzerland  
K. Brooks  
glass2energy, Villaz-St-Pierre, Switzerland
- 6AV.5.24 Appreciating Performance of a BIPV Lab in Bangalore (India)**  
M. Mani, G. Aaditya & B. N.C  
Indian Institute of Science, Bangalore, India
- 6AV.5.25 Outdoor Characterization of Innovative BIPV Modules for Roof Application.**  
F. Frontini, P. Bonomo & C.S. Polo López  
SUPSI, Canobbio, Switzerland  
F. Cais  
Tegola Canadese, Vittorio Veneto, Italy  
C. Erban  
Meyer Burger, Gwatt (Thun), Switzerland
- 6AV.5.26 Architectural Solution for Using Area of Side Streets and Alleys to Utilize Solar Panels**  
A. Rahmani  
KIT, Sanandaj, Iran

**6AV.5.27 PVSITES Project – Building Integrated Photovoltaic Technologies and Systems for Large-Scale Market Deployment**

M. Machado  
Tecnalia Research & Innovation, San Sebastián, Spain  
E. Rico  
Onyx Solar Energy, Avila, Spain  
T. Reijenga  
BEAR-iD, Gouda, The Netherlands  
P. Brassier  
Nobatek, Anglet, France  
P. Surguy  
Film Optics, Watchfield, United Kingdom  
V. Francisco  
CTCV, Coimbra, Portugal  
D. Brémaud  
Flisom, Dübendorf, Switzerland  
J. Martínez  
Cricursa, Barcelona, Spain  
F. Burgun  
CEA, Le Bourget du Lac, France  
R. Díaz  
Acciona Infraestructuras, Madrid, Spain  
D. Deramaix  
Bureau d'Architectes Format D2, Sirault, Belgium  
A. Bogucka  
Vilogia, Paris, France  
F. Noris  
R2M Solution, Pavia, Italy  
N. Van Khai  
Cadcamation, Onex, Switzerland  
I. Weiss  
WIP - Renewable Energies, München, Germany

**6AV.5.28 Smart-FLeX Solution Way Forward for Cost Competitive BIPV Production?**

J. Ulbikas, A.J. Galdikas & A. Stonkus  
Applied Research Institute for Prospective Technologies,  
Vilnius, Lithuania

**VISUAL PRESENTATIONS 2AV.3**

**17:00 - 18:30 Silicon Solar Cell Improvements and Innovation (III)**

**2AV.3.1 Bifacial Solar Cells Fabricated by PERC Process for Mass Production**

S.-Y. Chen, Y.-H. Lin, S.-H. Yu, W.-J. Lih & C.-H. Du  
ITRI, Hsinchu, Taiwan  
H.-Y. Chang, Y.-Y. Chiu & Y.-H. Wang  
Big Sun Energy Technology, Hsinchu, Taiwan

**2AV.3.2 The Investigation of Emitter Profile on Copper Plated Silicon Solar Cells**

L.-Y. Li, C.-K. Peng & C.-H. Du  
ITRI, Hsinchu, Taiwan  
P. Yu  
NCTU, Hsinchu, Taiwan

**2AV.3.3 Influence of the Bottom WO<sub>3</sub> Layer on the Series Resistance in Silicon Based Solar Cells with WO<sub>3</sub>/Ag/WO<sub>3</sub> Emitter**

J. Bao, W. Wu & H. Shen  
Sun Yat-sen University, Guangzhou, China

**2AV.3.4 SiNx/SiOxNy Stack Passivation for n-Type Si**

J. Zhu, R. Søndena, E. Stensrud Marstein & S.E. Foss  
Institute for Energy Technology, Kjeller, Norway  
C. Zhou  
CAS, Beijing, China

**2AV.3.5 Application of Rear Etching in n-Type Crystalline Silicon Solar Cells Production**

J.K. Ma, M.J. Chen, D.S. Zhang, Y.C. Li, J.G. Cui,  
J.C. Shi & B. Yu  
Yingli Green Energy, Baoding, China

**2AV.3.6 New Promising c-Si Solar Cell and Busbar Concepts for Industry Application**

W. Mühleisen, L. Neumaier & C. Hirschl  
CTR, Villach, Austria  
S. Seufzer  
KIOTO, St. Veit/Glan, Austria  
M. Trobej  
Energetica, Klagenfurt-Viktring, Austria  
W. Pranger  
Ulbrich of Austria, Müllendorf, Austria  
J. Scheurer  
Polytec-PT, Waldbronn, Germany  
R. Lorenz  
teamtechnik Maschinen und Anlagen, Freiberg, Germany  
M. Schwark  
AIT, Vienna, Austria

**2AV.3.8 Analysis on Emitter of n-Type Monocrystalline Silicon PERT Photovoltaic Cell**

T. Morioka, T. Watahiki, S. Nishimura, K. Nishimura,  
D. Niinobe, Y. Kobayashi, H. Tokioka & M. Yamamuka  
Mitsubishi Electric, Amagasaki, Japan

**2AV.3.9 Interface Carrier Selective Modification for Efficiency Enhancement to Silicon Hybrid Solar Cells**

Y.-S. Kou, S.-T. Yang, H.-J. Syu, J.-W. Wu, S. Thiyagu,  
Y. Lai & C.-F. Lin  
NTU, Taipei, Taiwan



- 2AV.3.10 Improved Passivation of Black Multi-Crystalline Silicon by Wet Chemical Pretreatment and Atomic Layer Deposition**  
Y. Jiang, H. Shen, T. Pu & C. Zheng  
NUAA, Nanjing, China
- 2AV.3.11 Single-Chamber Silicon Deposition Process for Industrial Silicon Heterojunction Solar Cells**  
H. Li, O. Astakhov, D. Weigand, A. Lambertz & K. Ding  
Forschungszentrum Jülich, Germany
- 2AV.3.12 Advantages of Transition to 4 and 5 Busbar Front Contact Grid Designs for Ni/Cu/Ag Plated Silicon Solar Cells**  
D. Pysch, J. Burschik, N. Bay, A. Hoffmann, H. Kühnlein, M. Passig, M. Sieber & K. Vosteen  
RENA, Freiburg, Germany  
Y. Shengzhao & P. Verlinden  
Trina Solar Energy, Shanghai, China  
B. Lee & A. Letize  
MacDermid, Waterbury, United States
- 2AV.3.13 Black Silicon by Electrochemical Reduction of Silica Layers in Molten Salt**  
P.R. Coxon & D.J. Fray  
University of Cambridge, United Kingdom  
E. Juzeliunas  
Klaipda University, Klaipeda, Lithuania
- 2AV.3.14 Metal Wrap through Heterojunction Solar Cell with Plated Electrode**  
F. Ishimura, L. Wenjun, E. Kobayashi, K. Hashimoto, S. Sato & Y. Watabe  
Choshu Industry, Sanyo Onoda, Japan  
E. Bende & G. Coletti  
ECN, Petten, The Netherlands
- 2AV.3.15 Implantation of Phosphorus into Pyramidal Texture in Silicon Solar Cell**  
K. Tanahashi, M. Moriya, Y. Kida, T. Fukuda, K. Shirasawa & H. Takato  
AIST, Koriyama, Japan
- 2AV.3.16 Excellent c-Si Surface Passivation by Atomic Layer Deposited TiO<sub>2</sub> Films and Its Optical, Material Properties**  
B. Liao, N. Dwivedi, G. Kaur & B. Charanjit Singh  
National University of Singapore, Singapore
- 2AV.3.17 Loss Analysis of 21.4% Industrial PERC Solar Cells**  
P. Saint-Cast, J. Greulich, S. Werner, U. Jäger, T. Dannenberg, S. Maier, K. Zimmermann, U. Belledin, R. Ackermann, S. Gutscher, A. Brand, M. Linse, M. Retzlaff, A. Krieg, K. Krieg, K. Krauß, J. Broisch, T. Chipei, H. Höffler & R. Preu  
Fraunhofer ISE, Freiburg, Germany

- 2AV.3.19 Passivation of Silicon Solar Cells via Low Temperature Wet Chemical Oxidation**  
G. Kökbudak, E.H. Çiftpinar, O. Demircioglu & R. Turan  
METU, Ankara, Turkey
- 2AV.3.20 Surface Passivation Provided by an Alneal through SiO<sub>2</sub>/TiO<sub>2</sub> Bilayer**  
K.A. Collett, M. Cyrson, R.S. Bonilla & P.R. Wilshaw  
University of Oxford, United Kingdom
- 2AV.3.22 Merging Homo- and Hetero-Junctions Silicon Solar Cells Advantages: a Novel Junction to Outperform Silicon Cells Efficiencies**  
T. Carrere, R. Varache & D. Muñoz  
CEA, Le Bourget du Lac, France  
R. Lachaume & J.-P. Kleider  
GeePs, Gif-sur-Yvette, France  
M. Coig  
CEA, Grenoble, France
- 2AV.3.23 19.27%-Efficient Multi-Crystalline Silicon Solar Cell with MCCE Black Silicon Technology**  
S. Zou, X.-S. Wang, F. Cao & G. Xing  
Canadian Solar, Suzhou, China
- 2AV.3.24 Solving the LID problem for PERC by LIR**  
J. Wu, X. Meng, X.-S. Wang & G. Xing  
Canadian Solar, Suzhou, China
- 2AV.3.25 Novel Vacuum-Free Technique and Technologies for High Efficient and Low-Cost Photovoltaics**  
G.K. Zhavnerko & V.Y. Shiripov  
Izovac Technologies, Minsk, Belarus  
O.V. Sergeev  
Next Energy, Oldenburg, Germany
- 2AV.3.26 Phosphorous Doping from APCVD Deposited PSG**  
F. Book, F. Mutter & G. Hahn  
University of Konstanz, Germany  
H. Knauss & C. Demberger  
Gebrüder Schmid, Freudenstadt, Germany
- 2AV.3.27 Forward-Bias-Plated Ni/Cu Front Contacts for 20.5% Efficiency n-Type Bifacial Solar Cell**  
S.-Y. Liu, Y.-L. Lee, M.-S. Lin, C.-M. Wei, K.-C. Lai & C.-C. Chuang  
Motech Industries, Tainan, Taiwan
- 2AV.3.28 The Effect of Surface Passivation at Low-Injection Level on Fill Factor of Silicon Heterojunction Solar Cells**  
L. Zhang, M. Ren, J. Wang, R. Yang, L. Li, Y. Meng & T. Guo  
ENN Solar Energy, Langfang, China



**2AV.3.29 Doped a-Si:H/ $\mu$ c-Si:H Hybrid Layers Used to Improve the Performance of Top-Con Silicon Solar Cells**

K. Tao, R. Jia, Y. Sun, Z. Jin & X. Liu  
CAS, Beijing, China  
J. Wang  
Nankai University, Tianjin, China

**2AV.3.30 The Swiss Inno-HJT Project: Performance of Si-HJT Systems Produced in a Pilot R&D Line**

B. Strahm, D. Bätzner, W. Frammelsberger, D. Lachenal, B. Legradic, J. Meixenberger, P. Papet & G. Wahli  
Meyer Burger Research, Hauterive, Switzerland  
M. Despeisse, C. Allebé, P.-J. Alet, N. Badel, A. Faes, A. Lachowicz, J. Levrat & C. Ballif  
CSEM, Neuchâtel, Switzerland  
Y. Yao, T. Söderström, J. Heiber, M. Lanz & S. Leu  
Meyer Burger, Gwatt, Switzerland  
V. Fakhfour  
Pasan, Neuchâtel, Switzerland

**2AV.3.31 Review on Metallization and Interconnection for Si Heterojunction Solar Cells**

A. Faes, M. Despeisse, J. Levrat, J. Champlaud, A. Lachowicz, N. Badel, J. Geissbühler, H. Watanabe & C. Ballif  
CSEM, Neuchâtel, Switzerland  
T. Söderström & Y. Yao  
Meyer Burger, Gwatt, Switzerland  
J. Ufheil  
Somont, Umkirch, Germany  
P. Papet & B. Strahm  
Meyer Burger Research, Hauterive, Switzerland  
J. Hermans  
Meyer Burger, Eindhoven, The Netherlands  
A. Tomasi  
EPFL, Neuchâtel, Switzerland  
J. Fleischer & P.V. Fleischer  
PVP, Neufinsing, Germany

**2AV.3.32 A Comparison of Three Well Known Laser Separation Methods for Half Cell Production**

J. Röth & N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany  
C. Belgardt & M. Grimm  
3D-Micromac, Chemnitz, Germany

**2AV.3.33 The Bifacial nPERT Solar Cell Coupling Boron Spin-on with POC13 Diffusion and Its Glass-Glass Module Performance**

C. Wu, Q. Wei, P. Ni, J. Lu & W. Lian  
Talesun Solar, Suzhou, China

**2AV.3.34 The IBC Structure as Support for Three Band-Gaps Tandem Devices**

J.C. Jimeno, R. Gutiérrez, V. Fano & A. Habib  
UPV/EHU, Zamudio, Spain  
C. del Cañizo  
UPM, Madrid, Spain

**2AV.3.35 A Low Current High Efficiency Solar Cell Composed of a 80 $\mu$ m Thin Monocrystalline Silicon Foil Transferred on a Low Cost Substrate**

G. Sun, E. Terraz, Y. Boye, Y. Salinesi, A. Sow, A. Malinge & A. Straboni  
S'Tile, Poitiers, France  
J. Arumughan  
ISC Konstanz, Germany

**2AV.3.36 A Study on Tunnel Oxide Passivated Contact of Silicon Solar Cells**

H. Kim, S. Bae, J.W. Yang, C.H. Lee, Y. Kang, H.-S. Lee & D. Kim  
Korea University, Seoul, Korea South  
K. Ji  
LG Electronics, Seoul, Korea South

**2AV.3.37 ITO/n-Si Based Solar Cells: the Influence of Interfaces on Solar Cell Efficiency**

A. Simashkevich, L. Bruc, N. Curmei & D. Serban  
Institute of Applied Physics, Kishinev, Moldova  
M. Rusu  
HZB, Berlin, Germany  
A. Thøgersen & A. Ulyashin  
SINTEF, Oslo, Norway

**2AV.3.38 Lead Free Ohmic Connections on High Efficiency Silicon Solar Cells**

E. Skuras, G. Sempros, H. Zoubos, E. Mantzopoulou, T. Giouis & D. Anagnostopoulos  
University of Ioannina, Greece  
T. Makris, P. Fleming & A. Santamaria  
Ipsol Energy, Nottingham, United Kingdom

**2AV.3.39 Investigations on Laser Fired Contacting and Annealing of RST Silicon PERC-Type Solar Cells**

B. Albrecht, Y.P. Botchak Mouafi, P. Keller & G. Hahn  
University of Konstanz, Germany  
F. de Moro  
SolarForce, Bourgoin-Jallieu, France

**VISUAL PRESENTATIONS 6AV.6**

**17:00 - 18:30 Utility-Scale PV / PV Applications without a Centralised Grid**

**6AV.6.4 Optimal Design of Renewable Energy Resources Considering Electric Load Control for Carbon Free Jeju Island in Korea**

C.-Y. Cho, S.-S. Kim, H.G. Lee, J.-W. Ko, J.-R. Lim,  
S.C. Woo, H.-L. Cha, D.K. Kim & H.K. Ahn  
Konkuk University, Seoul, Korea South  
W.C. Lawrence & C.-S. Won  
LSIS, Anyang-Si, Korea South  
H.-S. Jeong  
Korea Water Resources, Daejeon -Si, Korea South

**6AV.6.5 State of Charge Variation for Small off-Grid PV-Battery Systems in Bolivia**

F. Benavente-Araoz, A. Lundblad, Y. Zhang & G. Linberg  
KTH Royal Institute of Technology, Stockholm, Sweden  
P. Elia Campana  
Mälardalen University, Västerås, Sweden  
S. Cabrera  
UMSA, La Paz, Bolivia

**6AV.6.6 Optimization of Stand-Alone PV Power Systems with Hybrid Energy Storages Based on Ultra Capacitors**

S.M. Karabanov, D.V. Suvorov, E.V. Slivkin,  
G.P. Gololobov & D.Y. Tarabrin  
RSREU, Ryazan, Russia

**6AV.6.8 A Power Managing Unit for Standalone Solar PV Installation**

D. Oulad-Abbou & S. Doubabi  
Cadi Ayyad University, Marrakech, Morocco  
A. Rachid  
University of Picardie, Amiens, France

**6AV.6.9 Design and Cost Optimization of Small-Scale PV-Powered Reverse Osmosis Desalination (Case Study)**

S. Hajji  
Masen, Rabat, Morocco  
N. Mbodji & A. Hajji  
Agronomic and Veterinary Institute Hassan II, Rabat, Morocco

**6AV.6.11 Rural Water Supply in Ethiopia with PV Pumps**

C. Nyman  
Soleco, Porvoo, Finland  
T. Beshah  
BISIT, Kerpen, Germany  
T.B. Woldekirkos  
Solatec, Addis Ababa, Ethiopia

**6AV.6.12 Sizing of PV Array for Water Pumping Application**

A.F. Almarshoud  
Qassim University, Buraydah, Saudi Arabia

**6AV.6.13 Performance of SPV Water Pumping System at Lower Irradiance Condition**

M. Bangar, B. Bora, O.S. Sastry, R. Singh, S. Rai &  
R. Dahiya  
NISE, Gurgaon, India

**6AV.6.14 Optimum Array Sizing of Solar Photovoltaic Water Pumping System**

R. Dahiya, B. Bora, M. Bangar & O.S. Sastry  
NISE, Gurgaon, India  
B. Prasad  
TERI, New Delhi, India

**6AV.6.15 Product Integrated PV: Why Design and Styling Is a Requirement**

A.H.M.E. Reinders & W. Eggink  
University of Twente, Enschede, Netherlands

**6AV.6.17 A New Photovoltaic Charging Topology and Regenerative Braking Analysis for Solar Tricycle**

D. Mohamed, I. Salhi & S. Doubabi  
Cadi Ayyad University, Marrakech, Morocco  
A. Rachid  
University of Picardie, Amiens, France

**6AV.6.18 Design, Characterization and Modelling of High Efficient Solar Powered Lighting Systems**

P. Behrendorff Poulsen, S. Thorsteinsson, J. Lindén,  
R. Overgaard Ploug, P. Nymann & F. Svane  
Technical University of Denmark, Roskilde, Denmark  
M.C. Mira Albert & A. Knott  
Technical University of Denmark, Lyngby, Denmark  
I. Mogensen & K. Retoft  
Out-sider, Copenhagen, Denmark

**6AV.6.19 Development of a Photovoltaic Powered Poultry Egg Incubator**

I. Okonkwo & O. Onyekwere  
University of Nigeria, Nsukka, Nigeria

**6AV.6.20 Integration of Renewable Energy Technologies in the Community of the Agricultural University of Athens**

C.-S. Karavas & G. Papadakis  
Agricultural University of Athens, Greece

**6AV.6.21 How Solar Energy Connected to Development in Rural India**

A. Kumar  
Asha for Education, Atlanta, United States



- 5BV.1.8 Effect of Different UV Cut off Wavelength of EVA Encapsulant on the Performance & Reliability of Cr-Si PV Modules**  
A.K. Singh & R. Singh  
RenewSys, Bangalore, India
- 5BV.1.9 UV-Fluorescence Measurements – Imaging and Spectroscopy**  
B. Kubicek  
AIT, Vienna, Austria  
G.C. Eder & Y. Voronko  
OFI, Vienna, Austria  
D. Mayrhofer  
Vienna, Austria
- 5BV.1.10 Gel Content Determination of Polyolefin Elastomer (POE)-Based PV Encapsulant: Proper Solvent Extraction and Development towards a Fast and Non-Destructive Approach**  
H.-Y. Li, A. Faes, J. Champliand, C. Ballif & L.-E. Perret-Aebi  
CSEM, Neuchâtel, Switzerland
- 5BV.1.12 Module Inspection Using Line Scanning Photoluminescence Imaging**  
I. Zafirovska, O. Kunz & T. Trupke  
UNSW Australia, Sydney, Australia  
J. Weber  
BT Imaging, Sydney, Australia
- 5BV.1.13 Optical Simulation for Ribbon with Optical Structure in c-Si PV Module**  
C.-W. Yang, C.-M. Yang & C.-L. Cheng  
AU Optronics, Taichung, Taiwan
- 5BV.1.14 Influence of Photovoltaic Module Mounting Systems on the Thermo-Mechanical Stresses in Solar Cells by FEM Modelling**  
A.J. Beinert, M. Ebert & U. Eitner  
Fraunhofer ISE, Freiburg, Germany  
J. Aktaa  
KIT, Eggenstein-Leopoldshafen, Germany
- 5BV.1.15 Non-Stationary Outdoor EL-Measurements with a Fast and Highly Sensitive InGaAs Camera**  
J. Adams, C. Buerhop-Lutz, T. Pickel, J. Teubner, C. Camus & C.J. Brabec  
ZAE-Bayern, Erlangen, Germany
- 5BV.1.16 Impedance Spectroscopy and Its Possible Use for Defects Detection**  
L. Cerná, T. Finsterle, P. Hrzina & V. Benda  
CTU Prague, Czech Republic

- 5BV.1.17 Quantitative Luminescence Analysis of Solar Modules in Full Daylight**  
Y. Augarten, A. Wrigley, A. Gerber, B. Pieters & U. Rau  
Forschungszentrum Jülich, Germany
- 5BV.1.18 Impedance Characterization of PV Modules in Outdoor Conditions**  
M.I. Oprea, S.V. Spataru & D. Sera  
Aalborg University, Denmark  
S. Thorsteinsson & P. Behrendorff Poulsen  
Technical University of Denmark, Roskilde, Denmark  
A.R. Andersen & R. Basu  
EmaZys Technologies, Vejle, Denmark
- 5BV.1.19 Light Induced Degradation of P-Mono PERC from Ingot, Cell, Module to System**  
M.Y. Chang, H. Chen, C.H. Hsueh & C. Chen  
AU Optronics, Taichung, Taiwan
- 5BV.1.20 Non-Destructive PV Module Failure Analysis Using Dark Lock-in Thermography**  
D. Philipp, I. Dürr, S. Stecklum & C. Völker  
Fraunhofer ISE, Freiburg, Germany
- 5BV.1.21 Measuring Anti-Reflection Coatings on Patterned Glass**  
B. Brophy, Z.R. Abrams & P. Gonsalves  
Enki Technology, San Jose, United States
- 5BV.1.22 Measuring Anti-Reflection and Anti-Soiling Properties of PV Module Coatings**  
M. Gostein & W. Stueve  
Atonometrics, Austin, United States  
B. Brophy  
Enki Technology, San Jose, United States  
K. Jung  
University of California, Riverside, United States  
S. Zhang, Y. Jin & J. Xu  
Trina Solar Energy, Changzhou, China
- 5BV.1.23 Guidelines for the Development of Abrasion-Resistant AR Coatings: Input from Modelling and Experimental Work**  
R. Cauchois, M. Meuwissen, M. Tian, H. Keul, P. Steeman & D. Reardon  
DSM, Geleen, The Netherlands
- 5BV.1.24 Variations in Spectral Transmittance due to Dust on CdTe and Mono Crystalline Silicon Modules**  
S. Rai, B. Bora, O.S. Sastry, R. Singh, M. Bangar, R. Dahiya, G.K. Jha & T.R. Khadka  
NISE, Gurgaon, India

**5BV.1.25 1500v PID Test Results on 60-Cells Modules with Different Encapsulants, Glasses and Double Glasses**

B. Braisaz & D. Binesti  
EDF R&D, Moret-sur-Loing, France  
B. Commault, E. Gerritsen & M. Joanny  
CEA LITEN, Le Bourget du Lac, France  
N. Le Quang & G. Goer  
EDF ENR PWT, Bourgoin Jallieu, France  
K. Radouane  
EDF EN, Paris La Defense, France

**5BV.1.26 Durability of Bifacial Solar Modules under Potential Induced Degradation: Role of the Encapsulation Materials**

M. Barbato, M. Meneghini, A. Barbato & G. Meneghesso  
University of Padua, Padova, Italy  
G. Tavernaro & M.P. Rossetto  
MegaCell, Carmignano di Brenta, Italy

**5BV.1.27 Lifetime Warranty Test Method Considering Potential Induced Degradation Recovery Behavior**

K. Kang, B. Kim, S. Park & S. Chang  
LG Electronics, Gumi, Korea South

**5BV.1.28 Does the New IEC 62804-2 PID Test Procedure Cover a Service Life of CIGS PV Modules?**

P. Lechner, J. Schnepf & D. Geyer  
ZSW, Stuttgart, Germany  
R. Schäffler, R. Wächter & T. Repmann  
Manz CIGS Technology, Schwäbisch Hall, Germany

**5BV.1.29 An Investigation of Factors Contributing to Potential-Induced Degradation (PID) and Its Countermeasures**

X.-S. Wang, S. Wan, A. Fu & G. Xing  
Canadian Solar, Suzhou, China

**5BV.1.30 Potential Induced Degradation (PID) – Applied Field Analysis and Monitoring Data Evaluation, Regeneration and Prevention in the Field**

G. Mathiak, N. Bogdanski, W. Herrmann & F. Reil  
TÜV Rheinland, Cologne, Germany

**5BV.1.31 Analysis of PID Affected Photovoltaic Module during Regeneration and Degeneration Process**

J. Vanek, J. Hylsky, D. Strachala, M. Sturm & P. Cudek  
Brno University of Technology, Czech Republic

**5BV.1.32 Yield Losses of PID-Affected PV Systems - Simulation of Yield Losses Beyond Power Loss**

J. Arp  
PV Lab Germany, Potsdam, Germany  
B. Jaeckel  
UL International, Neu-Isenburg, Germany  
J. Behrschmidt  
Obst & Ziehmman, Hamburg, Germany

**5BV.1.33 PID and UVID Resistant n-Type Solar Cells and Modules**

M.K. Stodolny, G.J.M. Janssen, B.B. Van Aken, C.J.J. Tool, M.W.P.E. Lamers, I.G. Romijn & J. Löffler  
ECN, Petten, The Netherlands  
P.R. Venema & M.R. Renes  
Tempress, Vaassen, The Netherlands  
O. Siareyeva & E.H.A. Granneman  
Levitech, Almere, The Netherlands  
J. Wang, J. Ma, J. Cui, F. Lang & Z. Hu  
Yingli Green Energy, Baoding, China

**5BV.1.34 Evaluation of Potential Induced Degradation for Crystalline Silicon Solar Cells using Na Evaporated Ethylene Vinyl Acetate**

W. Oh, J. Kim, B. Kang & S.-I. Chan  
KETI, Seongnam, Korea South  
S. Bae, H.-S. Lee & D. Kim  
Korea University, Seoul, Korea South

**5BV.1.35 Recovery Method for Solar Modules Affected by Potential Induced Degradation in Utility-Scale Solar Plants**

Y. Hu, L. Hu, P. Ni, Q. Wei, F. Qian, Y. Yan & C. Liu  
Talesun Solar, Suzhou, China

**5BV.1.36 Performance Evaluation of PV Modules After Accelerated Testing Followed by Four Years of Field Exposure in Hot-Humid Climate of Florida**

V. Gade, N. Shiradkar, J. Opalewski & S. Vaishnav  
Jabil Circuit, St. Petersburg, United States

**5BV.1.37 PID Study of n-Type Bifacial Module**

K. Liu, Z. Sun, B. Yu, X. Lv, T. Feng, D. Rong, J. Jiang & Y. Zhang  
Yingli Green Energy, Baoding, China

**5BV.1.38 Compatibility of PV Ribbons and Fluxes with EVA Encapsulant Films**

N.S. Pujari  
Alpha Cookson India, Bangalore, India  
A. Lifton & M. Murphy  
Alpha109, South Plainfield, United States

**VISUAL PRESENTATIONS 5BV.2**

**13:30 - 15:00 Operation of PV Systems**

**5BV.2.1 Assessment of 13MWp DEWA PV Plant Cleaning Performance**

H. Qasem, P. Banda & A. Elnosh  
Dubai Electricity & Water Authority, United Arab Emirates  
R. Bkayrat  
First Solar, Dubai, United Arab Emirates

**5BV.2.4 Safety Analysis of Grounding Resistance for Zero Energy Town Floating PV System Using n-Type Bifacial Solar Cell Modules**

J.-W. Ko, J.R. Lim, H.-L. Cha & H.K. Ahn  
Konkuk University, Seoul, Korea South  
C.-S. Won & W.C. Lawrence  
LSIS, Anyang, Korea South  
H.-S. Jeong  
Korea Water Resources, Daejeon, Korea South

**5BV.2.5 Optimal Design, Field Performance and Impact of Energy Legislation on the Cost Effectiveness of a Domestic on-Grid Photovoltaic System in Morocco**

N. Mbodji & A. Hajji  
Agronomic and Veterinary Institute Hassan II, Rabat, Morocco  
K. Ababou & A. Heddouch  
SEWT, Rabat, Morocco

**5BV.2.6 Development of a Matlab Based Sizing and Simulation Tool for Solar Photovoltaic Pumping System (PVPS)**

R. Hasan & M. Zehner  
Rosenheim University of Applied Sciences, Germany  
O. Mayer  
GE Global Research, Garching, Germany

**5BV.2.7 Thermovision Testing of the Solar Power Plant Lifetime in the Czech Republic**

K. Jandová & J. Vanek  
Brno University of Technology, Czech Republic

**5BV.2.8 Simple and Accurate Monitoring of Expected PV Power Generation by Using Mini-PV Module**

K. Saito & M. Kondo  
Fukushima University, Japan  
J. Yamazaki & D. Yoshino  
The University of Aizu, Fukushima, Japan  
N. Higuchi  
Fukushima National College of Technology, Japan

**5BV.2.11 Automatic Detection of Defective Solar Modules by Thermovision**

J. Vanek, I. Repko & J. Klima  
Brno University of Technology, Czech Republic

**5BV.2.12 On the Way to Accurately Calculate Yearly Energy Harvest of a Solar Panel System**

X. Liao, K. Spee & C. van der Schouw  
Avans University of Applied Science, Hertogenbosch, The Netherlands

**5BV.2.13 Parameter Estimation of Commercial Flexible Amorphous and Crystalline Silicon Solar Cell Using Firefly Optimization Algorithm**

M. Louzazni, A. Khouya & K. Amechnoue  
University Abdelmalek Essaadi, Tanger, Morocco

**5BV.2.16 Evaluation of a Detailed Electro-Thermal PV Model on a 62.5 kWp Installation**

D.G. Anagnostos & D. Soudris  
NTUA, Athens, Greece  
K.M. Paasch  
University of Southern Denmark, Sønderborg, Denmark  
H. Goverde & F. Catthoor  
imec, Leuven, Belgium

**5BV.2.17 Modelling PV Modules Based on IEC 61853 Data**

B. Gatzka, M. Hofmann, R. Hunfeld & S. Lindemann  
Valentin Software, Berlin, Germany

**5BV.2.18 Skelion: the 3D Simulation Tool for PV Systems**

J. Pons Alemán  
Skelion, Valencia, Spain  
B. Soucase & I. Guaita  
UPV, Valencia, Spain

**5BV.2.19 Automatic Computation of Shading Mask on a PV Field Based on Production Data**

J. Dupas & B. Gaiddon  
Hespul, Lyon, France  
M. Joos & S. Fraisse  
Epices Energie, Lyon, France

**5BV.2.21 A Critical Review of PV System Design Rules for Optimizing Energy Yield and Space Utilization**

N. Narayan, A.H.M. Smets & M. Zeman  
Delft University of Technology, The Netherlands

**5BV.2.23 Calculation- and Visualization-Tool (CVT) for Partial Shading of Photovoltaic Systems**

F. Kuonen, U. Muntwyler, H. Heck, D. Gfeller & T. Schott  
BUAS, Burgdorf, Switzerland



- 5BV.2.24 Implications of Reference Data Accuracy and Stability for Performance Monitoring of PV Sites**  
H. Staab & A. Clerc  
Renewable Energy Systems, Kings Langley, United Kingdom
- 5BV.2.25 3 Year Field Performance of Anti-Soiling Coatings at Several Locations**  
B. Brophy  
Enki Technology, San Jose, United States  
K. Schexnaydre  
SunEdison, Belmont, United States
- 5BV.2.27 Optimization of the Photovoltaic System Power by a New Hyperbolic Tangent Approximation of the of Artificial Neural Network MPPT under Xilinx System Generator**  
F. Dkhichi, B. Oukarfi, Y. El Kouari, D. Ouoba & A. Fakkar  
University of Hassan II, Mohammédia, Morocco
- 5BV.2.28 Evaluation of Remote Diagnoses Performance by Using Operating Performance Index at Different Measurement Intervals for Residential PV Systems**  
M. Ajisaka & Y. Ueda  
Tokyo University of Science, Japan
- 5BV.2.29 Performance Enhancement of a Neural Network Model for PV Panel Power Prediction Using Self-Organizing Maps**  
S. Pulipaka, P. Upadhyay & R. Kumar  
BITS, Pilani, India
- 5BV.2.30 Study of Newly Installed PV Module Performance in Northern India**  
V. Khanna & A. Singh  
NCU Gurgaon, Harayana, India  
A. Shekher  
NGU Gurgaon, Harayana, India  
V. Budhraj  
BITS, Goa, India
- 5BV.2.31 A Simultaneous IV Tracer System: Solution for Monitoring and Diagnosing Photovoltaic System**  
Y.-C. Ou & J.-L. Kwo  
All Real Technology, Kaohsiung, Taiwan
- 5BV.2.32 The Design and Deployment of PV Systems at Aerodromes**  
P. Rodden, L. Frearson & M. Tuckwell  
CAT Projects, Alice Springs, Australia
- 5BV.2.33 Comparison of Various Models for the Estimation of the Performance Loss Rate of 7 PV Technologies over 5 Years in Alpine Climate**  
P. Ingenhoven, G. Belluardo & D. Moser  
Eurac Research, Bolzano, Italy

- 5BV.2.34 Drone-based Assessment of Cleaning Effects on Large PV Installations**  
M. Lanz, U. Muntwyler & E. Schüpbach  
BUAS, Burgdorf, Switzerland
- 5BV.2.35 Floating PV Installations in the Maltese Sea Waters**  
M. Grech, L. Mule'Stagno & M. Aquilina  
University of Malta, Msida, Malta  
M. Cadamuro  
General Membrane, Venice, Italy  
U. Witzke  
Pandia Energy, Victoria Gozo, Malta
- 5BV.2.36 Development, Application and Validation of a Compact, Portable Solar Cell Characterization Device Utilized for BIPV Analysis**  
D. Holzmann, C. Mayer, L. Neumaier & C. Hirschl  
CTR, Villach, Austria
- 5BV.2.37 Thermal Classification Modelling and Energy Yield Performance of Different Crystalline Silicon Photovoltaic Modules with Innovative Packaging Components**  
G. Makrides, I. Koumparou & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
J. Bratcher & J. Pratt  
Honeywell, Morristown, United States
- 5BV.2.38 Advanced Performance Monitoring System for Improved Reliability and Optimized Levelized Cost of Electricity**  
G. Makrides, A. Phinikarides & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
J. Sutterlueti  
Gantner Instruments, Schruns, Austria  
S. Ransome  
Steve Ransome Consulting, Kingston upon Thames, United Kingdom
- 5BV.2.39 A Use of Artificial Intelligence for Improving PV Array Performance (Empirical Approach)**  
A. Macq, L. Mercier des Rochettes, L. Martin-Carron & N. Cristi  
SUNiBRAIN, Colomiers, France  
M.-P. Gleizes & C. Bernon  
University of Toulouse, France
- 5BV.2.40 Floating PV Power System Evaluation over Five Years (2012 ~ 2016)**  
W. Lawrence, C.-S. Won, D.C. Kim, K.W. Kim, B.R. Kang & G.-H. Lee  
LSIS, Anyang-Si, Korea South

**5BV.2.42 Monitoring of over 10 GW of PV-Systems Throughout Europe – Analyses of Irradiance, Yield and Operational Performance of Modern PV Systems**

M. Schneider, N. Riewald, L. Richter & C. Kurz  
Meteocontrol, Augsburg, Germany  
A. Hammer  
University of Oldenburg, Germany  
M. Hartmann & M. Zehner  
University of Applied Sciences Rosenheim, Germany  
R. Gottschalg  
Loughborough University, United Kingdom

**5BV.2.43 Investigation of Battery Energy Storage System (BESS) Unit Sizing Using Trnsys for an on-Campus Photovoltaic Charging Station**

A. Esfandyari, B. Norton & M. Conlon  
Dublin Institute of Technology, Ireland  
S.J. McCormack  
Trinity College Dublin, Ireland

**5BV.2.44 Outdoor Performance and Modelling Study of Innovative Crystalline Silicon Photovoltaic Modules under Hot Climate Conditions**

G. Makrides, A. Phinikarides & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus  
E. Herzog & M. Strobel  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

**5BV.2.45 Performance Analysis of a New Class of Dual Axis Trackers**

E. Menard, G. Dambrine, B. Binet & J. Boardman  
HeliosLite, Le Bourget du Lac, France  
J. Sudres  
Quadran Energies Libres, Villeneuve-lès-Béziers, France

**5BV.2.46 Evaluation of Soiling during a 2-Months Drought and Construction Works Near a PV Test Facility in North-East Italy**

G. Belluardo, P. Ingenhoven & D. Moser  
EURAC, Bolzano, Italy

**5BV.2.47 Global Method for Calculating Location Specific MPP Tracking Losses Using Available Weather Statistics**

M. Egler, S. Gordon & P. Yim  
OST Energy, Brighton, United Kingdom

**5BV.2.48 Cell to Module Losses of an MWT Module**

L.H. Slooff, E.E. Bende, M.J. Jansen, L.A.G. Okel,  
F.J.K. Danzl & P. Manshanden  
ECN, Petten, The Netherlands

**5BV.2.49 Annual Yield Comparison of Module Level Power Electronics and String Level PV Systems with Standard and Advanced Module Design**

K. Sinapis, C. Tzikas, M.N. van den Donker & W. Folkerts  
SEAC, Eindhoven, The Netherlands  
T.T.H. Rooijackers, G.B.M.A. Litjens & W.G.J.H.M. van Sark  
Utrecht University, The Netherlands

**5BV.2.50 IR-Imaging a Tracked PV-Plant Using an Unmanned Aerial Vehicle**

C. Buerhop-Lutz, H. Scheuerpflug, T. Pickel & C. Camus  
ZAE Bayern, Erlangen, Germany

**5BV.2.51 aIR-PV-Check of Thin-Film PV-Plants – Detection of PID and Other Defects in CIGS Modules**

C. Buerhop-Lutz, T. Pickel, H. Scheuerpflug & C. Camus  
ZAE Bayern, Erlangen, Germany  
C. Dürschner  
Ing.-Büro Dürschner, Erlangen, Germany

**5BV.2.52 Titanium-Dioxide Nanotechnological Coating Application on Photovoltaic Modules for Preventive Yield Maintenance over Time**

A. Andaloro  
Polytechnic University of Milan, Italy  
L. Manni, M. Pravettoni & F. Frontini  
SUPSI, Canobbio, Switzerland

**5BV.2.53 IR-Images of Defective PV-Modules Influenced by Short-Time Changes of the Electric System**

C. Buerhop-Lutz, T. Pickel & C. Camus  
ZAE Bayern, Erlangen, Germany

**5BV.2.55 Selection Criteria of PV Technology Based on Specific Site**

G.K. Jha, R. Kumar, R. Siddiqui, S.R. Sykam, P. Rajput,  
M. Morampudi, S.L. Panchal & G. Gowri  
NISE, Gurgaon, India

**5BV.2.58 Forecasting the Degradation Rate of Different Photovoltaic Systems Using Robust Principal Component Analysis and Arima**

A. Kyprianou, A. Phinikarides, G. Makrides & G.E. Georghiou  
University of Cyprus, Nicosia, Cyprus

**5BV.2.59 Success Factor Proven Reliability of PV Modules and Systems**

W. Bergholz  
Q-Team, Schwanewede, Germany  
A. Raykov  
Ucha.se, Sofia, Bulgaria  
J. Wittmann  
Beuth Hochschule Berlin, Germany

**5BV.2.60 Performance of a Module and Defect Detection Algorithm for Aerial Infrared Images as a Function of the Flying Altitude**

M. Dalsass  
ZAE Bayern, Hof, Germany  
S. Dotenco & F. Gallwitz  
Nuremberg Institute of Technology, Germany  
P. Luchscheider  
ZAE Bayern, Erlangen, Germany  
C.J. Brabec  
FAU i-MEET, Erlangen, Germany

**5BV.2.62 A Simulation Based Optical and Electrical Approach to Estimate Energy Yield for Various Designs of Curved Modules**

H. Hanifi, C. Pfau, J. Schneider & J. Bagdahn  
Fraunhofer CSP, Halle, Germany

**5BV.2.63 A Software Suite for Simulation and Design of PV Plants**

I. Lokhat, S. Boussac & B. Lelong  
Cythelia, Montagnole, France

**5BV.2.64 Spectral Studies Investigating the Influence of Dust on Solar Transmittance**

M. Mani, P.C. Ramamurthy & K.K. Khanum  
Indian Institute of Science, Bangalore, India

**5BV.2.65 PID Detection and Management in Ground Mounted PV Installations**

L. Garreau-Iles  
DuPont, Meyrin, Switzerland  
W. Nasse  
Suncycle, Hamburg, Germany  
W.J. Gambogi, J. Kapur & A. Bradley  
DuPont, Wilmington, United States

**5BV.2.66 Analysis of Different Shading Pattern on the Total Cross Tide Connected Configuration of Solar PV Power Plant**

D. Singh, B. Pradhan, A. Sharma & K. Saikia  
Central University of Jharkhand, Brambe, India  
B. Bora, O.S. Sastry, Y.K. Singh, R. Singh, S. Rai,  
M. Bangar, R. Dahiya & R. Singh  
NISE, Gurgaon, India

**5BV.2.67 Accurate Modeling and Maximum Power Point Detection of Photovoltaic Module Using a Few Collected Data**

M.-A.-E.-H Mohamed  
Al-Azhar University, Qena, Egypt

**5BV.2.68 Design and Analysis of 10MWp Grid Connected PV System Installed West Kuwait**

H.M. Abdullah, R.M. Kamel & M. El-Sayed  
Kuwait University, Kuwait

**5BV.2.70 Performance Analysis of Different Thin Film Module Technology in Indian Climatic Condition**

Y.K. Singh, B. Bora, R. Singh, S. Chakravarty, O.S. Sastry,  
R. Singh, S. Rai & K. Yadav  
NISE, Gurgaon, India

**5BV.2.72 Performance Comparison of PV Module Based on Temperature Coefficient in Indoor and Outdoor Conditions as per IEC 61853-1**

M. Morampudi, B. Bora, G.K. Jha, R. Kumar, R. Siddiqui,  
S. Panchal, G. Gowri, P. Rajput, S. Raghava & B. Dubey  
NISE, Gurgaon, India  
M. Singh  
Kurukshetra University, India  
G. Nanda  
KIIT University, Bhubaneswar, India

**5BV.2.73 Control Strategy of a Photovoltaic Module Emulator Based on Hill-Climbing and Single-Diode Model**

B. Ospina & J.S. Parra  
Universidad del Valle, Cali, Colombia  
E. Franco & J.D. Bastidas-Rodriguez  
Universidad Industrial de Santander, Bucaramanga,  
Colombia

**5BV.2.74 Optimum Sizing and Exploitation of Results of Ndem's Solar Power Plant Capacity**

S.N. Leye & S. Mbodji  
University of Alioune DIOP, Bambey, Senegal  
F.S. Dia & G. Sissoko  
University of Dakar, Senegal

**5BV.2.75 LowCost-Outdoor-Electroluminescence: Significant Improvements of the Method**

K. Mertens & A. Arnds  
Münster University of Applied Sciences, Steinfurt, Germany  
G. Behrens & A. Domnik  
University of Applied Sciences Bielefeld, Minden, Germany

**5BV.2.76 Innovative Semi-Automatic Cleaning Technique for High Concentration Photovoltaic Panels**

D. Dahlioui, Y. Elfatimy, A. Benazzouz & A. Barhdadi  
University Mohammed V-Agdal, Rabat, Morocco  
G. Borelli, M. Carpanelli & D. Verdilio  
Becar, Monteveglio, Italy

**5BV.2.77 Modeling and Planning Optimum Sites for PV Solar Energy Farms in Qatar Using Geographic Information System (GIS)**

Y.E. Mohieldeen, H. AL Hajiri & D. Martinez  
Qatar Foundation, Doha, Qatar

- 5BV.2.78 PV Module Ageing in Southern Europe – Hot Spots and Impact on Yield**  
M. Grottko  
WIP - Renewable Energies, Munich, Germany  
F. Espin  
Efficiency Services Consulting, Bullas, Spain
- 5BV.2.79 A Comparative Study of Different Types PV System Technologies**  
A. El Yaakoubi, K. Attari, A. Asselman, E. Aroudam & A. Djebli  
Abdelmalek Essaadi University, Tetouan, Morocco
- 5BV.2.81 Investigation and Diagnostic Tools Comparison: Infrared Thermography vs Electroluminescence**  
D. Bertani & S. Guastella  
RSE, Milan, Italy  
C. Camilloni & C. Liciotti  
KB Development, San Zeno Naviglio, Italy
- 5BV.2.83 DaySy Reliably Detects PID in the Field**  
L. Stoicescu & M. Reuter  
Solarzentrum Stuttgart, Germany  
J.H. Werner  
University of Stuttgart, Germany
- 5BV.2.84 Outdoor Performance of the Anti-Soiling and Anti-Reflection Coating for Photovoltaic Modules**  
S.-I. Chan, S. Kang, J. Kim, J.-H. Kim & W. Oh  
KETI, Seongnam-si, Korea South  
S. Choi & H. Hwang  
University of Sungkyunkwan, Suwon, Korea South
- 5BV.2.85 Evaluation of a PV-Panel via Long Term High Speed Recording of IV-Curves**  
K.M. Paasch  
University of Southern Denmark, Sønderborg, Denmark  
C. Cornaro  
University of Rome II, Italy  
M. Nyman  
University of Southern Denmark, Odense, Denmark

#### VISUAL PRESENTATIONS 1BV.5

13:30 - 15:00 Fundamental Studies / New Materials and Concepts for Modules

- 1BV.5.1 Models for Lambertian Optics in Si**  
L. Abenante  
ENEA, Rome, Italy

- 1BV.5.3 An Inexpensive Spectral Sensor for MMPT in Partial Shade**  
M. López-Álvarez & J. Hernández-Ándres  
University of Granada, Spain  
S. Collins  
University of Oxford, United Kingdom
- 1BV.5.4 Contact-Free Raman Spectroscopic Measurement of Residual Stress in Silicon Solar Cells Caused by Stringing**  
L. Neumaier, W. Mühleisen & C. Hirschl  
CTR, Villach, Austria  
T. Fischer  
Teamtechnik, Ingersheim, Germany  
J. Scheurer  
Polytec PT, Waldbronn, Germany  
W. Pranger  
Ulbrich of Austria, Müllendorf, Austria
- 1BV.5.6 Air Cooling of Photovoltaic Panels: a Numerical Approach**  
L. Martin-Carron, D. Ugarte, A. Macq & N. Cristi  
SUNIBRAIN, Toulouse, France  
R. Becker, D. Graebing & R. Luce  
CNRS, Pau, France
- 1BV.5.7 The Effect of Phosphorus Gettering on Fine-Grained Multicrystalline Silicon**  
K.E. Ekstrøm, A. Autruffe, L. Arnberg & M. Di Sabatino  
NTNU, Trondheim, Norway  
R. Søndena  
Institute for Energy Technology, Kjeller, Norway  
G. Stokkan  
SINTEF, Trondheim, Norway
- 1BV.5.8 New Modeling for Field Emission Current in Graphene-Oxide/n-Semiconductor Schottky Barrier Solar Cells**  
A.C. Varonides  
University of Scranton, United States
- 1BV.5.9 New Modeling for Combined Thermionic and Field Emission Current in Ideal Graphene/n-Si Schottky Barrier Solar Cells in the Landauer Formula Context**  
A.C. Varonides  
University of Scranton, United States
- 1BV.5.10 Temperature and Frequency Dependencies of Electrical Conductivity of the Nanostructured Photoabsorbers Cu<sub>2</sub>SnS<sub>3</sub>, for the Conversion of Solar PV**  
L. Essaleh, M. Belaqqiz, H. Chehouani & S. Lahlali  
Cadi Ayyad University, Marrakech, Morocco  
K. Djessas  
University of Perpignan, France  
J.L. Gauffier  
INSA Lyon, Toulouse, France

- 1BV.5.12 ZnO Nanowires Obtained by Electrochemical Method**  
L. Nkhaili, A. El Kissani, M. Ait Ali, A. Elmansouri & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco
- 1BV.5.13 Intrinsic Transport in Non-Uniformly Doped Si Regions**  
L. Abenante  
ENEA, Rome, Italy
- 1BV.5.14 The Influence of the Exciton Nonradiative Recombination in Silicon on the Photoconversion Efficiency**  
A.V. Sachenko, V.P. Kostlyov, V.M. Vlasjuk & I.O. Sokolovskyi  
NAS ISP, Kiev, Ukraine  
M. Evstigneev  
Memorial University of Newfoundland, St. John's, Canada
- 1BV.5.15 A Novel Synthetic Approach for CNTs-Decorated Nb3O7F Hierarchical Nanomaterials with Enhanced Photovoltaic Properties**  
F. Huang, Q. Liang, A. Yan, H. Liang & S. Zhang  
China University of Mining and Technology, Xuzhou, China
- 1BV.5.16 Graphene-Perovskite Interaction Utilizing Graphene Coated Metal Nano-Spheres: Application in Photovoltaic**  
S. Bhardwaj & R.P. Sharma  
IIT Delhi, New Delhi, India
- 1BV.5.18 Unveiling the Influence of Lead Halide on Thermal Stability of Perovskite Solar Cells**  
Y. Du, H.K. Cai, Y. Wu, J. Ni, J. Li, H. Wen, D. Zhang & J. Zhang  
Nankai University, Tianjin, China
- 1BV.5.19 Numerical Simulation of Plasmon Coupling of Metal Nanoparticles in Perovskite Medium**  
S. Roopak & R. Sharma  
Indian Institute of Technology, New Delhi, India
- 1BV.5.21 Colloidal Synthesis, Structural and Optical Properties of CuIn3Se5 Nanocrystals for Photovoltaics**  
M. Ghali, G.F. Ali, A.M. Eissa & M. Dewidar  
Kafrelsheikh University, Egypt  
M.K. El-Nimr  
Tanta University, Egypt  
H. Talaat  
Ain Shams University, Cairo, Egypt
- 1BV.5.22 Intermetallic Phase Distribution of CuIn<sub>1-x</sub>GaxSe<sub>2</sub> (CIGS) Electroless Deposited Solar Hybrid Electrode Contacts Using Nano-Indented Atomic Force Microscopy**  
S.H. Kwon, L.S. Zheng, E. Choi, M. Nam, K. Kang, A. Kim, S. Chae & S.G. Pyo  
Chung-Ang University, Seoul, Korea South

- 1BV.5.24 Fast Processing of Sol-Gel TCO**  
J. van Deelen, M. Rem, N. Arfsten & P. Buskens  
TNO, Eindhoven, The Netherlands
- 1BV.5.25 First Principle Investigation of Optical Properties of Rutile TiO<sub>2</sub>**  
A. Eddiouane, S. Boussaidi & H. Zgou  
Ibn Zohr University, Ouarzazate, Morocco  
H. Chaib  
University of Agadir, Ouarzazate, Morocco  
A. Nafidi  
Ibn Zohr University, Agadir, Denmark
- 1BV.5.26 Investigation of the Relaxation Dynamics and Carrier Temperature of PbS QDs**  
W. Cao, Y. Lin, X. Wen, S. Huang, S. Shrestha & G.J. Conibeer  
UNSW Australia, Kingsford, Australia
- 1BV.5.28 Vibrational Study of Hybrid Systems Based on Graphene for Photovoltaics**  
M. Boutahir, A.H. Rahmani, H. Chadli & A. Rahmani  
University Moulay Ismail, Meknes, Morocco
- 1BV.5.29 Betavoltaics. Analysis of the Attainable Efficiency for Direct-Bandgap Semiconductors**  
A.V. Sachenko, R.M. Korkishko, V.P. Kostlyov, M.R. Kulish & I.O. Sokolovskyi  
NAS ISP, Kiev, Ukraine  
M.A. Evstigneev  
Memorial University of Newfoundland, St. John's, Canada  
A.I. Shkrebtii  
University of Ontario, Oshawa, Canada
- 1BV.5.30 Black, Infrared Reflective Backsheet Structures for PV: where Aesthetics Meet Performance**  
S.L. Luxembourg, M. Kloos, A. Gutjahr, P. Manshanden & J.A.M. Van Roosmalen  
ECN, Petten, The Netherlands  
J. Theewis  
Eurolocke, Tiel, The Netherlands
- 1BV.5.31 Investigations on Half Cells for Heterojunction Modules**  
H. Mehlich, F. Kirchhoff, M. Leonhardt, A. Waltinger & M. König  
Meyer Burger, Hohenstein-Ernstthal, Germany  
M. Grimm & C. Belgardt  
3D-Micromac, Chemnitz, Germany  
Y. Yao & T. Söderström  
Meyer Burger, Gwatt, Switzerland  
M. Gragert  
Meyer Burger, Thun, Switzerland



**1BV.5.32 Triangular Ribbons for Improved Module Optics**

M. Mittag, A.J. Beinert, L.C. Rendler & U. Eitner  
Fraunhofer ISE, Freiburg, Germany

**1BV.5.34 DSM AR Coating Performance on PV Glass, Modules and System with Long Term Outdoor Exposure in Different Climates**

M. Mrcarica, J. Gaury & N. Voicu  
DSM Innovation Center, Sittard, The Netherlands

**1BV.5.35 Thin-Film Barriers for Durable Thin-Film PV Modules**

J. Hüpkes  
Forschungszentrum Jülich, Germany  
N. Wyrsh & F. Sculati-Meillaud  
EPFL, Neuchâtel, Switzerland  
G. Cattaneo  
CSEM, Neuchâtel, Switzerland  
B. Stannowski  
HZB, Berlin, Germany

**1BV.5.36 Proposed Evaluation Framework for Exploration of Smart PV Module Topologies**

M.-I. Baka & D. Soudris  
NTUA, Athens, Greece  
F. Catthoor  
imec, Leuven, Belgium

**1BV.5.38 Towards Ultra-Thin Glasses for Solar Energy Applications**

B. Allsopp & P. Bingham  
Sheffield Hallam University, United Kingdom  
R. Orman, S. Johnson & J. Booth  
Johnson Matthey Technology Centre, Reading, United Kingdom  
I. Baistow  
Solar Capture Technologies, Blyth, United Kingdom  
K. Lundstedt, P. Sundberg, C. Stålhandske & S. Karlsson  
Glafo, Växjö, Sweden  
A. Andersson  
SP Technical Research Institute, Boras, Sweden  
P. Aitor Postigo  
IMM - CSIC, Tres Cantos, Spain

**1BV.5.39 The Anti-Glaring Module Simulation, Proto-Type Design and Module Performance**

Y.-C. Chen, C.-W. Yang, T. Lai & C.L. Cheng  
AU Optronics, Taichung, Taiwan

**1BV.5.40 Outdoor Durable Materials Technology for Light Management of PV Modules**

C. Panofen, P. Wyman & K. Van Durme  
DSM Advanced Surfaces, Sittard, The Netherlands

**1BV.5.41 Lamination Cycle Time Optimization Using New POE Encapsulants**

I. Fidalgo, R. Merino & B. Pérez  
STRE, Asturias, Spain

**1BV.5.42 A Bypass Diode for Integrated Smart Solar Cell Module**

Z.Q. Ma, H.W. Du, F. Xu, M. Gao & L. Zhao  
University of Shanghai, China

**1BV.5.43 Selectively Modulated Aesthetic Reflector Technology (SMART) – a Novel Colour Coating for Photovoltaics Modules**

A. Soman & A. Antony  
IIT Bombay, Mumbai, India

**1BV.5.44 Hybrid Encapsulation Film for PV Modules Operating at High Voltage**

S.C. Pop & R. Schulze  
Yingli Green Energy, San Francisco, United States  
J. Kapur  
DuPont, Wilmington, United States

**1BV.5.45 Investigation on Yield Improvement and Application in Energy-Saving Building of Bifacial Module**

Z. Sun, Y. Li, J. Jiang, X. Lv, D. Rong, Y. Zhang, Y. Geng, T. Feng, Y. He, K. Liu & B. Yu  
Yingli Green Energy, Baoding, China

**1BV.5.46 Phase Change Materials for Hybrid Technology: Review**

D. Gonzalez Peña, M. Díez-Mediavilla,  
M.C. Rodríguez-Amigo & C. Alonso-Tristán  
UBU, Burgos, Spain

**1BV.5.47 Aisovol Project, a Photovoltaic Generation Solution as an Alternative Construction Material**

C. Montes, A. Linares, E. Llarena, O. González, D. Molina, A. Pío, L. Ocaña, C. Quinto, M. Friend & M. Cendagorta-Galarza López  
ITER, Granadilla de Abona, Spain  
A.B. Cueli, J. Moracho, I. Petrina, J. Díaz, E. Zugasti, J. Bengoechea, M.J. Rodriguez, M. Ezquer Mayo, J.M. Cuadra & A.R. Lagunas  
CENER, Sarriguren-Navarra, Spain

**1BV.5.48 Design and Performance of High Efficiency ZWS(TM) Modules**

B. Nadimpally, R. Nandan, F. Novoa, C. Kearns-McCoy, E. Rhee, V. Chaudhari, D. Amin, G. Shi, L. Ferry, O. Rezvanian, J. Bearden, J. Posbic & A. Deshpande  
SunEdison, Maryland Heights, United States  
S. Koppikar  
SunEdison, Maryland Heights, India

**1BV.5.49 An Experimental Investigation into Passive Temperature Regulation of a Novel WICPV System with Phase Change Material**

S. Sharma, A. Tahir & T.K. Mallick  
University of Exeter, Penryn, United Kingdom  
N. Sellami  
Heriot Watt University, Dubai, United Arab Emirates

**1BV.5.50 Combination of nFOG™ and DSMAR Coating Technologies to Deliver Superior Quality of Anti-Reflective Coating on Solar Cover Glass**

S. Tammela, K. Asikkala, T. Määttä & P. Meriläinen  
Beneq, Vantaa, Finland  
J. Boonen, R. de Rijk & M. Mennig  
DSM, Geleen, The Netherlands

**VISUAL PRESENTATIONS 5BV.3**

**15:15 - 16:45 Balance of System Components**

**5BV.3.1 Integrated Testing and Measurement System for a PV Module-Based Transformer-Less DC/DC Converter**

U. Chatterjee, A. Pevere, T. Dat Mai & J. Driesen  
Catholic University of Leuven, Belgium  
S. De Breucker  
VITO, Mol, Belgium

**5BV.3.2 A High Speed Global Maximum Power Point Tracking Algorithm for PV Systems**

M. Basoglu & B. Çakir  
Kocaeli University, Turkey

**5BV.3.3 Analyzing the Performance of Commercial PV Modules under Field Conditions**

J.-K. Lim, S.-I. Yoon, M.-S. Kim, J.H. Ahn, K. Lee, M.-I. Hwang & E.-C. Cho  
Hyundai Heavy Industries, Yongin, Korea South

**5BV.3.4 Analysis of the Performance of PV Modules with Cell-String Level Optimizers from a LCOE Perspective**

S. Zhang, P. Quan, S. Deng, E. Lee, J. Yu, M. Wu, Z. Zhang, P.J. Verlinden & Z. Feng  
Trina Solar Energy, Changzhou, China

**5BV.3.5 Testing of Smart PV Modules**

D. Gfeller, C. Renken, L. Borgna & U. Muntwyler  
BUAS, Burgdorf, Switzerland

**5BV.3.7 High Efficiency and Low Leakage Current Photovoltaic Power Conditioning System for Corner Grounded Three-Phase Grid**

K.-I. Jeong & J.-M. Kwon  
Hanbat National University, Daejeon, Korea South  
B.-H. Kwon  
Postech, Pohang, Korea South

**5BV.3.8 Tracking of the Maximum Power Point in a Partially Shaded Photovoltaic Panel Using Kalman Algorithm**

A. Aoune, S. Motahhir, A. El Ghzizal, S. Sebti & A. Derouich  
USMBA, Fez, Morocco

**5BV.3.9 Weighted Efficiency of SPV Power Converters/Inverters in Indian Composite Climate**

K. Yadav, O.S. Sastry, B. Bora, M. Kumar, R. Singh & R. Parmar  
NISE, Gurgaon, India  
A. Kumar & B. Prasad  
TERI, New Delhi, India

**5BV.3.11 Testing of Multi-MPPT PV Inverters: Approach and Test Results**

D. Gfeller, L. Borgna & U. Muntwyler  
BUAS, Burgdorf, Switzerland

**5BV.3.12 Ekogrid - the Most Innovative Platform for IoT, M2M to Optimize PV Plant Energy Processes**

R. Cancho, A. Rasello & F. Rasello  
Integrare, Milan, Italy  
Y. Bongiovanni  
Ekogenio, Berlin, Germany

**5BV.3.13 Comparing the Impact of the off-Grid System and on-Grid System on a Realistic Load**

A. Algaddafi, N. Brown, R. Gammon & J. Alshahrani  
De Montfort University, Leicester, United Kingdom

**5BV.3.14 Aiming at Optimization of Tracking Technology through Seasonally Tilted Sun Trackers: an Indian Perspective**

S. Mukherjee & S. Sengupta  
Vikram Solar, Kolkata, India

**5BV.3.15 Reduction of Leakage Current in Three-Phase Z -Source Neutral Point Clamped Inverter for Photovoltaic Systems**

C. Bharatiraja & J. Munda  
TUT, Pretoria, South Africa  
S. Raghu  
SRM University, Chennai, India



- 5BV.3.17 Design and PIL Simulation of an AEKF for Real Time Battery SOC Estimation Using ARM Based Core**  
A. Gaga, O. Diouri, Y. Cheddadi, F. Errahimi & N. Es-Sbai  
USMBA, Fez, Morocco
- 5BV.3.18 Performance Comparison of Three Inverters with Different Transformer Topology**  
M. Kumar, O.S. Sastry, K. Yadav, R. Parmar, R. Singh & B. Bora  
NISE, Gurgaon, India
- 5BV.3.19 A Novel Suitable Resonant Filter to Improve the THD for a PV Inverter**  
R. El Bachtiri, M. Khanfara & K. El Hammoui  
USMBA, Fez, Morocco
- 5BV.3.21 Photovoltaic Modules Monitoring System Using a Wireless Sensor Network**  
E. Ortega & G. Aranguren  
University of the Basque Country, Bilbao, Spain  
M.J. Sáenz, R. Gutiérrez & J.C. Jimeno  
University of the Basque Country, Zamudio, Spain
- 5BV.3.22 Experimental Evaluation of the Solar Radiation Gains over Photovoltaic Cells due to the Use of TiO<sub>2</sub> Treated Surfaces. Applications to Photovoltaic Systems with Micro-Inverters**  
I. Lillo Bravo  
University of Seville, Spain  
R. Dominguez  
AICIA, Sevilla, Spain  
M. Larrañeta Gómez-Caminero & M. Silva Pérez  
AICIA, Seville, Spain
- 5BV.3.24 A Refined Method to Evaluate Grid-Connected PV Inverters for Western Regions of China**  
B. Wang & N. Ma  
Ningxia Panshi Inspection and Research, Yinchuan, China

#### VISUAL PRESENTATIONS 1BV.6

15:15 - 16:45 New Materials and Concepts for Cells

- 1BV.6.1 Enhancement of Two-Step Photon Absorption due to Miniband Formation in InAs/GaAs Quantum Dot Superlattice Solar Cell**  
S. Watanabe, T. Kaizu & T. Kita  
Kobe University, Japan  
S. Asahi, T. Kada & Y. Harada  
Kobe University, Japan

- 1BV.6.2 Short-Circuit Current Density Boost with Oxygen Chemisorption/Desorption of ZnO Nanowires**  
D.-C. Perng, K.-H. Chen, K.-H. Chen & M.-H. Hong  
National Cheng Kung University, Tainan, Taiwan
- 1BV.6.4 Effects of Luminescent Coupling in Perovskite/c-Si Multijunction Solar Cells with Nanostructured Interlayer**  
T. Tayagaki  
AIST, Tsukuba, Japan  
Y. Kurokawa & N. Usami  
Nagoya University, Japan
- 1BV.6.6 5% Efficiency Enhancement in Thin-Film SiGe HIT Solar Cells Using 200nm Plasmonic Gold Nanoparticles**  
H. Al Mazem, F.I. Chowdhury, S. Abdul Hadi & A. Nayfeh  
Masdar Institute, Abu Dhabi, United Arab Emirates
- 1BV.6.7 Copper Iodide – Hole Selective Contact for the Hot Carrier Solar Cell**  
S. Chung, R. Patterson, S. Shrestha & G.J. Conibeer  
UNSW, Sydney, Australia
- 1BV.6.9 Potential of Poly-Crystalline ZnTe for Low-Cost Intermediate Band Solar Cell Application**  
C. Liu, N. Tang, A. Ren, W. Li, L. Wu, J. Zhang & L. Feng  
Sichuan University, Chengdu, China
- 1BV.6.10 Integrated Power and Data Transceiver Devices for Power-by-Light Systems – a Concept Study**  
H. Helmers, D. Lackner, G. Siefer, E. Oliva, F. Dimroth & A.W. Bett  
Fraunhofer ISE, Freiburg, Germany
- 1BV.6.11 Innovative Point-Contacting Technique for Thin-Film Silicon Solar Cells**  
R. Houry, P. Bulkin, D. Daineka & E.V. Johnson  
CNRS, Palaiseau, France  
J. Alvarez  
CNRS, Gif-sur-Yvette, France
- 1BV.6.12 Free the Bandgap! Series-Parallel Connection of Tandem Cells**  
M. Stocks, Y.X. Loo & N. Lal  
ANU, Canberra, Australia
- 1BV.6.13 ZnO Nanorods as an Antireflection Coating for Silicon Solar Cells**  
S.K. Sardana, P.S. Chandrasekhar & V.K. Komarala  
IIT Delhi, New Delhi, India

- 1BV.6.14 Monovalent Cation Doping of PbS Nanocrystals**  
M. Chavez, H. Juárez Santiesteban, M. Pacio & O. Portillo  
UPAEP, Puebla, Mexico  
X. Mathew & E. Osorio  
UPAEP, Temixco, Mexico
- 1BV.6.15 Synthesis and Controlling the Physical and Optical Properties of Zinc Oxide Nanowires with Applications in Photovoltaic Systems**  
N. Seifi Mamaghani, F. Shahshahani, J. Sabbaghzadeh & I. Hadi  
Alzahra University, Tehran, Iran
- 1BV.6.16 Influence of GaAsSb Structural Properties on the Optical Properties of InAs/GaAsSb Quantum Dots**  
Z. Zhang, P.J. Reece & S.P. Bremner  
UNSW Australia, Sydney, Australia  
N.N. Faleev  
Arizona State University, Tempe, United States
- 1BV.6.17 ZnO Nanorods as Antireflective Layer in Silicon Heterojunction Solar Cells**  
M. Ahrlich, O. Sergeev, M. Juilfs, A. Neumüller, M. Vehse & C. Agert  
NEXT ENERGY, Oldenburg, Germany
- 1BV.6.18 Effect of Nanowire Length on Device Performance of n-ZnSe/p-Si Nanowire Heterojunctions**  
E. Coskun, H.H. Güllü, T. Çolakoglu, O. Bayrakli & M. Parlak  
METU, Ankara, Turkey
- 1BV.6.19 Electric Properties of Nanocrystalline Diamond Thin Film Deposited on Active Substrate Solar Cell Structure**  
M. Kusko  
Fill Factory, Rožnov pod Radhoštm, Czech Republic  
M. Perný, V. Saly, M. Váry & J. Packa  
Slovak University of Technology, Bratislava, Slovakia
- 1BV.6.20 Diode Property of Metal and/or Si Nanoparticle Embedded Liquid Source SiO<sub>2</sub> on Si**  
H. Nagayoshi & H. Demura  
TNCT, Tokyo, Japan  
A. Ulyashin  
SINTEF, Oslo, Norway
- 1BV.6.22 Atmospheric-Pressure Plasma Production of Silicon Quantum Dots for Photovoltaic Applications**  
M. Macias-Montero, T. Velusamy, P. Maguire & D. Mariotti  
University of Ulster, Newtownabbey, United Kingdom  
C.S. Ni, P. Connor & J.T.S. Irvine  
University of St Andrews, United Kingdom  
V. Svrcek  
AIST, Tsukuba, Japan

- 1BV.6.23 Photo-Thermoionic Nanostructured Cells Development for High Concentrating Solar Applications**  
R. García-Gutierrez, R. Cabanillas-Lopez, C. Davila-Peralta, M. Barboza-Flores & R. Rodriguez-Carvajal  
University of Sonora, Hermosillo, Mexico
- 1BV.6.27 Role of Textured Silicon Surface in Plasmonic Light Trapping for Solar Cells: Effect of Pyramids Width and Height**  
E. Thouti & V.K. Komarala  
IIT Dehli, New Dehli, India  
A.K. Sharma  
IIT Dehli, New Delhi, India
- 1BV.6.28 Enhanced Light Scattering and Hydrophobicity of Glass with Upright Nanopyramid Structure for Solar Cells Using UV Nanoimprint Lithography**  
A. Peter Amalathas & M.M. Alkaisi  
University of Canterbury, Christchurch, New Zealand
- 1BV.6.29 Improvement of Short Circuit Current of Single Junction Amorphous Silicon Solar Cells by Incorporating Nanoparticle as Back Reflector**  
S. Mandal, S. Dhar & A.K. Barua  
IEST, Howrah, India
- 1BV.6.30 Chemical Bath pH Influence on SnS Thin Film Physical and Optical Properties**  
J.L. Peña Chapa, A. Higareda, R. Mis-Fernández, I. Rimmaudo & V. Rejón  
CINVESTAV, Merida, Mexico
- 1BV.6.33 I-V Double Exponential Modeling in Pc1d6**  
L. Abenante  
ENEA, Rome, Italy
- 1BV.6.34 Lead and Bismuth Oxide Free Thick Film Metallizations with High Adhesion on Silicon Solar Cells**  
P. Gierth & L. Rebenklau  
Fraunhofer IKTS, Dresden, Germany
- 1BV.6.36 Simulation of the Enhancement Offered by Innovative Optical Structures in the Conversion Efficiency of Photovoltaic Technologies**  
J. Walshe, J. Doran & H. Ahmed  
Dublin Institute of Technology, Ireland  
S.J. McCormack  
Trinity College Dublin, Ireland

- 1BV.6.38 The Influence of Neutron and Xe-Ions Flux on c-Si – a-SiC Photovoltaic Device**  
M. Perný, M. Váry, V. Saly & M. Mikolasek  
Slovak University of Technology, Bratislava, Slovakia  
J. Huran  
Slovak Academy of Sciences, Bratislava, Slovakia
- 1BV.6.40 Effects of Temperature and Post Deposition Annealing on SnS Polycrystalline Thin Film Growth**  
S. Di Mare, A. Salavei, D. Menossi, F. Piccinelli,  
E. Artegiani, A. Kumar, G. Mariotto & A. Romeo  
University of Verona, Italy
- 1BV.6.41 Polyalkylene Carbonate Binders for Cleaner Burning Thick Film Ag Paste: Comparison to Commercially Available Ag Pastes**  
I.B. Cooper  
SUNY College, Rochester, United States  
R. Stephenson  
Stephenson & Associates, Sunnyvale, United States  
P. Ferraro  
Empower Materials, New Castle, United States
- 1BV.6.42 Electrical Transport in Silicon Heterojunction Solar Cells with Nanocrystalline Silicon Oxide Front Surface Fields**  
A. Richter, F. Lentz & K. Ding  
Forschungszentrum Jülich, Germany
- 1BV.6.43 Minority Carrier Lifetime Enhancement of C-Si/TiO2 Heterojunction by Post Deposition Annealing**  
S. Bhatia, S. Khotari, N. Raorane, S. Lodha, P.R. Nair &  
A. Antony  
IIT Bombay, Mumbai, India
- 1BV.6.44 The Impact of Interface Trap Density on n-ZnO/p-Si Single Heterojunction Solar Cells**  
A. Ali  
GC University Faisalabad, Pakistan  
B. Hussain & A. Ebong  
UNC Charlotte, United States
- 1BV.6.45 Impact of Minority Carrier Lifetime and Temperature on SiC Based Rear Contact SiGe Solar Cell for Concentrator Photovoltaic (CPV) Applications**  
R. Pandey, A. Kumar, R. Chaujar & A. Jain  
Delhi Technological University, New Delhi, India
- 1BV.6.47 Comparative Study of the Effects of Rare Earth Ions Doped BiSrFeO3 Nanomultiferroic**  
M. Ayman  
GUC, Cairo, Egypt

- 1BV.6.48 12.5% Silicon Nano-Hole Morphology with PEDOT:PSS Hybrid Solar Cell with Simple Solution Based Surface Treatment**  
Z. Li, A.B. Prakoso, L. Hong & R. Rusli  
Nanyang Technological University, Singapore, Singapore
- 1BV.6.50 Feasible Strategy towards Low Temperature Fabrication of Flexible Perovskite Solar Cells**  
K. Wang, Y. Shi & C. Lan  
Dalian University of Technology, Panjin, China  
S. Hayase & T. Ma  
Institute of Technology, Kitakyushu, Japan

#### VISUAL PRESENTATIONS 5BV.4

17:00 - 18:30 PV Cells and Modules (II)

- 5BV.4.1 Non-Uniformity Measurements of a Steady State Solar Simulator Using the Hishikawa-Hashimoto Method and Subsequent Improvement**  
U. Hoyer, M. Hofer, T. Pickel, C. Camus & J. Hauch  
ZAE Bayern, Erlangen, Germany  
C. Brabec  
University of Erlangen, Germany
- 5BV.4.2 Measuring Uniformity under Simulated Sunlight**  
F. Plag & S. Winter  
PTB, Braunschweig, Germany  
F. Haas & K. Ramspeck  
h.a.l.m. elektronik, Frankfurt am Main, Germany
- 5BV.4.3 Influence of Low Concentration on the Energy Harvest of PV Systems Using Bifacial Modules**  
H. Nussbaumer, G. Petrzilek, M. Klenk, S. Schartinger,  
N. Keller, T. Baumann, F. Carigiet & F.P. Baumgartner  
Zurich University of Applied Sciences, Winterthur,  
Switzerland
- 5BV.4.4 Maximizing Energy Production by High Efficiency n-Type Bifacial Module**  
K. Shim, S.-Y. Cho, H. Kim & Y. Choe  
LG Electronics, Seoul, Korea South
- 5BV.4.5 Bifacial Crystalline Silicon Solar Cell Basic Parameters and Characteristics**  
H.W. Choi, S.H. Jung & Y.B. Kim  
GERI, Gumi, Korea South

- 5BV.4.6 Bifacial Outdoor Rotor Tester**  
F.P. Baumgartner, G. Petrzilek, S. Schartinger, T. Baumann,  
F. Carigiet, N. Keller, M. Klenk & H. Nussbaumer  
ZHAW, Winterthur, Switzerland
- 5BV.4.7 Characterization and Testing of Bifacial Modules**  
A. Schmid, D. Philipp & C. Reise  
Fraunhofer ISE, Freiburg, Germany
- 5BV.4.8 Angular-Dependent Outdoor Investigation of Bifacial Modules**  
S. Malik, D. Daßler, J. Fröbel & M. Ebert  
Fraunhofer CSP, Halle, Germany
- 5BV.4.9 The Si-Traceable Calibration of Shunted Reference Solar Cells via Differential Spectral Responsivity Measurements**  
F. Witt, I. Kröger & S. Winter  
PTB, Braunschweig, Germany
- 5BV.4.10 Investigation of the Influence of Temperature Inhomogeneity on the Measurement Uncertainty of Solar Cell Temperature Coefficients**  
A. Schweitzer, I. Kröger & S. Winter  
PTB, Braunschweig, Germany
- 5BV.4.11 High Efficiency Photovoltaic Modules Performance Measurements Used Long Pulse I-V Simulator**  
H.-C. Liu, C.-T. Huang, W.-K. Lee & F.-M. Lin  
ITRI, Hsinchu, Taiwan  
J.-L. Kwo, Y.-C. Ou & L.-Y.-. Liao  
AllReal Technology, Kaohsiung, Taiwan
- 5BV.4.12 Fault Detection of Photovoltaic Modules through Analysis of Reverse I/V Curves**  
G. Vannier, I. Tsanakas, N. Chaintreuil, D.L. Ha & F. Barruel  
CEA, Le Bourget du Lac, France
- 5BV.4.13 Performance Monitoring of 4 PV Modules of Different Technologies under Outdoor Conditions in Benguerir, Morocco**  
A. Benazzouz, B. Ikken, Z. Naimi, A. Benlarabi,  
K. Belrhiti Alaoui & A. El Hassani El Alaoui  
IRESEN, Rabat, Morocco
- 5BV.4.14 Portable LED Flasher - a Cost Effective Tool to Improve Quality of Field Tests**  
F.P. Baumgartner, D. Schär & R. Knecht  
Zurich University of Applied Sciences, Winterthur,  
Switzerland  
C. Frei & F. Beglinger  
Electrosuisse, Fehraltorf, Switzerland

- 5BV.4.15 Exergy Analysis of a Solar Photovoltaic Module**  
F. Serrano-Casares & E. Zaragoza  
UMA, Málaga, Spain
- 5BV.4.16 Short Circuit Current Measurements at Clear-Sky Conditions on Photovoltaic Modules: Basic for a Reliable Self-Reference Algorithm**  
M. Wachter, L. Gottschalk & B. Hüttl  
University of Applied Sciences Coburg, Germany  
A. Schulze  
Rosenheim University of Applied Sciences, Germany  
F. Becker & M. Sayala  
Calyxo, Bitterfeld-Wolfen, Germany
- 5BV.4.17 Analysis of Air Mass Dependence of Three Photovoltaic Arrays**  
H. Wang, M.A. Muñoz-García & G.P. Moreda  
UPM, Madrid, Spain  
M.C. Alonso-García  
CIEMAT, Madrid, Spain
- 5BV.4.18 Outdoor Performance and Seasonal Analysis of SunPower Based Maxeon™ Technology in Composite Climate of India**  
A. Sharma, D. Singh, K. Saikia & S.K. Samdarshi  
CUJ, Brambe, India  
B. Bora, O.S. Sastry, Y.K. Singh, B. Mohan Jha, R. Singh,  
S. Rai, M. Bangar, R. Dahiya, S. Chakraborty & K. Yadav  
NISE, Gurgaon, India
- 5BV.4.19 Studying the Effect of Spectral Distribution with Seasonal and Irradiance Variations**  
I.K. Barua & B. Prasad  
TERI, New Delhi, India  
B. Bora, R. Singh, S. Rai, M. Bangar & M. Kumar  
NISE, Gurgaon, India  
O. Sastry  
NISE, Gurgoan, India
- 5BV.4.20 Intercomparison of PTB and ESTI Spectroradiometers Using Simulated and Natural Sunlight**  
I. Kröger, F. Plag & S. Winter  
PTB, Braunschweig, Germany  
R. Galleano & H. Müllejans  
European Commission, Ispra, Italy
- 5BV.4.21 Looking at the Yearly Yield from Various Angles: Optical Model Verification for Structured Glass**  
L.H. Slooff, A.J. Carr & P.M. Sommeling  
ECN, Petten, The Netherlands  
R. Van de Voort  
SCX Solar, Someren, The Netherlands

**5BV.4.22 Seasonal Analysis of Most Frequent Condition and Energy Rating of PV Module Technologies**

B. Bora & O.S. Sastry  
NISE, Gurgaon, India  
B. Prasad  
TERI University, New Delhi, India

**5BV.4.23 Angle Resolved Performance Measurements on PV Glass and Modules**

L. Tollund Juutilainen, S. Thorsteinsson, P. Behrensdoeff  
Poulsen, A. Thorseth, M. Wubishet Amdemeskel &  
S. Canulescu  
Technical University of Denmark, Roskilde, Denmark  
P. Melchior Rødder & K. Rødder  
SolarLab, Viby, Denmark

**5BV.4.24 Energy Rating of Crystalline Solar Modules: Investigation of Uncertainties due to Binning in Mass Production**

G. Kleiss, H. Schülbe & B. Nacke  
University of Hannover, Germany

**5BV.4.26 Evaluating the Influence of Typhoon on PV Module Reliability**

M.Y. Chang, C.H. Hsueh, H. Chen & C. Chen  
AU Optronics, Taichung, Taiwan

**5BV.4.27 Failure Classification of Defective PV Modules Based on Maximum Power Point Analysis**

F. Fecher, T. Pickel, C. Buerhop-Lutz, C. Camus & C.J. Brabec  
ZAE Bayern, Erlangen, Germany

**5BV.4.28 Reliability of Bonding of the Rail Attachment Fixture to the Rear Glass of Dual-Glass PV Modules**

J. Mao, Q. Zhu, J. Xu, H. Shen, Y. Shu, Z. Ji,  
P.J. Verlinden & Z.Q. Feng  
Trina Solar Energy, Changzhou, China

**5BV.4.29 Evaluation of the Durability of Metallization Pastes via Accelerated Aging Method**

H.-C. Lin, Y.-C. Chen, C.-C. Wang, C.-T. Tsai &  
W.K.W. Huang  
Gintech Energy, Miaoli, Taiwan

**5BV.4.30 Effect of the Revision of Mechanical Load Test in IEC61215 Certification Standard**

J.H. Ahn, K. Lee, M.-S. Kim, J.-K. Lim, S.-I. Yoon,  
M.-I. Hwang & E.-C. Cho  
Hyundai Heavy Industries, Yongin, Korea South

**5BV.4.31 A Methodology for Assessing Field Performance of Flexible PV Modules Based on Thermal Cycling Test Results**

K. Hardikar & B. Liu  
MiaSolé, Santa Clara, United States

**5BV.4.32 In-Situ Monitoring of Moisture Ingress in PV Modules with Different Encapsulants**

M. Jankovec, G. Matic & M. Topic  
University of Ljubljana, Slovenia  
E. Annigoni, F. Galliano & F. Sculati-Meillaud  
EPFL, Neuchâtel, Switzerland  
H.-Y. Li, L.-E. Perret-Aebi & C. Ballif  
CSEM, Neuchâtel, Switzerland

**5BV.4.33 Shadowing Investigations on Thin Film Modules**

S. Wendlandt, T. Weber, J. Berghold, S. Krauter &  
P. Grunow  
PI Berlin, Germany

**5BV.4.34 Investigation of UV-Induced Degradation of Different Types of WPVS Reference Solar Cells**

I. Kröger & S. Winter  
PTB, Braunschweig, Germany  
J. Hohl-Ebinger & S. Brachmann  
Fraunhofer ISE, Freiburg, Germany

**5BV.4.35 Influence of Lightning Strikes on Photovoltaic Modules Properties**

I. Naxakis, V. Perraki & E. Pyrgioti  
University of Patras, Greece

**5BV.4.36 Effect of Temperature on Insulation Resistance of Different PV Technologies**

M. Morampudi, S. Lata, G. Gowri, S.R. Sykam, P. Rajput,  
R. Kumar, G.K. Jha & R. Siddiqui  
NISE, Gurgaon, India

**5BV.4.37 PV Module Characterisation of the MS Tûranor PlanetSolar Catamaran after 5 Years on the World Oceans**

S. Dittmann, M. Caccivio & M. Marzoli  
SUPSI, Canobbio, Switzerland  
P. Goulpiè & L. Ditton  
PlanetSolar, Lausanne, Switzerland

**5BV.4.39 Defect Identification and Correlation with Electrical Degradation of Field Aged Thin Film Photovoltaic Technologies in Composite Climate**

R. Rawat  
IIT Dehli, New Delhi, India  
S.C. Kaushik  
IIT Dehli, New Dehli, India  
O.S. Sastry, Y.K. Singh, B. Bora & R. Singh  
NISE, Gurgaon, India

**5BV.4.41 Preliminary Assessment of Degradation in Field-Aged Multi-Crystalline Silicon PV Modules Installed in Hot-Humid Climate of Mid Ghana**

D.A. Quansah & M.S. Adaramola  
NMBU, Ås, Norway  
G. Takiy  
KNUST, Kumasi, Ghana

**5BV.4.42 How to Reduce I-V Measurement Deviation between Research and Production**

J. Abe, Y. Takeda, H. Kojima, K. Iwamoto, Y. Fujita,  
T. Morishima & K. Shibamoto  
Kyoshin Electric, Kyoto, Japan

**5BV.4.43 New Cross-Linking Assistant for Encapsulating Materials of EVA**

Y. Kawamura & M. Yamaura  
Nippon Kasei Chemical, Fukushima, Japan

**VISUAL PRESENTATIONS 2BV.7**

**17:00 - 18:30 Silicon Solar Cell Characterisation and Modelling / Manufacturing and Processing**

**2BV.7.2 Temperature Dependence of the Main Characteristics of HIT Elements**

A.V. Sachenko, Y.V. Kryuchenko, V.P. Kostilyov &  
I.O. Sokolovskyi  
NAS ISP, Kiev, Ukraine  
A.V. Bobyl, E.I. Terukov & M.Z. Shwarts  
RAS/ Ioffe, St. Petersburg, Russia  
A.S. Abramov & S.N. Abolmasov  
TFTC Ioffe, St. Petersburg, Russia  
D.A. Andronikov  
TFTC Ioffe, St-Petersburg, Russia  
M. Evstigneev  
Memorial University of Newfoundland, St. John's, Canada

**2BV.7.3 A Simulation Study of Depletion Effect of Negatively Charged Passivation Layer on n-Type Back-Contact Back-Junction Silicon Solar Cell**

C.-M. Wei, C.-C. Li & C.-C. Chuang  
Motech Industries, Tainan, Taiwan

**2BV.7.4 TCAD Modeling of TLM Contact Resistance Structures**

G. Gregory & K.O. Davis  
University of Central Florida, Orlando, United States  
A.M. Gabor, R. Janoch & A. Anselmo  
BrightSpot Automation, Westford, United States  
A.M. Payne  
Suniva, Norcross, United States

**2BV.7.6 Ultra-Thin Silicon Solar Cell: Flexibility, Modelling and Prediction**

J. Han, M. Abbott, B. Hoex, L. Wang & A. Barnett  
UNSW, Sydney, Australia  
P. Hamer  
University of Oxford, United Kingdom  
A. Lochtefeld  
AmberWave, Salem, United States

**2BV.7.7 Investigation of Light Induced Degradation of High Performance Multi Crystalline Solar-Cells**

K. Sporleder, T. Luka & M. Turek  
Fraunhofer CSP, Halle, Germany  
K. Hübener & K. Petter  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

**2BV.7.8 Performance of c-Si Photovoltaic Devices Based on Optical Measurements and Spectral Irradiance in the Atacama Desert**

P. Ferrada & A. Marzo  
University of Antofagasta, Chile  
H. Chu, E. Cabrera & A. Schneider  
ISC Konstanz, Germany

**2BV.7.9 Point-by-Point Parameter Mapping of a mc-Si Solar Cell**

N. Kwarikunda & W. Okullo  
Makerere University, Kampala, Uganda

**2BV.7.10 Silicon Nanowire Based Photovoltaic Cells: Analytical vs Numerical Modeling**

O. AL-Zoubi  
AL-Albzyt Univeristy, Mafrag, Jordan

**2BV.7.11 Numerical Calculation of Single Diode Solar Cell Modelling Parameters Using the Multi-Dimensional Newton-Raphson Method**

F. Ghani & T.S. O'Donovan  
Heriot-Watt University, Edinburgh, United Kingdom

**2BV.7.12 Rapid Calculation of Series and Shunt Resistance Values for a Solar Cell**

F. Ghani & T.S. O'Donovan  
Heriot-Watt University, Edinburgh, United Kingdom



- 2BV.7.13 LED Technology Enhancement in IV Testing of Solar Cells**  
M. Martire, F. Bettin & M. Galiazzo  
Applied Materials, Olmi di San Biagio, Italy
- 2BV.7.14 An Online, Web Based Solar Cell Simulation Interface for the Personalized Simulation of Various Solar Cell Architectures, Using Various Simulation Programs**  
R. Stangl, G. Anand, C. Ke, J. Wong & A.G. Aberle  
SERIS, Singapore, Singapore
- 2BV.7.15 Estimating the Effect of LED Spectra on EQE Measurements**  
A.R. Paduthol, M.K. Juhl & T. Trupke  
UNSW, Sydney, Australia
- 2BV.7.17 Influence of Thermal Dry Oxidation Process on the Silicon Solar Cell Emitter Profiling and Performance**  
A. Habib, M.A. Rasool, V. Fano, J.R. Gutiérrez & J.C. Jimeno  
UPV/EHU, Zamudio, Spain  
M.T. Ahmed  
Mansoura University, Egypt
- 2BV.7.18 Characterization of Large-Area Laser Ablation Processes for IBC Solar Cells**  
S. Großer  
Fraunhofer CSP, Halle, Germany  
J. Theobald  
ISC Konstanz, Germany  
R. Mayerhofer  
ROFIN-BAASEL, Starnberg, Germany
- 2BV.7.19 Enhanced Light Absorption by SiNx Antireflection Layer with Imbedded SiO<sub>2</sub> Thin Film on Micro and Nano-Textured Crystalline Si Solar Cells**  
S.G. Ryu, H.Y. Ji, M.J. Kim & J.H. Peck  
KITECH, Cheonan, Korea South  
K. Kim  
Chonbuk National University, Jeonju, Korea South
- 2BV.7.20 Inverted Random Pyramids: Simulation of the Influence of Surface Texture on Light Absorption in PERC Solar Cells**  
A. Stapf, C. Gondek & E. Kroke  
Freiberg University of Technology, Germany
- 2BV.7.21 Automated Void Detection in PERC Cells with Photoluminescence**  
K. Ogutman, K.O. Davis, E. Schneller, H. Ali & W.V. Schoenfeld  
University of Central Florida, Orlando, United States
- 2BV.7.22 A Rigorous Testing on Regenerated PERC Solar Cell**  
G. Li, J. Wang, J. Huang, S. Fu, J. Zhang, Y. Bai & L. Yang  
Jinergy, Lvliang, China

- 2BV.7.23 The Design and Industry Road of a Low Cost and High Efficient Multi Busbar Technology**  
S. Wan, X.-S. Wang, D. Wang, Y. Wu, Z. Xia & G. Xing  
Canadian Solar, Suzhou, China
- 2BV.7.25 Monofacial IV Measurements of Bifacial Silicon Solar Cells in an Inter-Laboratory Comparison**  
M. Rauer & J. Hohl-Ebinger  
Fraunhofer ISE, Freiburg, Germany  
K. Bothe  
ISFH, Emmerthal, Germany  
C. Comparotto  
ISC Konstanz, Germany  
P. Danzl & P. Manshanden  
ECN, Petten, The Netherlands  
M. Debucquoy  
imec, Leuven, Belgium  
N. Enjalbert & Y. Veschetti  
CEA, Le Bourget du Lac, France  
J. Wong  
SERIS, Singapore, Singapore
- 2BV.7.28 A First Study of Terahertz Emission Spectroscopy for a-Si:H/c-Si Passivated Interface in HIT Solar Cells**  
J. Mitchell, T. Mochizuki & H. Takato  
AIST, Koriyama, Japan  
A. Ito & H. Nakanishi  
SCREEN, Kyoto, Japan
- 2BV.7.30 Automated Statistical Algorithms to Interpret Root Cause Variance in Photovoltaic Cell Manufacturing**  
R. Evans & M. Boreland  
UNSW Australia, Sydney, Australia
- 2BV.7.32 Alternative Inline Analysis of Acidic Etching Baths**  
L. Mohr, T. Dannenberg, M. Zimmer & J. Rentsch  
Fraunhofer ISE, Freiburg, Germany
- 2BV.7.33 Dry Plasma Texturing of Mono-Si for Silicon Heterojunction Solar Cell Application**  
M.L. Addonizio, L. Fusco, A. Spadoni & A. Antonaia  
ENEA, Portici, Italy
- 2BV.7.34 Evaluation of Boron Nitride Solid Source Diffusion in p-Type Emitter Formation for n-Type Crystalline Silicon Solar Cells**  
B. Singha & C. Singh Solanki  
IIT Bombay, Mumbai, India
- 2BV.7.36 A Study of Improving Wafer Quality with the Phosphorus Gettering Process on Silicon Heterojunction Solar Cells**  
Z.-Y. Shih, W.-C. Hsieh, H.W. Yin, J. Chang & M.Y. Chen  
AU Optronics, Taichung, Taiwan



**2BV.7.37 Evaluation of Spatial ALD of Al<sub>2</sub>O<sub>3</sub> for Rear Surface Passivation of mc-Si PERC Solar Cells**  
F. Kersten, I. Förster & S. Peters  
Hanwha Q CELLS, Bitterfeld-Wolfen, Germany

**2BV.7.38 Upgrade of an Industrial Al:BSF Solar Cell Line into PERC Using Spatial ALD Al<sub>2</sub>O<sub>3</sub>**  
F. Souren, X. Gay, B. Dielissen & R. Görtzen  
SoLayTec, Eindhoven, The Netherlands

**2BV.7.39 Back Side Passivation in Industrial Mass Production**  
K. Vanormelingen, J. Beijersbergen, E. Granneman,  
R. Schiermann, X. Pages & V. Kuznetsov  
Levitech, Almere, The Netherlands

**2BV.7.41 Innovative PECVD Reactor Concept for Smart Manufacturing of Silicon Heterojunction Solar Cells**  
O. Shojaei, F. Jeanneret & A. Limouzin  
INDEOtec, Neuchâtel, Switzerland  
A. Descoedres, L. Barraud, M. Despeisse & C. Ballif  
CSEM, Neuchâtel, Switzerland

**2BV.7.43 Advantages of Waveform Adaptability in Low Frequency PECVD Applications**  
K. Ruda, W. Gajewski & P. Ozimek  
TRUMPF Huettinger, Zielonka, Poland

**2BV.7.44 The Optimization of Laser Contact Opening Process for n-Type Rear Junction Printing PERT Solar Cells**  
J. Lee, Y.S. Choi, J. Lee, H. Oh, D.-H. Kyeong, T. Kim,  
M.-I. Hwang & E.-C. Cho  
Hyundai Heavy Industries, Yongin, Korea South

**2BV.7.45 A Simple Route to Fabrication of Local Back Contacts to Silicon Solar Cells**  
C.-K. Hsu, J.-H. Yang & I.-C. Chen  
National Central University, Jhongli, Taiwan  
C.-W. Kuo, T.-M. Kuan & C.-Y. Yu  
TSEC, Hsinchu, Taiwan

**2BV.7.46 Fine Line Double Printing for Today and Tomorrow Cell Metallization and Module Interconnection**  
M. Galiazzo, O. Borsato & E. Bortoletto  
Applied Materials, Treviso, Italy

**2BV.7.47 Ultra Fine Finger Electrodes Reproduction by Screen Printing Method**  
K. Kawanaka, K. Masuri & J. Kawanobe  
MURAKAMI, Chiba, Japan

**2BV.7.48 The "Easy Plate" Process - Analysis of Process Route Options in Direct Plating of Nickel and Copper for Crystalline Silicon Solar Cell Metallization**  
J. Bartsch, S. Kluska, A. Büchler, A.A. Brand, S. Nold,  
G. Cimiotti, J.-F. Nekarda, M. Glatthaar & S.W. Glunz  
Fraunhofer ISE, Freiburg, Germany

**2BV.7.49 High-Productive Aluminum Deposition of Back Contacts for Hetero-Junction Solar Cells by Electron Beam Evaporation**  
J.-P. HeiB  
Fraunhofer FEP, Dresden, Germany  
H. Schlemm  
Meyer Burger, Hohenstein-Ernstthal, Germany  
F. Wünsch  
Roth & Rau, Hohenstein-Ernstthal, Germany

**2BV.7.50 High Efficiency Vacuum Coater for TCO Production for HIT Solar Cells**  
E. Khokhlov, S. Nastochkin, A. Yasunas, V.Y. Shiripov &  
K. Miasnikov  
Izovac Technologies, Minsk, Belarus

**2BV.7.51 Electroluminescence Characterization of Light-Induced Degradation Processes in Si Solar Cells**  
T. Mtchedlidze, K. Krechan, B. Pötschick & J. Weber  
Technical University of Dresden, Germany  
A. Herguth  
University of Konstanz, Germany

**2BV.7.52 The Progress and Improvement of the Initial Degradation of Industrial p-Type Czochralski-Grown Monocrystalline Silicon Solar Cells and Panels**  
S. Park, K.S. Lee, J.H. Lee, M.-H. Choi & Y. Choe  
LG Electronics, Seoul, Korea South

**2BV.7.53 Ultrahigh PID-Resistance for Mono Silicon PERC Solar Cells by Using Industrial Mass-Production Technology**  
C.-W. Kuo, T.-M. Kuan, L.-G. Wu, C.C. Huang,  
H.-Y. Peng & C.-Y. Yu  
TSEC, Hsinchu, Taiwan

**2BV.7.54 Comparison of Influence on mc-Si Solar Cell Performance of Dislocation Clusters and Grain Boundaries by Using Photoluminescence Imaging**  
X. Niu, S. Qiao, L. Zhang, M. Pan, Y. Zhang, W. Gao,  
D. Song & B. Yu  
Yingli Green Energy, Baoding, China

**2BV.7.56 Overcoming Image Blurring in Photoluminescence Imaging Metrology for Silicon Solar Cell Manufacturing**  
B. Mitchell, D. Chung, A. Teal & T. Trupke  
UNSW, Sydney, Australia

**2BV.7.57 Fabrication and Electrical Characterization of Semi-Transparent Silicon Solar Cells**

T. Makris, P. Fleming & A. Santamaria  
Ipsol Energy, Nottingham, United Kingdom  
E. Skuras  
University of Ioannina, Greece  
A.R. Long  
University of Glasgow, United Kingdom

**2BV.7.58 Soldering Property and Element Investigation on Thermal Conditions by Infrared Lamp Tabbing Process for c-Si Solar Modules**

S.H. Kim, H.J. Son & J.J. Lee  
KETI, Gyeonggi-do, Korea South  
K.-I. Jung  
Zeus, Gyeonggi-do, Korea South  
D. Kim  
Korea University, Seoul, Korea South

**2BV.7.60 Optical Loss Analysis of PV Modules**

M.D. Abbott, K.R. McIntosh & B. Sudbury  
PV Lighthouse, Coledale, Australia

**2BV.7.61 Large Area IBC Zebra Solar Cells in Pilot Production: the Results of FP7 HERCULES Project Industrial Integration**

G. Galbiati, V.D. Mihailetchi, H. Chu, A. Halm & R. Kopecek  
ISC Konstanz, Germany

**2BV.7.62 Depth Profiling of Non-Conducting Layers with rf GD-OES**

J. Rinder, P. Keller, J. Steffens, B. Terheiden & G. Hahn  
University of Konstanz, Germany

**2BV.7.63 Impact of Operating Temperature and Absorption-Layer Thickness on All-Back-Contact (ABC) Solar Cell Efficiency**

J.E. O'Connor & S. Michael  
Naval Postgraduate School, Monterey, USA

**2BV.7.64 Advantages of Inline High-Intensity LED Light-Annealing for LID Prevention**

D. Ruf, E. Anderson, G. Cheng & J. Bell  
Despatch Industries, Lakeville, USA

Wednesday, 22 June 2016

**VISUAL PRESENTATIONS 4CV.1**

**08:30 - 09:30 III-V-based Devices for Terrestrial and Space Applications / Concentrator and Space Systems**

**4CV.1.3 Low Concentration GaAs/CuInGaSe and GaAs/Si Multi-Junction Solar Cells with Smart Stack Technology**

K. Makita, H. Mizuno, R. Oshima, T. Tayagaki, J. Nishinaga, H. Shibata, H. Takato & T. Sugaya  
AIST, Tsukuba, Japan  
M. Baba & N. Yamada  
Nagaoka University of Technology, Japan

**4CV.1.4 CPVMatch - Concentrating Photovoltaic Modules Using Advanced Technologies and Cells for Highest Efficiencies**

S.P. Philipps & A.W. Bett  
Fraunhofer ISE, Freiburg, Germany  
M. Baudrit  
CEA, Le Bourget du Lac, France  
K. Hillerich  
AZUR SPACE, Heilbronn, Germany  
V. Moreau  
Cycleco, Ambérieu-en-Bugey, France  
R. Parmesani  
ASSE, Gorizia, Italy  
E. Román  
Tecnalia, Zamudio, Spain  
G. Sala  
UPM, Madrid, Spain  
B. Schineller  
AIXTRON, Herzogenrath, Germany  
G. Timò  
RSE, Milan, Italy

**4CV.1.5 External Quantum Efficiency and First Results of Electric Performance Measurements on a Quadruple Junctionspace Solar Cell**

G. Jüngst & A. Grás  
INTA, Madrid, Spain  
R. Campesato, G. Gori & E. Greco  
CESI, Milan, Italy

**4CV.1.6 On the Effect of Optical Configuration and Spectral Variation on the Performance of III-V Triple-Junction Cell Used in H-CPV Systems**

R.D. Schultz, E.E. van Dyk & F.J. Vorster  
NMMU, Port Elizabeth, South Africa

- 4CV.1.7 Design and Preparation of Antireflection Coating for Inverted Metamorphic 4 Junction (IMM 4J) Solar Cell**  
X. Sun, Y. Du & Z. Xiao  
Tianjin Hengdian Space Power, China
- 4CV.1.8 Indoor Characterization of Wind Influence on CPV Modules through Cell-to-Ambient Thermal Resistance Measurements**  
A.V. Chekalin, V.D. Rumyantsev & N.A. Sadchikov  
RAS/ Ioffe, St. Petersburg, Russia  
N.Yu. Davidyuk  
St. Petersburg Academic University, Russia
- 4CV.1.10 Fundamental Study for the Power Tower's HCPV/T Combined Thermal Receiver**  
A.O.M. Hagfarah & M. Nazarinia  
Heriot Watt University, Dubai, United Arab Emirates
- 4CV.1.11 Temperature-Dependent Photovoltaic Properties of Lightweight Flexible InGaP/InGaAs/Ge Triple-Junction Solar Cells**  
K.-S. Kim, J.-H. Kim & B.-I. Choi  
KIMM, Daejeon, Korea South  
K. Kim, S.H. Jung, C.Z. Kim, H.-B. Shin & H.K. Kang  
Korea Advanced Nano Fab Center, Suwon, Korea South  
E.H. Lee & J.S. Yeo  
Agency for Defense Development, Daejeon, Korea South
- 4CV.1.12 Radiation Effects on Advanced Multi Junction Solar Cells for Space Missions**  
R. Campesato, G. Gori, M. Casale & G. Gabetta  
CESI, Milan, Italy  
M. Sankaran, E.P. Suresh & B.R. Uma  
ISRO Satellite Centre, Bangalore, India
- 4CV.1.13 Results and Achievements of the Large Area Multi-Source Solar Array Tester 'HighLIGHT Sat'**  
C. Droz, N. Bassi, G. Arnoux, Y. Pelet, N. Frick & F. Seydoux  
Pasan, Neuchâtel, Switzerland  
E. Fernández Lisbona & N. Girault  
ESA-ESTEC, Noordwijk, The Netherlands
- 4CV.1.14 Next Generation Space Solar Cells Utilising Lattice-Matched 4J Dilute Nitride Technology – Project 'LONGESST'**  
A.D. Johnson & I. Davies  
IQE, Cardiff, United Kingdom  
C. Algora, I. Rey-Stolle, M. Ochoa & I. García  
UPM, Madrid, Spain  
K. Dessein & A. Peetermans  
Umicore, Olen, Belgium  
W. Meredith & S. McDougall  
Compound Semiconductor Technologies, Glasgow,  
United Kingdom

- 4CV.1.15 A Quantum Engineering Approach to Voltage Preservation in Intermediate Band Solar Cells**  
P.M. Ushasree, G. Zoppi & N.S. Beattie  
Northumbria University, Newcastle upon Tyne, United Kingdom  
P. See  
National Physics Laboratory, Teddington, United Kingdom  
S. Tomic  
University of Salford, Manchester, United Kingdom  
M. Duchamp  
Forschungszentrum Jülich, Germany  
I. Farrer  
University of Sheffield, United Kingdom  
D.A. Ritchie  
University of Cambridge, United Kingdom
- 4CV.1.16 Optically Enhanced GaInNAs Solar Cell**  
T. Aho, A. Aho, A. Tukiainen, V. Polojärvi, M. Raappana & M. Guina  
Tampere University of Technology, Finland
- 4CV.1.18 Models of Light Collection of 3D-CPC Concentrators under Lambertian Irradiation**  
A. Parretta  
University of Ferrara, Italy  
M. Tucci  
ENEA, Rome, Italy
- 4CV.1.20 How to Take into Account the Proton Back Irradiation Contribution to Degradation on Deployable Solar Panels**  
S. Rodríguez, J. Plá, J. Duran & M. Alurralde  
CNEA, Buenos Aires, Argentina
- 4CV.1.21 Development of High-Efficiency Low-Concentrator Spectrum-Splitting Type Solar Cells**  
P. Sichanugrist  
MEXT/FUTURE-PV Innovation, Fukushima, Japan  
D.-W. Kang  
Cheongju University, Korea South  
Y. Takiguchi  
Tokyo Institute of Technology, Japan  
M. Konagai  
Tokyo City University, Japan
- 4CV.1.22 The Development of the PV Concentrator System With Electrical and Thermal Output**  
A. Okhorzina & A. Yurchenko  
Tomsk Polytechnical University, Russia  
N. Bernhard  
Anhalt University of Applied Sciences, Köthen, Germany

**4CV.1.23 Ray Tracing Modelling of Reflector for Vertical Bifacial Panel**

M. Linde Jakobsen, S. Thorsteinsson &  
P. Behrendorff Poulsen  
Technical University of Denmark, Roskilde, Denmark  
P. Melchior Rødderb & K. Rødder  
SolarLab, Viby, Denmark

**4CV.1.24 Integration of Spectral Splitting in a CPV-T Receiver Concept**

R. Reinbrech & R. Hoeller  
University of Applied Sciences Upper Austria, Wels, Austria

**4CV.1.25 Performance Uniformity of Ultra-High Growth Rate Solar Cells Grown by MOCVD**

K.J. Schmieder, M.K. Yakes & R.J. Walters  
US Naval Research, Washington, United States  
E.A. Armour & Z. Pulwin  
Veeco Compound, Somerset, United States  
M.P. Lumb  
George Washington University, United States

**4CV.1.27 High Performance GaAs Solar Cell Using Heterojunction Emitter and Its Further Improvement by ELO Technique**

S. Kim, S.-T. Hwang, W. Yoon & H.-M. Lee  
LG Electronics, Seoul, Korea South

**4CV.1.28 Experimental Performance Study of a Hybrid Symmetric Concentrating Photovoltaic/Thermal Concentrator for Building Applications**

G.Z. Naman, B. Chen & S. Nazmi  
Heriot-Watt University, Edinburgh, United Kingdom  
T.K. Mallick  
University of Exeter, Penryn, United Kingdom  
H.M. Upadhyaya  
Brunel University, London, United Kingdom

**VISUAL PRESENTATIONS 3CV.2**

**13:30 - 15:00 CdTe, CIS and Related Thin Film Solar Cells and Modules (I)**

**3CV.2.1 Growth of Cu<sub>2</sub>ZnSnS<sub>4</sub> Thin Films by Sequential Reactive Sputtering of Metal Targets**

O.P. Singh, K.S. Gour, R. Parmar & V.N. Singh  
NPL, New Delhi, India

**3CV.2.2 Properties of CuInS<sub>2</sub> Nano-Particles on TiO<sub>2</sub> Thin Film by Spray Pyrolysis for CuInS<sub>2</sub> / TiO<sub>2</sub> Composite Solar Cell**

G.-C. Park  
Mokpo National University, Muan, Korea South  
R. Kim  
Photonic Device Integration, San Jose, United States

**3CV.2.3 Electrical Properties of CZTS Thin Films Grown by Coevaporation and Its Relation with Secondary Phase Formation**

G. Gordillo, F.E. Guzmán, J.S. Oyola Villegas, R. Moreno & A.A. Ramírez  
National University of Colombia, Bogotá, Colombia

**3CV.2.4 Study on the Current Blocking Effect Induced by the Residual Secondary Phase Materials in the Cu<sub>2</sub>ZnSnSe<sub>4</sub> Thin Film Solar Cells**

J. Moon, H.R. Choi, K. Kim, J. Gwak, J.H. Yun, A. Cho, Y. J. Eo, J.-S. Cho, S.J. Ahn, J.H. Park, J.S. Yoo, K.S. Shin, K.H. Yoon & S.K. Ahn  
KIER, Daejeon, Korea South  
D. Nam & H. Cheong  
Sogang University, Seoul, Korea South  
B. O  
Chungnam National University, Daejeon, Korea South

**3CV.2.5 Dielectric Barrier Layer: Alternative Materials and Processing Comparison for Scalable PV Technologies on Rough Steel Substrates**

M.C. López-López, E. Sanchez-Cortezon & J.M. Delgado Sánchez  
Abengoa, Sevilla, Spain  
E. Zugasti, J. Armentia, M. Ezquer Mayo, M.J. Rodriguez & A.R. Lagunas  
CENER, Sarriguren-Navarra, Spain

**3CV.2.6 Cadmium Sulfide Films Grown by Photochemical Deposition and Their Application in CIGS Solar Cells**

Z. Zhang, Y. Xiaojie & S. Lexi  
Lingnan Normal University, Zhanjiang, China

**3CV.2.7 Fabrication of Vertical Cu<sub>2</sub>ZnSnS<sub>4</sub>/Mo/Si Nanocylinder Arrays Using a Patterned Si Nanowire Arrays Template**

C. Wang  
Changchun University, China  
T. Shimizu & S. Shingubara  
Kansai University, Suita, Japan

**3CV.2.8 Influence of the Preparation Conditions on the Properties ZnO:Al Thin Film Obtained by Sol-Gel Deposition**

E.P. Zaretskaya & V.F. Gremenok  
NASB, Minsk, Belarus  
A.V. Semchenko, A.V. Rogachev & V.V. Sidsky  
F. Skorina Gomel State University, Belarus

**3CV.2.10 Effect of Cd and Te<sub>2</sub> Vapor Phase Mixture in CMBD on Growth Rate and Morphology of CdTe Films for Use in Thin-Film Solar Cells**

T.M. Razykov, B. Ergashev, K.M. Kouchkarov & R. Yuldashev  
Academy of Sciences of Uzbekistan, Tashkent, Uzbekistan  
A. Bosio & N. Romeo  
University of Parma, Italy  
C.S. Ferekides & D.Y. Goswami  
University of South Florida, Tampa, United States  
A. Romeo  
University of Verona, Italy  
H.S. Ullal  
NREL, Golden, United States  
H.M. Upadhyaya  
Brunel University, London, United Kingdom

**3CV.2.11 Surface Photovoltage Study of Cu<sub>1.95</sub>Zn<sub>1.1</sub>Sn<sub>0.96</sub>Se<sub>4</sub> Single Phase Powder**

T. Dittrich, G. Gurieva, S. Kapil & S. Schorr  
HZB, Berlin, Germany  
L.E. Valle Rios  
Free University of Berlin, Germany  
N. Rujisamphan  
KMUTT, Bangkok, Thailand

**3CV.2.12 Investigations on the Structural, Optical and Electrical Properties of ZnO Thin Films with Various pH Values Prepared by Sol Gel Method for Photovoltaic Application**

K. Meziane, A. Elhichou, A. Almagoussii & A. El Hamidi  
UCA Marrakech, Morocco

**3CV.2.13 Structural and Optical Properties of RF-Sputtered ZnS:Cu Thin Films**

O.M. Cheikh, L. Nkhaili, A. El Kissani, M. Chaik & A. Outzourhit  
Ibn Tofail University, Kenitra, Morocco  
M. Aggour  
Cadi Ayyad University, Marrakech, Morocco

**3CV.2.14 Formation of Cu<sub>2</sub>ZnSnSe<sub>4</sub> Thin Films on Flexible Substrates by an Electrochemical Technique**

V.F. Gremenok & S.A. Bashkurov  
NASB, Minsk, Belarus  
R. Juskenas, R. Giraitis & A. Naujokaitis  
Center for Physical Sciences and Technology, Vilnius, Lithuania  
M.B. Dergacheva & K.A. Urazov  
National Academy of Sciences, Almaty, Kazakhstan  
W.Y. Kim & S.-H. Chai  
Hoseo University, Chungnam, Korea South

**3CV.2.15 Influence of H<sub>2</sub>Se Flow Rate on Cu<sub>2</sub>ZnSnSe<sub>4</sub> Based Solar Cells Made by Selenization of Metallic Precursors**

S. Ranjbar  
University of Aveiro, Portugal  
G. Brammertz, B. Vermang, S. Sahayaraj, A. Mule, S. Oueslati, M. Meuris & J. Poortmans  
imec, Leuven, Belgium  
A.F. da Cunha  
University Aveiro, Portugal

**3CV.2.16 Fabrication of Cu-Based I-V-VI Photovoltaic Absorber Thin Films**

A. Cho, S. Banu, S.J. Ahn, J.H. Yun, J. Gwak, S.K. Ahn, Y. J. Eo, J.-S. Cho, J.H. Park, J. Yoo, K. Kim & K.S. Shin  
KIER, Daejeon, Korea South

**3CV.2.17 Cost-Efficient, Earth-Abundant CuSbS<sub>2</sub> Solar Cells Fabricated with Hybrid Ink**

S. Banu, S.K. Ahn, J.S. Cho, J.H. Yun & A. Cho  
KIER, Daejeon, Korea South

**3CV.2.18 Characterization and Post-Processing of Cadmium Sulfide Polycrystalline Thin Films**

H. Xu, L. Wu, W. Wang, G. Zeng, C. Liu, W. Li, B. Li, J. Zhang & L. Feng  
Sichuan University, Chengdu, China

**3CV.2.19 Identification of Loss Mechanisms in CIGS Micro-Cells for Concentrator Applications**

E. Lotter, P. Jackson, S. Paetel & W. Wischmann  
ZSW, Stuttgart, Germany

**3CV.2.20 Stabilization of a Reactive Mid-Frequency Sputtering Process of Al-Doped Zinc Oxide Films with Rotatable Targets**

V. Sittinger, F. de Campos Carreri, S. Jung, A. Kaiser, W. Werner & G. Bräuer  
Fraunhofer IST, Braunschweig, Germany



- 3CV.2.21 Thickness Effect of Top-Cell CuGaSe<sub>2</sub> Absorber Layers Grown on ITO/SLG Substrates for Application of Tandem Solar Cells**  
J. Yoo, J.H. Choi, K. Kim, Y.-J. Eo, J.H. Park, J. Gwak, S.-K. Ahn, A. Cho, S.J. Ahn, J.-S. Cho, K. Shin, K. Yoon, S.H. Kong & J.-H. Yun  
KIER, Daejeon, Korea South
- 3CV.2.22 Electro-Mechanical Response of Sputter-Deposited Mo Thin Films for Back Contacts in CIGS Flexible Solar Cells**  
T. Jörg, M.J. Cordill, R. Franz & C. Mitterer  
University of Leoben, Austria  
C. Linke & J. Winkler  
PLANSEE, Reutte, Austria
- 3CV.2.23 Improved CIGS-Module Efficiency by H<sub>2</sub>O Injection into TCO-Deposition-Process**  
J. Nowoczin, K. Oehlstorm, S. Jander & P. Kratzert  
Solibro, Bitterfeld-Wolfen, Germany  
O. Lundberg & L. Stolt  
Solibro, Uppsala, Sweden
- 3CV.2.24 Band Alignment of CZTS at Grain Boundary**  
W. Li, Y. Feng, Z. Li, G. Zhong, C. Yang & X. Xiao  
CAS, Shenzhen, China  
Y. Ma  
CUHK, Hong Kong, Hong Kong
- 3CV.2.25 Effect of Zn Doping on CdS Thin Film Deposited by RF Magnetron Sputtering**  
M. Terlemezoglu, H.H. Güllü, O. Bayrakli & M. Parlak  
METU, Ankara, Turkey
- 3CV.2.26 Elaboration of ZnO:Ga Thin Films by Spray Pyrolysis for Photovoltaic Applications**  
Z. El Khalidi, S. Fadili & B. Hartiti  
University Hassan II, Mohammedia, Morocco  
A. Lfakir  
University Moulay Ismail, Errachidia, Morocco  
P. Thevenin  
University of Lorraine, Metz, France
- 3CV.2.27 A Simple, Nontoxic And Low-Cost Chemical Bath Deposition Method For High Efficiency CZTSSe Thin Films Solar Cells**  
J. Li, G. Jiang, W. Liu & C. Zhu  
CAS, Hefei, China
- 3CV.2.28 Comparative Studies of Transparent Conductive Oxide Layers for Application in Cu(In,Ga)Se<sub>2</sub> Modules**  
T. Koida, J. Nishinaga, H. Higuchi, M. Iio, A. Kurokawa, Y. Kamikawa-Shimizu, H. Shibata & S. Niki  
AIST, Tsukuba, Japan
- 3CV.2.30 Mechanism of Early-Stage Degradation of CIGS Solar Cells Induced by Air Exposure**  
J. Nishinaga, Y. Kamikawa-Shimizu, T. Koida, H. Shibata & S. Niki  
AIST, Tsukuba, Japan
- 3CV.2.31 Effects of the Extent of Cu-Rich Conversion on Surface Morphology of Three-Stage Co-Evaporated CuInGaSe<sub>2</sub> Absorbers**  
K. Kim, J.H. Choi, J.S. Yu, J.-S. Cho, J. Gwak, S.J. Ahn, A. Cho, S.K. Ahn, Y. J. Eo, J.H. Park, K.S. Shin, K. Yoon & J.H. Yun  
KIER, Daejeon, Korea South
- 3CV.2.32 Effects of Stacking Sequences in the Formation of CZTS Thin Film Using Electron Beam Evaporation**  
P.K. Kannan, S. Chaudhari & S.R. Dey  
IIT Hyderabad, Sangareddy, India
- 3CV.2.33 Effect of Annealing Atmosphere and Stabilizing Agent on the Formation of CZTS Film Using a Simple Dip Coating Technique**  
S. Chaudhari, K. Kannan & S.R. Dey  
IIT Hyderabad, Sangareddy, India
- 3CV.2.34 Optimization of Sulphurization Temperature for Obtaining Dense Cu<sub>2</sub>ZnSnS<sub>4</sub> Films with Phase Purity and Preferred Composition**  
A. Agasti, S. Mallick & P. Bhargava  
IIT Bombay, Mumbai, India
- 3CV.2.35 Super High Efficiency Cu(In,Ga)Se<sub>2</sub> Thin-Film Solar Cells Approaching 25%: Results of the EU Project Sharc25**  
W. Witte, P. Jackson, D. Hariskos & F. Kessler  
ZSW, Stuttgart, Germany  
S. Buecheler, R. Carron, E. Avancini, B. Bissig & A.N. Tiwari  
EMPA, Dübendorf, Switzerland  
S. Siebentritt, F. Werner & M. Wolter  
University of Luxembourg, Belvaux, Luxembourg  
P. Pareige, P. Muguerou, S. Duguay, E. Cadel, C. Castro & M. Raghuvanshi  
Université et INSA de Rouen, Saint Etienne du Rouvray, France  
R. Menozzi & G. Sozzi  
University of Parma, Italy  
E. Bourgeois, G. Degutis & A. Hardy  
imec, Leuven, Belgium  
M. Bär, R.G. Wilks & T. Kunze  
HZB, Berlin, Germany  
S. Sadewasser & N. Nicoara  
INL, Braga, Portugal  
M. Puska, M. Fedina, H.-P. Komsa & V. Havu  
Aalto University, Finland  
D. Brémaud  
Flisom, Dübendorf, Switzerland  
B. Dimmler & R. Wächter  
Manz CIGS Technology, Schwäbisch Hall, Germany



- 3CV.2.36 Impact of Contact Resistance on CIGS Panel Performance with Metal Interconnect**  
J. van Deelen, Y. Tezsevin, M. Barink & J.-P. Teunissen  
TNO, Eindhoven, The Netherlands
- 3CV.2.37 Indirect Ablation of Cu(In, Ga)Se<sub>2</sub>-Layers by ns Pulses with a Wavelength of 1342 nm**  
K. Kaufmann  
Anhalt University of Applied Sciences, Köthen, Germany  
C. Hagendorf  
Fraunhofer CSP, Halle, Germany
- 3CV.2.38 Electrical Element-Based Simulation of Thin Film CIGS Modules: Impact of Inhomogeneities**  
F. Braun & P. Borowski  
AVANCIS, Munich, Germany
- 3CV.2.39 Analysis of Surface Composition, Electronic Properties, and Solar Cell Performance of UHV-Transferred CIGSe Thin Film Solar Cell Absorbers on Alkali-Containing Substrate Glass**  
W. Calvet, B. Ümsür, A. Steigert, I. Lauermann, B. Chacko, V. Parvan, T. Olar, C.A. Kaufmann, D. Greiner, J. Lauche, I. Majumdar, H. Allaf Navirian, R. Schlatmann & M.C. Lux-Steiner  
HZB, Berlin, Germany  
G. Voorwinden  
Manz CIGS Technology, Schwäbisch Hall, Germany
- 3CV.2.40 Hot-Spot Analysis Using Distributed Equivalent Circuit Model for CIGS Solar Cells**  
J. Jo & M. Shin  
Korea Aerospace University, Goyang, Korea South  
Y. Kang  
Korea University, Seoul, Korea South
- 3CV.2.43 Single Step and Room Temperature Sputtering Deposition Process for the CIGS Absorber Layer of Solar Cells**  
B. Ayachi  
IEMN, Villeneuve d'Ascq, France  
T. Aviles  
CROSSLUX, Villeneuve d'Ascq, France  
J.-P. Vilcot  
IEMN, Villeneuve d'Ascq, France  
C. Sion  
Ecole Centrale Lille, Villeneuve d'Ascq, France
- 3CV.2.44 Effect of Sulfur on the Phase Formation of Cu<sub>2</sub>ZnSnS<sub>4</sub> Solar Cell Material**  
V. Erkkara Madhavan  
Qatar Foundation, Doha, Qatar  
C. Sripan & A. Kasi Viswanath  
Pondicherry University, India  
R. Ganesan  
Indian Institute of Science, Bangalore, India

**VISUAL PRESENTATIONS 5CV.3**

**15:15 - 16:45 Solar Resource and Forecasting / Sustainability and Recycling**

- 5CV.3.1 Quantitative Comparison of Measures from Calibrated PV Cells and Thermopile Pyranometer Supported by a Spectrophotometer**  
A. Tettamanti & M. Potenza  
University of Milan, Italy  
A. Calatroni  
SOLUZIONE SOLARE, Vicenza, Italy
- 5CV.3.2 The Impact of Indoor and Outdoor Radiometer Calibration on Solar Measurements**  
A. Habte, M. Sengupta, A. Andreas & I. Reda  
NREL, Golden, United States  
J. Robinson  
Groundwork, Logan, United States
- 5CV.3.3 Design and Test of a PTFE Made Scattering Optical Couplings to Substitute State-of-the-Art Cosine Corrector**  
R. Cahuantzi & A. Buckley  
University of Sheffield, United Kingdom
- 5CV.3.5 Solargis Solar Resource and Meteorological Database for PV Power Simulation**  
T. Cebebauer, M. Suri, A. Skoczek & J. Betak  
GeoModel Solar, Bratislava, Slovakia
- 5CV.3.6 Validation of Satellite Based Solar Irradiance According to the Heliosat-4-Method for Germany**  
K. Ditz, H. Ruf, D. Funk & G. Heilscher  
Ulm University of Applied Sciences, Germany  
M. Schroedter-Homscheidt  
German Aerospace Center, Wessling, Germany  
C. Köhler  
German Meteorological Service, Offenbach, Germany
- 5CV.3.7 Satellite Data Assimilation in Regional Numerical Weather Prediction as a Key for Better Cloud Cover Forecasts in Tropical Environments**  
F. Kurzrock  
ESPACE-DEV, Saint-Pierre, Reunion  
S. Cros  
Reuniwatt, Sainte-Clotilde, Reunion  
F. Chang-Ming & L. Linguet  
University of la Réunion, Sant-Denis, Reunion  
R. Potthast  
German Meteorological Service, Offenbach, Germany

- 5CV.3.8 Investigation of Reference Cell and Photodiode Calibrations under Different Conditions**  
A. Driesse  
PV Performance Labs, Freiburg, Germany  
W. Zaaïman & N. Taylor  
European Commission JRC, Ispra, Italy  
D.S. Riley & J.S. Stein  
Sandia National Laboratories, Albuquerque, United States
- 5CV.3.11 Solar Potential in Castilla y León (Spain) through Mathematical Interpolation Methods**  
M.C. Rodríguez-Amigo, M. Díez-Mediavilla,  
D. Gonzalez Peña, M.I. Dieste-Velasco & C. Alonso-Tristán  
UBU, Burgos, Spain
- 5CV.3.12 Use of Lidar Data in Photovoltaic Energy Yield Estimation: the Case of Amsterdam Zuidas**  
R. Caroprese, O. Isabella & M. Zeman  
Delft University of Technology, The Netherlands  
J. Brinkman  
Accenture, Amsterdam, The Netherlands
- 5CV.3.13 Global Vertical Irradiation in the Fourth Cardinal Orientations in Burgos, Spain**  
M. Díez-Mediavilla, M.C. Rodríguez-Amigo,  
A. Pérez-Burgos, T. García-Calderón & C. Alonso-Tristán  
UBU, Burgos, Spain
- 5CV.3.16 A New Method for the Benchmarking of Irradiance Predictions**  
A. Guérin de Montgareuil & T. Hedde  
CEA, St Paul lez Durance, France  
L. Bellemare  
AME, Ducos, Martinique  
R. Blondou & T. Soubdhan  
UAG, Pointe-à-Pitre, Guadeloupe  
M. David & P. Lauret  
University of Reunion Island, St Pierre, Reunion  
S. Mével & J.P. Morel  
Meteo France, Carpentras, France  
P. Poggi & C. Voyant  
University of Corsica, Ajaccio, France
- 5CV.3.18 Evaluating a Model to Estimate DNI and DHI from POA Irradiance**  
M. Gostein & W. Stueve  
Atonometrics, Austin, United States  
K. Passow & A. Panchula  
First Solar, San Francisco, United States

- 5CV.3.19 Detailed Irradiance Statistics for the Design of PV-Systems from a Set of Ground Stations in Central Africa (Rwanda)**  
H.G. Beyer  
University of Agder, Grimstad, Norway  
F. Habyarimana  
University of Rwanda, Kigali, Rwanda
- 5CV.3.20 Stochastic Downscaling Algorithm to Generate High-Resolution Time-Series for Improved PV Yield Simulations**  
C.A. Duscha, J. Lezaca & R. Meyer  
Suntrace, Hamburg, Germany  
S.A. Buehler  
University of Hamburg, Germany
- 5CV.3.21 Diagnosing Model Errors in Simulation of Solar Radiation on Inclined Surfaces**  
Y. Xie & M. Sengupta  
NREL, Golden, United States
- 5CV.3.22 Algorithm for Technical and Economic Design Optimization of Photovoltaic Systems**  
J. Birtel & H. te Heesen  
Trier University of Applied Sciences, Neubrück, Germany
- 5CV.3.24 Maximum Power Point Modeling through Irradiance Based Duty Cycle Calculation**  
P. Upadhyay, S. Pulipaka & R. Kumar  
BITS, Pilani, India
- 5CV.3.25 Comparative Life Cycle Assessment of PV Technologies**  
S. Dahiya & T. Vogt  
Next Energy, Oldenburg, Germany
- 5CV.3.26 Water Usage for Photovoltaic Solar Manufacturing: Life Cycle Costs Analysis and Resource Demands**  
A. Yazdani  
Exergy, Irvine, United States
- 5CV.3.27 Life Cycle Assessment of the Recycling of c-Si and CdTe PV Modules**  
P. Stolz & R. Frischknecht  
Treeze, Uster, Switzerland  
K. Wambach  
Wambach-Consulting, Aindling, Germany  
G. Heath & G. Heath  
NREL, Golden, United States
- 5CV.3.30 Estimating Future Recycling Quantities of PV Modules in the European Union**  
G. Kleiss  
SolarWorld, Bonn, Germany

**5CV.3.31 Non-Compliance with End-of-Life Legislation: Risks for the Sustainable Development of PV in Europe**  
J. Clyncke & P.A. Lange  
PV Cycle, Brussels, Belgium

**5CV.3.32 Photovoltaic Modules under the EU WEEE Directive - First Results and Future Outlook**  
A. Campen  
1cc, Holzgerlingen, Germany

**5CV.3.35 Efficient Recovery Method for Unbroken Solar Cell from Photovoltaic Module**  
J.-K. Lee, J.S. Lee, Y.S. Ahn & G.-H. Kang  
KIER, Daejeon, Korea South  
C.-H. Cho  
Chungnam National University, Daejeon, Korea South

**5CV.3.36 ECOLUX – PV Recycling Simply with Light**  
W. Palitzsch & U. Loser  
Loser Chemie, Zwickau, Germany

**5CV.3.37 Predictability of Solar Radiation by Ground-Based All-Sky Camera Imagery and Cloud Motion Vector Analysis: a Theoretical Investigation Using Modelled Cloud Fields and Radiative Transfer Simulations**  
A. Los  
Dexa Solar, Noordwijk, The Netherlands  
S.R. de Roode  
Delft University of Technology, The Netherlands

**5CV.3.38 Can We Do Better with Satellite Data Post-Processing?**  
G. Lizcano, P. Puig & O. Lacave  
Vortex, Barcelona, Spain  
J. Calbó  
University of Girona, Spain

**5CV.3.39 Long Term Projection of Global Horizontal Irradiance Ground Measurement Using Satellite Modeled Time Series**  
W. Ferrara  
ENEL, Roma, Italy  
I. Cascone  
ENEL, Rome, Italy  
O. Privitera  
ENEL, Catania, Italy

## VISUAL PRESENTATIONS 3CV.4

17:00 - 18:30 CdTe, CIS and Related Thin Film Solar Cells and Modules (II)

**3CV.4.1 Vitreous Enamel as Sodium Source for Efficient Kesterite Solar Cells on Commercial Ceramic Tiles**  
I. Becerril-Romero, S. López-Marino, Y. Sánchez, M. Colina, V. Izquierdo-Roca, S. Giraldo, P. Pistor & E. Saucedo  
IREC, Sant Adrià de Besòs, Spain  
A. Perez-Rodriguez  
IREC, Barcelona, Spain

**3CV.4.2 Variable-Range Hopping Versus Inter-Grain Tunneling in Cu<sub>2</sub>ZnSn(S<sub>x</sub>Se<sub>1-x</sub>)<sub>4</sub> Thin-Films Prepared by Spray Pyrolysis**  
K.G. Lisunov, L. Bruc, L. Dermenji, N. Curmei, D.A. Sherban, A.V. Simashkevich & E.K. Arushanov  
Academy of Sciences of Moldova, Chisinau, Moldova  
M. Rusu, G. Gurieva, S. Levcenko & S. Schorr  
HZB, Berlin, Germany  
M. Guc  
IREC, Sant Adrià de Besòs, Spain

**3CV.4.3 Introducing the Quality Factor as a Fast and Simple Link between PV Properties and the Crystal CIGS Structure**  
J. Emmelkamp, D. Roosen-Melsen & M. Theelen  
TNO/Solliance, Eindhoven, The Netherlands

**3CV.4.4 On the Interpretation of Photoluminescence and Vibrating Kelvin Probe Method for Quality Control of Cu(In,Ga)(Se,S)<sub>2</sub> Thin Films**  
T. Lavrenko & T. Walter  
Ulm University of Applied Sciences, Germany  
B. Plesz  
Budapest University of Technology and Economics, Hungary

**3CV.4.5 The Negative Influences of Excessive Oxygen Gas on the Electrical Properties of ITO Films Deposited by Magnetron Sputtering**  
X. Tan, A.E. Delahoy & K.K. Chin  
NJIT, Newark, United States  
S. Peng & X. Cao  
Bengbu Design & Research Institute for Glass Industry, Shanghai, China  
J. Pan  
CNBM, Chengdu, China  
X. Wang  
Evans Analytical, Liverpool, United States

**3CV.4.6 Surface Recombination Effects on Thin Films Absorber Characterization Techniques**

B. Bissig, S. Nishiwaki, F. La Mattina, R. Carron,  
J. Löckinger, S. Buecheler & A.N. Tiwari  
EMPA, Dübendorf, Switzerland  
C. Guerra-Nunez & I. Utke  
EMPA, Thun, Switzerland  
P.A. Losio  
ZHAW, Winterthur, Switzerland

**3CV.4.7 Characterization of CZTSe Thin Films for Solar Cell**

O. Bayrakli, H.H. Güllü, M. Terlemezoglu & M. Parlak  
METU, Ankara, Turkey  
E. Coskun  
METU, Canakkale, Turkey

**3CV.4.8 Room Temperature Diffusion in Electroplated Cu/In/Ga Precursor Films**

A. Hovestad, H. Rendering, J. Emmelkamp, F. van Zelst &  
F. van den Bruele  
TNO, Eindhoven, The Netherlands  
K. Bakker  
ECN, Eindhoven, The Netherlands

**3CV.4.9 Fabrication and Characterization of p-CuInSe<sub>2</sub>/n-Si Heterojunction Diodes**

H.H. Güllü, O. Bayrakli, E. Coskun & M. Parlak  
METU, Ankara, Turkey

**3CV.4.10 Investigation of P3 Patterning Approaches in CZTSe Thin Film Solar Cells**

E. Markauskas, P. Gecys & G. Raciukaitis  
Center for Physical Sciences and Technology, Vilnius,  
Lithuania  
I. Repins & C. Beall  
NREL, Golden, United States

**3CV.4.11 CuInSe<sub>2</sub> Nanostructures Prepared by Metal Organic Chemical Vapour Deposition for Hybrid Photovoltaic Devices**

S. Vatavu, N. von Morzé, J. Albert, S. Wiesner, V. Hinrichs,  
M.C. Lux-Steiner & M. Rusu  
HZB, Berlin, Germany

**3CV.4.12 Effects of AZO Thin-Film Thickness and Substrate Temperature on the Characteristics of Cu(In,Ga)Se<sub>2</sub> Solar Cells**

J.-C. Chang, C.-C. Li, W.-S. Lin, L.-T. Cheng, Y.-Y. Wang,  
Y.-F. Chen, S.-W. Chan, C.-R. Huang, T.-P. Hsieh &  
S.-Y. Tsai  
ITRI, Hsinchu, Taiwan

**3CV.4.14 Optimization of Post-Deposition Annealing in Cu<sub>2</sub>ZnSnS<sub>4</sub> Thin Film Solar Cells and Its Impact on Device Performance**

M.G. Sousa & A.F. da Cunha  
University Aveiro, Portugal

**3CV.4.15 Two-Stage Synthesis of CZTS Thin Films and the Influence of Geometry and Sulphur and Tin Sulphide Supply**

S. Mazzamuto, N.M. Pearsall & I. Forbes  
Northumbria University, Newcastle Upon Tyne, United Kingdom  
Z. Wei & T.M. Watson  
Swansea University, United Kingdom  
G. Kissling & L.M. Peter  
University of Bath, United Kingdom

**3CV.4.16 Investigation of Light Induced Metastabilities through Colored Filters on Kesterite Cells**

A. Mittal, T. Dimopoulos & M. Rennhofer  
AIT, Vienna, Austria  
M. Ursprung & L. Plessing  
Crystalsol, Vienna, Austria  
V. Schlosser  
University of Vienna, Austria

**3CV.4.17 The Influence of Sodium in High Ga-Content Cu(In<sub>1-x</sub>Ga<sub>x</sub>)Se<sub>2</sub> (CIGS) Solar Cells**

X. Hao, K.T. Chowdhury, T. Sakurai & K. Akimoto  
University of Tsukuba, Japan  
Y. Kamikawa-Shimizu, S. Ishizuka, A. Yamada & H. Shibata  
AIST, Tsukuba, Japan

**3CV.4.18 Effect of Annealing Temperature on SLSG/Mo/CIGS/CdS/ZnO:Al Heterojunctions**

U. Canci Matur  
Istanbul Technical University, Turkey  
N. Baydogan  
Gedik University, Istanbul, Turkey

**3CV.4.19 Low-Temperature Processing of Cu<sub>2</sub>ZnSnSe<sub>4</sub> Solar Cells on Alkali-Free Polyimide Foils**

I. Becerril-Romero, S. López-Marino, M. Espindola-Rodriguez, M. Neuschitzer, L. Acebo, E. Saucedo & P. Pistor  
IREC, Sant Adria de Besos, Spain

**3CV.4.20 Prospects for Highly-Sensitive Compositional Characterization of Multicomponent CIGS Solar Cells by Field Emission Electron Probe Microanalysis**

T.-Y. Lin, C.-H. Chen, W.-C. Huang & C.-H. Lai  
NTHU, Hsinchu, Taiwan

**3CV.4.21 The Influence of Heating Time and Temperature on the Properties of CIGS<sub>Se</sub> Solar Cells**

M. Flammini, N. Debernardi, M. Le Ster & M. Theelen  
TNO/Solliance, Eindhoven, The Netherlands  
B. Dunne  
NEXCIS, Rousset, France

**3CV.4.22 High-Rate and Low Cost HF/DC-iZnO Sputtering Combination for Cu(In,Ga)Se<sub>2</sub>-Based Thin Film Photovoltaics**

L. Bürkert, M. Oertel & J. Meier  
Manz CIGS Technology, Schwäbisch Hall, Germany

**3CV.4.23 Advanced Light Management in Thin Film Solar Cells**

W. Soppe, D. Zhang & K. van der Werf  
ECN, Eindhoven, The Netherlands  
R. van Swaaij  
Delft University of Technology, The Netherlands  
M. Creatore & B. Williams  
Eindhoven University of Technology, The Netherlands  
Z. Vroon & J. van Deelen  
TNO, Eindhoven, The Netherlands  
B. Crombach  
C-Coatings, Velp, The Netherlands  
R. van Erven  
Morphotonics, Veldhoven, The Netherlands

**3CV.4.24 Fabrication and Characterization of CuZn(In,Ga)Se<sub>3</sub> Solar Cells with Different In/(In+Ga) Ratio**

R. Kondrotas, I. Becerril-Romero, M. Colina Brito,  
Y. Sánchez, F. Oliva, P. Pistor, V. Izquierdo-Roca &  
E. Saucedo  
IREC, Sant Adrià de Besòs, Spain  
X. Alcobé & A. Perez-Rodriguez  
University of Barcelona, Spain

**3CV.4.25 Radiative Substrate Heating during Selenization: the Relation between Absorptivity and the Selenium Content in CIGS**

J. Emmelkamp & D. Roosen-Melsen  
TNO/Solliance, Eindhoven, The Netherlands

**3CV.4.26 Temperature Dependence of Extremely Bright EL Inhomogeneities in CdTe PV Devices**

M. Bokalic, R. Kimovec & M. Topic  
University of Ljubljana, Slovenia  
J.R. Sites  
Colorado State University, Fort Collins, United States

**3CV.4.27 Structural, Morphological, and Optical Properties of Single Step Electrodeposited Cu<sub>2</sub>ZnSnS<sub>4</sub> (CZTS) Thin Films for PV Applications**

H. Kirou, L. Atourki, E.H. Ihalane, A. Elfanaoui, K. Bouabid,  
M. Nya & A. Ihlal  
Ibn Zohr University, Agadir, Morocco

**3CV.4.28 Optical Loss Analysis of CIGS Solar Cells**

O. Kiowski, A. Bauer, P. Jackson & M. Powalla  
ZSW, Stuttgart, Germany

**3CV.4.29 Characterization of (Ag, Cu)<sub>2</sub>ZnSn(S,Se)<sub>4</sub> Kesterite Solar Cell Fabricated by Spray Pyrolysis of Aqueous Precursor Solution**

W.-C. Huang, S.-Y. Wei, C.-H. Cai, T.-Y. Lin & C.-H. Lai  
NTHU, Hsinchu, Taiwan

**3CV.4.30 Study of MoO<sub>x</sub> Back Contact for Low Temperature CdTe Solar Cells on Superstrate Configuration**

E. Artegiani, D. Menossi, F. Piccinelli, S. Di Mare,  
A. Salavei, A. Kumar, G. Mariotto & A. Romeo  
University of Verona, Italy

**3CV.4.31 The Influence of Compound Target Preparation, Sputtering Power and Substrate Temperature on the Achievement of Cu(In,Ga)Se<sub>2</sub> Precursors Suitable to Get High Efficiency Solar Cells**

A. Bosio, G. Rosa & N. Romeo  
University of Parma, Italy  
S. Mazzamuto  
Northumbria University, Newcastle Upon Tyne, United Kingdom

**3CV.4.32 Evolutionary Optimization of TCO/Mesh Electrical Contacts in CIGS Solar Cells**

P.A. Losio & B. Ruhstaller  
ZHAW, Winterthur, Switzerland  
T. Feurer & S. Buecheler  
Empa, Dübendorf, Switzerland

**3CV.4.33 Comparative I-V Study Indoor/Outdoor on a Kesterite-Based Sub-Module**

R. Aninat, D. Guisado-Mariscal, E. Sanchez-Cortezon &  
J.M. Delgado Sánchez  
Abengoa Solar, Sevilla, Spain  
G. Rey & J. Sender  
University of Luxembourg, Belvaux, Luxembourg  
E. Garcia-Llamas  
Autonomous University of Madrid, Spain  
Y. Ren  
Uppsala University, Sweden  
M. Dimitrievska  
IREC, Sant Adrià de Besòs, Spain

**3CV.4.34 Analysis of Build-in Electrostatic Field in CdTe Thin Film Solar Cells by QE Measurements at Bias Voltage**  
L. Feng, L. Wu, X. Li, H. Xu, S. Cao, Q. Shu, W. Li, G. Zeng, J. Zhang & B. Li  
Sichuan University, Chengdu, China

**3CV.4.35 Electrical Properties of the Al/Cu(InGa)Se<sub>2</sub> Junctions: Paving the Way towards Schottky Barrier CIGS Solar Cells?**  
B. Theys, F. Mollica, F. Donsanti & D. Lincot  
CNRS, Chatou, France  
T. Klinkert, E. Leite & M. Jubault  
EDF, Chatou, France

**3CV.4.37 Opto-Electronic Properties of Cu<sub>2</sub>ZnSnS<sub>4</sub> Films Prepared Using Electroplating and CS<sub>2</sub> Sulfurization Process**  
T. Shimizu, K. Nishida, T. Nishida, T. Ito & S. Shingubara  
Kansai University, Osaka, Japan  
K. Takase  
Nihon University, Tokyo, Japan  
C. Wang  
Changchun University of Science and Technology, China  
S. Tanaka  
NICT, Hyogo, Japan

**3CV.4.38 Monolithic Two-Terminal Hybrid a-Si:H/CIGS Tandem Cells**  
J. Blanker, Y.H. Liu, M. Zeman & A. Smets  
Delft University of Technology, The Netherlands  
Z. Vroon  
Solliance/TNO, Eindhoven, The Netherlands

**3CV.4.39 Interface Characterization of ZnS Buffer Layer Prepared by Sulfur Thermal Cracker on Cu(In,Ga)Se<sub>2</sub> Absorber for Photovoltaic Application**  
D.-H. Cho, W.-J. Lee, J.-H. Wi, W.S. Han & Y.-D. Chung  
ETRI, Daejeon, Korea South  
T.G. Kim  
UST, Daejeon, Korea South  
J.W. Kim  
KRISS, Daejeon, Korea South

**3CV.4.40 Fabrication of CIGS Solar Cell with Sputtered Zn(O,S) Buffer Layer**  
T.R. Rana, S.Y. Kim & J.H. Kim  
Incheon National University, Korea South  
K. Kim & J.H. Yun  
KIER, Daejeon, Korea South

**3CV.4.41 CIGS Solar Cell with Sprayed Sn-Doped In<sub>2</sub>S<sub>3</sub> Buffer**  
S.Y. Kim & J.H. Kim  
University of Incheon, Korea South  
K. Kim & J.H. Yun  
KIER, Daejeon, Korea South

**3CV.4.42 Study of Promotion of Antimony Doping to the Crystallization of Cu<sub>2</sub>ZnSnS<sub>4</sub> (CZTS) Films during the Annealing Process**  
X.F. Zhang, Y. Umejima & M. Kobayashi  
Waseda University, Tokyo, Japan

**3CV.4.43 5.3 % Flexible CZTS(Se) Solar Cell Using a Two-Step Etching Process**  
J.-H. Min, K.-Y. Kim, W.-L. Jeong, H.-M. Kwak & D.-S. Lee  
GIST, Gwangju, Korea South

**3CV.4.44 Morphological and Structural Properties of the Uniform Cu<sub>2</sub>ZnSnSe<sub>4</sub> Thin Film Deposited by Sputtering for Solar Cell Application**  
W.-L. Jeong, J.-H. Min & D.-S. Lee  
GIST, Gwangju, Korea South



## NOTES

PROGRAMME

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## Thursday, 23 June 2016

### VISUAL PRESENTATIONS 3DV.1

**08:30 - 09:30 Silicon-based Thin Film Solar Cells and Modules II**

- 3DV.1.1 Periodic, Aperiodic and Random Texturing for Thin-Film Si Solar Cells: a Comparative Study**  
L.V. Mercaldo, I. Usatii, G. Pandolfi & P. Delli Veneri  
ENEA, Portici, Italy  
A. Micco, A. Ricciardi, M. Pisco & A. Cusano  
University of Sannio, Benevento, Italy
  
- 3DV.1.2 Study of Shunt Distributions in Thin Film Multijunction Solar Cells**  
J. Holovsky, T. Finsterle, P. Hrzina, L. Cerná & V. Benda  
CTU Prague, Czech Republic  
J. Klusacek  
ASCR, Prague, Czech Republic  
J.-W. Schüttauf  
EPFL, Neuchâtel, Switzerland
  
- 3DV.1.3 Fabrication of Wide Bandgap p-Type nc-SiC:H Window Layers for Thin-Film Silicon Solar Cells**  
D. Lim, E. Jang, J.H. Park, J. Yoo, S.K. Ahn, K. Yoon & J.-S. Cho  
KIER, Daejeon, Korea South
  
- 3DV.1.4 Changes in Temperature-Coefficient of the Diode Model Caused by Light-Induced Degradation of a-Si/ $\mu\text{c}$ -Si Solar Cells**  
J.A. Weicht, F.U. Hamelmann & G. Behrens  
University of Applied Sciences Bielefeld, Minden, Germany
  
- 3DV.1.5 Bifacial Power Generation of Ultra-Thin and Transparent a-Si:H Film Solar Cells**  
J.W. Lim, G. Kim & S.J. Yun  
ETRI, Daejeon, Korea South  
M. Shin  
Korea Aerospace University, Goyang, Korea South
  
- 3DV.1.6 Electron Beam Crystallization of Amorphous Silicon Thin Films in the Solid Phase Regime and Assisted Simulations by Finite Element Method**  
S. Saager  
Fraunhofer FEP, Dresden, Germany
  
- 3DV.1.7 Surface Texturization of Glass: a New and Innovative Way to Improve the Light Management in Superstrate Type Thin Film Solar Cell**  
G. Das, S. Bose, S. Mandal, S. Dhar, S. Mukhopadhyay, C. Banerjee & A.K. Barua  
IEST Shibpur, Howrah, India

PROGRAMME

- 3DV.1.8 Laser Ablation of Sub-Stoichiometric Silicon Oxide for Rear Side of PERC Thin Si Solar Cells**  
F. Gérenton, F. Mandorlo, E. Fourmond & M. Lemiti  
INSA Lyon, Villeurbanne, France
- 3DV.1.9 Industrial Scale Optimization of SiO<sub>x</sub> Bottom n-Layer in Tandem Solar Cell**  
G. Condorelli, A. Battaglia, A. Canino & D. Rapisarda  
3Sun, Catania, Italy  
M. Foti  
ST Microelectronics, Catania, Italy  
C. Gerardi  
Enel Green Power, Catania, Italy
- 3DV.1.10 An Equivalent Circuit Solar Cell Model**  
B.E. Pieters  
Forschungszentrum Jülich, Germany
- 3DV.1.11 Development of Well Dispersed Tapered ITO Nanorods as a Potential Light Trapping Structure for Amorphous Silicon Based Solar Cells**  
S. Dhar, C. Banerjee & A.K. Barua  
IEST, Howrah, India
- 3DV.1.12 Comparison between Structural and Optical Properties of Aluminium- and Cobalt-Doped Zinc Oxide Thin Films Prepared by RF Sputtering**  
M. Chaik, C. Sambeval, H. El Aakib & A. Outzourhit  
Cadi Ayyad University, Marrakech, Morocco
- 3DV.1.13 Temperature during the Formation of Reverse-Bias Breakdown Defects in Thin Film Modules**  
V. Payak, G. Olivera Pimentel, Y. Augarten, A. Gerber & B.E. Pieters  
Forschungszentrum Jülich, Germany
- 3DV.1.14 Subbandgap Absorption Spectroscopy of Thin Film Photovoltaic Materials**  
J. Holovsky & A. Purkrt  
ASCR, Prague, Czech Republic  
M. Stuckelberger & M. Bertoni  
ASU, Tempe, United States  
T. Finsterle, L. Musálek & V. Benda  
CTU, Prague, Czech Republic  
F.-J. Haug  
EPFL, Neuchâtel, Switzerland

- 3DV.1.15 Solar Cells and Mini-Modules Based on 40 µm-Thick Epitaxial Si Foils: Towards Conductive Bonding onto Low-Cost Si Powder Sintered Supporting Substrates**  
H. Sivaramakrishnan Radhakrishnan,  
K. Van Nieuwenhuysen, J. Govaerts, V. Depauw, T. Bearda,  
M. Debucquoy, I. Gordon, J. Szlufcik & J. Poortmans  
imec, Leuven, Belgium  
R. Roozeman & J. Heikkinen  
INKRON, Esbo, Finland  
M. Schumann  
Fraunhofer THM, Freiburg, Germany  
R. Buchwald & H.J. Möller  
Fraunhofer THM, Freiburg, Germany  
A. Ciftja, G. Stokkan & E.-J. Øvrelid  
SINTEF, Trondheim, Norway  
A. Stonkus, P. Dubravskij & J. Ulbikas  
Applied Research Institute for Prospective Technologies,  
Vilnius, Lithuania  
A. Ulyashin  
SINTEF, Oslo, Norway
- 3DV.1.16 Characterization of Doped Polycrystalline Silicon Thin Films Obtained by RF-Sputtering Deposition and Crystallization of Amorphous Silicon**  
A. Pacio, H. Juárez Santiesteban, M. Pacio & J.A. Garcia  
BUAP, Puebla, Mexico  
N. Budini  
National University of Littoral, Santa Fe, Argentina  
X. Mathew  
UNAM, Temixco, Mexico
- 3DV.1.17 Two-Dimensional Characterization of Active Dopant Distribution in a p-i-n Structured Amorphous Silicon Solar Cell Using Scanning Nonlinear Dielectric Microscopy**  
K. Hirose, N. Chinone & Y. Cho  
Tohoku University, Sendai, Japan
- 3DV.1.19 Deposition of Amorphous and Microcrystalline Silicon in Very High Frequency Range Up to 140 Mhz**  
B. Leszczynska, C. Strobel, S. Leszczynski, D.D. Fischer,  
M. Albert & J.W. Bartha  
Technical University of Dresden, Germany  
U. Stephan & J. Kuske  
FAP, Dresden, Germany

**VISUAL PRESENTATIONS 3DV.2**

**13:30 - 15:00 Perovskite, Organic and Hybrid Devices**

**3DV.2.1 Energy Yield Modelling of Perovskite/Silicon Multijunction Solar Cells**

U.-W. Paetzold, R. Gehlhaar, J.G. Tait, M. Debucquoy, M. Jaysankar, T. Aernouts & J. Poortmans  
imec, Leuven, Belgium

**3DV.2.2 Design of Perovskite/Crystalline-Silicon Tandem Solar Cells**

S. Altazin & L. Stepanova  
Fluxim, Winterthur, Switzerland  
K. Lapagna, P. Losio & B. Ruhstaller  
ZHAW, Winterthur, Switzerland  
J. Werner, B. Niesen, A. Dabirian, M. Morales Masis, S. De Wolf & C. Ballif  
EPFL, Neuchâtel, Switzerland

**3DV.2.3 Dye-Sensitized/c-Si and Perovskite/c-Si Tandem Solar Cells**

M.F. Vildanova, A.B. Nikolskaia, S.S. Kozlov & O.I. Shevaleevskiy  
RAS, Moscow, Russia

**3DV.2.6 Trap and Recombination Centers Study in Organolead Halide Perovskites**

G. Gordillo, C.A. Otalora, F.E. Guzmán & A.A. Ramírez  
National University of Colombia, Bogotá, Colombia

**3DV.2.12 Spectroscopic Ellipsometry Study of Soluble Organic-Inorganic Halide  $\text{FAPb}(\text{I}_x\text{Br}_{1-x})_3$  Perovskite Thin-Film Solar Cells**

T. Yamanaka, K. Uchiumi, K. Usuba, S. Funada, R. Ishikawa & H. Shirai  
Saitama University, Japan

**3DV.2.13 Perovskite Solar Cell Based on  $\text{CH}_3\text{NH}_3\text{PbI}_3\text{-}2\text{Cl}_2$  /  $\text{PC}_61\text{BM}$**

J. Vanek, D. Strachala, J. Hylsky, M. Kadlec, M. Sionova & M. Weiter  
Brno University of Technology, Czech Republic

**3DV.2.14 Processing and Optimization of the Perovskite Solar Cell Based on  $\text{PEDOT:PSS/CH}_3\text{NH}_3\text{PbI}_3\text{-XCIX}$**

M. Kadlec, J. Vanek, D. Strachala, M. Sionova & M. Weiter  
Brno University of Technology, Czech Republic

**3DV.2.15 Interfacial Engineering of Organic/Silicon Heterojunction Solar Cells Enables an Ultra-High Open-Circuit Voltage Beyond 660 mV**

H. Jian, G. Pingqi & Y. Jichun  
Chinese Academy of Science, Ningbo, China

**3DV.2.16 Highly Efficient Perovskite Solar Cell Based on ZnO Nanorods through Interface Engineering**

S. Li, P. Zhang, Y. Wang, D. Liu, Y. Yang, Z. Wu & Z.D. Chen  
UESTC, Chengdu, China  
H. Sarvari  
University of Kentucky, Lexington, United States  
J. Wu  
University College London, United Kingdom

**3DV.2.17 Threshold Trap Density for Valid Mott-Schottky Analysis in Carrier Selective Optoelectronic Devices**

V. Nandal & P.R. Nair  
IIT Bombay, Mumbai, India

**3DV.2.18 Organolead Halide Perovskite Solar Cells**

A.M. Jafar, F. Mustafa Al-Attar & M.K. Kalaf  
Ministry of Science and Technology, Baghdad, Iraq  
M.H. Suhail  
University of Baghdad, Iraq

**3DV.2.19 Morphological Differences with Solvent Treatment and Additives in Organic-Inorganic Halide Perovskite Solar Cells**

A. Kanwat, H.P. Kim & J. Jang  
Kyung Hee University, Seoul, Korea South

**3DV.2.20 Conductive Inks with Epoxy Resin Based Vehicles for Perovskite Screen Printing Metallization**

C. Montes, A. Linares, E. Llarena, O. González, D. Molina, A. Pío, L. Ocaña, C. Quinto, M. Friend & M. Cendagorta-Galarza López  
ITER, Granadilla de Abona, Spain

**3DV.2.24 Development and Optimization of the Blocking Layers in Perovskite Based Solar Cells**

K. Habashy, V. Steenhoff, M. Vehse & C. Agert  
Next Energy, Oldenburg, Germany

**3DV.2.25 Low Temperature Solution-Processed NiOx Nanoparticles for High Efficiency Perovskite Solar Cells**

C.-C. Cheng, M.-H. Jao & W.-F. Su  
NTU, Taipei, Taiwan

**3DV.2.26 Optimizing the Deposition of Thin Layers of Organic-Inorganic Hybrid Perovskite Methylammonium Lead Iodide (CH<sub>3</sub>NH<sub>3</sub>PbI<sub>3</sub>) on Large Surfaces through Their Optical Properties**

L. Ocaña, C. Quinto, C. Montes, E. Llarena, O. González, D. Molina, A. Pío, M. Friend & M. Cendagorta-Galarza López  
ITER, Granadilla de Abona, Spain  
A. Linares  
AIET, Granadilla de Abona, Spain  
C. Hernandez-Rodriguez, S. González-Pérez & R. Guerrero-Lemus  
ULL, La Laguna, Spain

**3DV.2.28 Carrier Dynamics and Ionic Motion in CH<sub>3</sub>NH<sub>3</sub>Pb(I,Br)<sub>3</sub> Probed by Nanometer-Scale Charge Transport and Surface Potential Microscopy**

H.R. Jung, B.P. Nguyen, G.Y. Kim & W. Jo  
Ewha Womans University, Seoul, Korea South

**3DV.2.29 Effect of Temperature on the Stability of Methylammonium Lead Iodide Perovskite Solar Cells**

S. Kim, S. Bae, T. Chung, S.W. Lee, K. Cho, S.H. Lee, Y. Kang, H.-S. Lee & D. Kim  
Korea University, Seoul, Korea South

**3DV.2.31 Grain Size Enhancement of Perovskite by Five Times with Polystyrene Doping for High Performances Perovskite Solar Cell**

H.P. Kim, A. Kanwat, S.R. Vasa, A.R. bin Mohd Yusoff & J. Jang  
Kyung Hee University, Seoul, Korea South

**3DV.2.32 Highly Sensitive Organic Photodetector Based on Si/NiPcTS/PEDOT:PSS Bulk Hetrojunction Blend**

M.A. Abood, F.I. Mustafa Al-Attar & I.M. Al-Essa  
Ministry of Science and Technology, Baghdad, Iraq

**3DV.2.34 Direct Laser Patterning of Transparent Electrodes on Barrier Film and Evaluation by a Novel 2D Damage Visualization Method**

H. Fledderus, H.B. Akkerman, A.P. Langen, R.J. Abbel, W.H. Manders & P. Groen  
TNO, Eindhoven, The Netherlands  
N.F. Schilling  
Fraunhofer IWS, Dresden, Germany

**3DV.2.35 Selective Laser Structuring of Organic Solar Cells on Flexible Substrates for Roll to Roll Production**

A. Gavrilova, R. Moser, H.P. Huber & J. Winter  
Munich University of Applied Sciences, Germany  
P. Kubis  
ZAE Bayern, Nuremberg, Germany  
S. Geiger & I. Richter  
InnoLas, Munich, Germany

**3DV.2.36 Band Gap Tunable Benzodithiophene-Based Copolymers with Active Layer Thickness Tolerance for Organic Solar Cells**

S.-J. Moon, T.T.T. Bui, S. K. Lee, W. S. Shin, J.C. Lee & C.E. Song  
KRICT, Daejeon, Korea South

**3DV.2.37 Improvement in Performance and Stability of Large-Area Printed Inverted Polymer Solar Cells and Modules**

Y.-C. Huang, H.-C. Cha, Z.-L. Yu, D.-H. Lu, C.-T. Yen, T.-Y. Chung, Y.-M. Sung, Y.-H. Su, C.-M. Chuang, C.Y. Chen & C.-S. Tsao  
INER, Longtan, Taiwan

**3DV.2.38 Homogeneous and Efficient Co-Evaporated MoO<sub>3</sub>:CuI Anode Buffer Layer for Organic Solar Cells**

M. Hssein, L. Cattin, G. Louarn & J.C. Bennède  
University of Nantes, France  
L. Barkat & A. Khelil  
University of Oran, Algeria  
M. Addou  
Ibn Tofail University, Kenitra, Morocco

**3DV.2.39 Triazoloquinoline Bearing Copolymer for Electrochromic and Organic Photovoltaic Applications**

S. Ozdemir Hacioglu, E. Aktas, G. Hizalan, N. Akbasoglu Unlu, A. Cirpan & L. Toppare  
METU, Ankara, Turkey

**3DV.2.40 The Effects of Different PCBM Derivatives on the Performance of P3HT:PCBM Organic Solar Cells**

B. Kadem, A. Hassan & W. Cranton  
Sheffield Hallam University, United Kingdom

**3DV.2.41 Alkyl Chain Tunability of DPP-Based Small Molecules for Solution-Processed Organic Solar Cells**

J.C. Lee, C.E. Song, S.R. Sanjaykumar, G.P. Kini, S. K. Lee, W. S. Shin & S.-J. Moon  
KRICT, Daejeon, Korea South

**3DV.2.42 Durability in Organic Solar Cells under Illumination through Long-Pass Filter**

H. Sato & K. Harafuji  
Ritsumeikan University, Kusatsu, Japan

**3DV.2.43 Structure Engineering of Solution Processable Small Molecules for Organic Solar Cells**

S. K. Lee, W. S. Shin, J.C. Lee, C.E. Song & S.-J. Moon  
KRICT, Daejeon, Korea South

**3DV.2.44 Enhancement of Power Conversion Efficiency of Dye Sensitized Solar Cells by Hybrid Polymer Composite of Nanocrystalline Rare Earth Oxides**

M. Ubaidullah & T. Ahmad  
Jamia Millia Islamia, New Delhi, India

**3DV.2.45 Performance Studies of Dye-Sensitized Solar Cell (DSSC) by Swift Heavy Ion (SHI) Irradiation**

H.K. Singh  
Modi Engineering College, Modinagar, India  
D.K. Avasthi  
Inter University Accelerator Center, New Delhi, India  
S. Aggarwal,  
GGS Indraprastha University, New Delhi, India

**3DV.2.46 Study on Dye-Sensitized Solar Cells Module Durability Optimization with Liquid Electrolyte**

S.I. Park, C. Han, S.-I. Chan & C. Han  
KETI, Seongnam-si, Korea South

**3DV.2.47 Liquid Phase Exfoliated Graphene Nanoplatelets as a Low Cost Counter Electrode for Dye-Sensitized Solar Cells**

S. Sankar, S. Prathapani, P. Bhargava, S. Bohm & S. Mallick  
IIT Bombay, Mumbai, India

**3DV.2.48 Dye Sensitized Solar Cells Prototyped Using Glass Capillaries as Support**

M. Gheorghe & S. Gheorghe  
NANOM MEMS, Rasnov, Romania  
N. Olariu & G. Mantescu  
Valahia University of Targoviste, Romania

**3DV.2.49 Titanium Oxide Films Deposited by E-Beam Evaporation**

R. Chierchia, P. Mangiapane, L. Serenelli, F. Menchini & M. Tucci  
ENEA, Rome, Italy

**3DV.2.50 PEDOT:PSS/rGO/CuNWs Based Counter Electrode for Use in DSSCs**

A.S. Shikoh, Z. Ahmed, F. Touati, R.A. Shakoor & M.A. Benammar  
Qatar University, Doha, Qatar  
Z. Zhu, T.S. Mankowski, M.A. Mansuripur & C.M. Falco  
University of Arizona, Tucson, United States

**3DV.2.51 Broadband and Omnidirectional Light Harvesting Enhancement of Dye-Sensitized Solar Cells**

M.-Y. Hsieh & S.-Y. Kuo  
Chang Gung University, Taoyuan, Taiwan

**3DV.2.52 Performance of ZnO-Based Dye Sensitized Solar Cells Fabricated with Natural Dye Extracts from Musa Paradisiaca and Carica Papaya Peels as Sensitizers**

A. Oluwaseun, M.K. Awodele & A.O. Awodugba  
LAUTECH, Ogbomoso, Nigeria

**3DV.2.53 Investigation of Photoluminescence Quenching in P3HT Induced by Holmium Doped ZnO Nanostructures**

G.L. Kabongo, P.S. Mbule, B.M. Mothudi & M.S. Dhlamini  
University of South Africa, Pretoria, South Africa  
G.H. Mhlongo & K.T. Hillie  
CSIR, Pretoria, South Africa

**3DV.2.54 All-Solution Processes for Manufacturing Photoelectrodes and Dye-Sensitized Solar Cells Using Inkjet Printing Technology**

C.-T. Chen & B.-C. Hu  
KUAS, Kaohsiung, Taiwan

**3DV.2.55 Preventing UV Degradation in Dye Sensitized Solar Cells**

G. Gava Sonai & A.F. Nogueira  
University of Campinas, Brazil  
A. Tiihonen, K. Miettunen & P. Lund  
Aalto University, Espoo, Finland

**3DV.2.56 Dye-Sensitized Solar Cells Integrated onto Transparent Cellulose-Based Substrates**

M. Özkan, S.G. Hashmi, M. Borghei, O. Rojas, P.D. Lund & J. Paltakari  
Aalto University, Espoo, Finland  
K. Lobato  
University of Lisbon, Portugal  
A. da Cunha  
University Aveiro, Portugal

**3DV.2.57 Ga-Doped Zinc Oxide Films as Transparent and Conductive Substrates Applying in Dye-Sensitized Solar Cell**

C. Li & S. Hou  
Kochi University of Technology, Kami, Japan

**3DV.2.58 Requirement of Durability Test for Organic Photovoltaic and Dye-Sensitized Solar Cell**

S.-T. Hsu, Y.-S. Long & T.-C. Wu  
ITRI, Hsinchu, Taiwan

**3DV.2.59 A Case Study of Developing Semi Standards for Organic Photovoltaic and Dye-Sensitized Solar Cell in Taiwan**

S.-T. Hsu, Y.-S. Long & T.-C. Wu  
ITRI, Hsinchu, Taiwan

**3DV.2.62 The Effect of Temperature on the Growth of High Quality Cadmium Sulfide Thin Films by RF Magnetron Sputtering for Solar Cell Applications**

T.H. Chowdhury, M.A.A. Wadi, N.K. Kamaruddin, A.K.M. Hasan, N. Amin, M.H. Ruslan, K. Sopian & M. Akhtaruzzaman  
National University of Malaysia, Bangi, Malaysia  
I.M. Bedja  
King Saud University, Riyadh, Saudi Arabia  
A. Islam  
NIMS, Tsukuba, Japan

**3DV.2.63 Characteristics of Emerging PV under Levels Lighting Indoor**

Y.-S. Long, S.-T. Hsu & T.-C. Wu  
ITRI, Hsinchu, Taiwan

**3DV.2.64 3-Dimensional Organic Thin-Film Solar Cell Fabricated by Electropray Deposition**

Y. Tajima, H. Takaku, H. Hayakawa & T. Aoyama  
RIKEN, Wako, Japan

**3DV.2.65 Carbon Nanotube-Assisted Recombination Reduction in Perovskite Solar Cells**

H. Wang  
Queensland University of Technology, Brisbane, Australia

**3DV.2.66 Extremely Thin Absorber Methylammonium Tin Iodide Perovskite Heterojunction Solar Cell with ZnO-ZnO<sub>1-x</sub>S<sub>x</sub> Core-Shell Nanorods as Graded Bandgap Electron Transport Layer**

F. Ballipinar, R.R. Thankalekshmi & A.C. Rastogi  
Binghamton University, United States

**VISUAL PRESENTATIONS 2DV.3**

15:15 - 16:45 Silicon Feedstock, Crystallisation and Wafering

**2DV.3.1 Scrap Recycling in an Electromagnetic Cold Crucible Furnace**

J.M. Míguez Novoa, G. Varela & R. Ordás Badia  
Silicio FerroSolar, Arteixo, Spain  
N. Pourade & F. Bouille  
EMIX, Saint Maurice la Souterraine, France

**2DV.3.2 Recent Results for the Silicio Ferrosolar UMG-Silicon Feedstock**

E. Zugasti, J. Armentia, M. Ezquer Mayo, M. Murillo, M.J. Rodriguez & A.R. Lagunas  
CENER, Sarriguren-Navarra, Spain  
J. Diéguez, J.M. Míguez Novoa & R. Ordás Badia  
Silicio FerroSolar, Arteixo, Spain

**2DV.3.3 Neutron Activation Analyses (NAA) Investigation of Transition-Metal Impurities Contents in Solar Grade Silicon Feedstock for Directional Solidification of Photovoltaic HEM Silicon Ingot**

Y. Chettat & A. Lami  
CRTSE, Algiers, Algeria  
L. Hamidatou, M. Salhi & H. Slamene  
CRNB, Djelfa, Algeria  
A. Benmounah  
UR-MPE, Boumerdès, Algeria

**2DV.3.4 Mathematical Modeling of Metallurgical-Grade Silicon Plasma-Chemical Purification Process**

S.M. Karabanov, D.V. Suvorov, D.Y. Tarabrin, E.V. Slivkin & G.P. Gololobov  
RSREU, Ryazan, Russia  
V.I. Yasevich & A.S. Karabanov  
Energy Ryazan, Russia

**2DV.3.5 Performance of FBR Blended CZ Wafers**

O. Nordseth, R. Søndena, C.C. You, M.S. Wiig, J. Zhu, B. Thomassen & S.E. Foss  
Institute for Energy Technology, Kjeller, Norway  
Y. Boulfrad  
Norwegian Crystals, Glomfjord, Norway  
G. Garrett  
REC Solar, Houston, United States

**2DV.3.6 Peering into Operating Polysilicon Reactors with a Suite of Online Instruments**

T.J. Preston, H. Klette, G.M. Wyller, E.S. Marstein, W.O. Filtvedt & T.T. Mongstad  
IFE, Kjeller, Norway

**2DV.3.7 Silicon Production by Centrifuge CVD Reactor on the Way to Industrial Verification**

W.O. Filtvedt & H. Klette  
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J. Safarian & G. Tranell  
NTNU, Trondheim, Norway

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Al. Kravtsov & An. Kravtsov  
KEPP-EU, Riga, Latvia

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UNICAMP, Campinas, Brazil

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H.V. Skarstad, A. Autruffe & M. Di Sabatino  
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G. Stokkan  
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Q. Wang & W. Chen  
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C. Reimann & M. Trempa  
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T. Lehmann  
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C. Löbel, L. Sylla & T. Richter  
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K.E. Ekstrøm & M. Di Sabatino  
NTNU, Trondheim, Norway

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J. Haunschild & R. Preu  
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B. Jang, H. Moon, S. Choi, S. Park & J. Kim  
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Georgia Institute of Technology, Atlanta, United States

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S. Kaminski & C. Arcona  
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S. Teske  
University of Technology Sydney, Australia

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S. Tselepis  
CRES, Athens, Greece

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S. Woess-Gallasch & D. Steiner  
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Arbeitsgemeinschaft Erneuerbare Energie Salzburg, Austria  
G. Korpitsch & M. Auer  
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W. Aichinger  
EAG, Salzburg, Austria

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A.P. Sanfilippo & L. Pederson  
Qatar Foundation, Doha, Qatar

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P.P. Bezrukikh  
RSREU, Ryazan, Russia  
S.M. Karabanov  
G.M. Krzhizhanovsky Power Engineering Institute, Moscow, Russia  
P.P.jr. Bezrukikh  
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A. Aghahosseini  
Lappeenranta University of Technology (LUT), Finland  
D. Bogdanov & C. Breyer  
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Becquerel Institute, Brussels, Belgium  
C. Werner  
Chris Werner Energy Consulting, Dessau, Germany

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JST, Tokyo, Japan

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Shahid Beheshti University, Tehran, Iran  
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L. Nespoli, G. Corbellini & V. Medici  
SUPSI, Canobbio, Switzerland

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Heliocentric Solutions, London, United Kingdom  
H.S. Nguyen  
INL, Ecully, France

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Austrian Institute of Technology, Vienna, Austria

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A. Khalid  
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T. Alghasham  
MEDAD Technologies, Dubai, United Arab Emirates  
K.C. Ng  
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Strathmore University, Nairobi, Kenya

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University of Jaén, Spain

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KNUST, Kumasi, Ghana

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S.S. Chandel  
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University of Leeds, United Kingdom

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European Patent Office, Rijswijk, The Netherlands

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## PARALLEL EVENTS

For more information please refer to  
[www.photovoltic-conference.com/parallel-events](http://www.photovoltic-conference.com/parallel-events)

## PARALLEL EVENTS

The EU PVSEC Parallel Events are open to all registered Conference Participants of the EU PVSEC 2016.

For detailed information and programme please visit [www.photovoltaic-conference.com/parallel-events](http://www.photovoltaic-conference.com/parallel-events).

## Monday, 20 June 2016

13:30 - 17:30

**Enhancing PV Competitiveness with Energy Storage**

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) - IEA PVPS Task 1

## Tuesday, 21 June 2016

08:30 - 12:30

**Acceleration of BIPV by international collaboration**

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) - IEA PVPS Task 15, Zuyd Applied University and the Becquerel Institute

13:30 - 17:30

**PV End-of-Life Management: Challenges and Opportunities**

jointly with IRENA – International Renewable Energy Agency and the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) - IEA PVPS Task 12



## Wednesday, 22 June 2016

08:30 - 12:30

**Solar PV: Changing our energy system**

jointly with IRENA – International Renewable Energy Agency

13:30 - 17:45

**PV Production, Quality, and Innovation Forum**

jointly produced by SOLARUNITED and the Becquerel Institute

13:30 - 18:30

**PHOTOVOLTAICS | FORMS | LANDSCAPES  
Beauty and power of designed Photovoltaics**

jointly with EC-JRC, ENEA and ETA-Florence Renewable Energies

## Thursday, 23 June 2016

08:30 - 18:00

**7th International Workshop on CIGS Solar Cell Technology  
(IW-CIGSTech 7)**

jointly organized by Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (HZB) and Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)



etaflorence \* renewableenergies



## Enhancing PV Competitiveness with Energy Storage

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) - IEA PVPS Task 1

**Day:** Monday, 20 June 2016

**Time:** 13:30 - 17:30

**Site:** Ground Floor, Auditorium Room 4

**Access:** Open to all registered Conference participants of the EU PVSEC 2016

Grid parity has been reached in some market segments but the real competitiveness of PV solutions has not been achieved yet everywhere. This workshop aims at redefining the concepts of competitiveness for PV solutions in the light of the last self-consumption regulations and the super-competitive tenders seen in Germany, India, the USA, the UAE or recently in Peru. In addition, the shift towards decentralized PV that several countries are attempting requires an in-depth look into the possibilities of energy storage, through batteries, but also energy storage in buildings or embedded in the grid.



### Programme Outline

13:30

#### **Welcome Speech & the Role of the IEA PVPS Program**

Stefan Nowak - IEA-PVPS Chairman

#### **Key note Speech**

Cédric Philibert - IEA (invited)

#### **Session 1 – From grid parity to Competitiveness**

This session will explore the questions of competitiveness of PV through its main aspects: the declining PV system prices through learning curve analysis, the evolution of LCOE in the coming years and its drivers. The question of competitiveness will be approached through regulatory aspects, technical aspects including the impact on grid costs and electricity integration aspects.

**A review of grid parity dynamics**

Christian Breyer (invited) - LUT

**Competitiveness of PV systems in Europe**

Eero Vartianen (invited) - Fortum

**Perspectives for cost decline in the PV industry**

Linda Koschier (invited) - UNSW

**A reality below competitive tenders**

Fabrizio Binatti (invited) - Enel Green Power

15.00 Coffee-Break

15:30

**Session 2 – Enhanced Competitiveness with Storage Options**

This session will explore how storage can support PV development. The experience from short-term distributed storage in Germany will be detailed. The options for energy storage in the buildings or electric vehicles will be assessed while the question of embedding storage inside the grid to support PV development will be questioned. At the end the question of storage technologies and competitiveness will be discussed.

**PV plus electricity storage**

Izumi Kaizuka – RTS Corporation

**PV with pump-hydro storage**

Lv Fang – Chinese Academy of Sciences

**Enhancing PV competitiveness with energy storage in buildings**

Pedro Vicente Quiles – UMH (invited)

**Virtual storage and innovative financial business models**

tbd

17:00

**Closing Speech**

Stefan Nowak - IEA-PVPS Chairman, Net Energy

Contact for further information:

Gaëtan Masson, Task 1 Operating Agent [g.masson@iea-pvps.org](mailto:g.masson@iea-pvps.org)**Acceleration of BIPV by international collaboration**

jointly with the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) - IEA PVPS Task 15, Zuyd Applied University and the Becquerel Institute

**Day:** Tuesday, 21 June 2016**Time:** 08:30 - 12:30**Site:** Ground Floor, Auditorium Room 4**Access:** Open to all registered Conference participants of the EU PVSEC 2016

BIPV is seen as one of the key development tracks of PV towards mass application. To facilitate this key development, a number of international collaborative initiatives are undertaken. In this interactive seminar, a number of international collaboration projects and platforms will be presented, with the aim to pinpoint the next step in international needs for collaboration.

**Programme Outline**

08:30 - 10:00

**International collaboration on BIPV**

- **Opening session 1**  
Adel El Gammal, Becquerel Institute
- **Overview on international BIPV research activities**  
Pierluigi Bonomo, SUPSI
- **IEA PVPS Task 15, Acceleration of BIPV**  
Michiel Ritzen, Zuyd University
- **BIPV “Custom Fit”; a Dutch Belgium German research collaboration**  
Ando Kuypers, Solliance
- **PVSITES project: Building-integrated photovoltaic technologies and systems for large-scale market deployment**  
Maider Machado, Tecnalia

10:00 - 10:30 Break

10:30 - 12:30

**Developments in BIPV research projects, mayor industrial actors**

- **Opening session 2**  
Zeger Vroon, Zuyd University/Solliance
- **BIPV innovative business models**  
Adel El Gammal, Becquerel Institute
- **Market assessment for thin film BIPV**  
Menno van den Donker, SEAC
- **OPV in mass BIPV applications**  
David Mueller, Merck Group
- **A low cost BIPV approach for mass market**  
Valerick Cassagne, Total
- **Panel Discussion: BIPV from Architectural to mass market applications**

**Closing Speech**

Stefan Nowak, IEA-PVPS Chairman, Net Energy

Contact for further information: Zeger.vroon@zuyd.nl

**PV End-of-Life Management: Challenges and Opportunities**

jointly with IRENA – International Renewable Energy Agency and the International Energy Agency Photovoltaic Power Systems Programme (IEA PVPS) - IEA PVPS Task 12

**Day:** Tuesday, 21 June 2016**Time:** 13:30 - 17:30**Site:** Ground Floor, Auditorium Room 4**Access:** Open to all registered Conference participants of the EU PVSEC 2016**Programme Outline**

13:30 - 13:40

**Welcome Remarks**

- Stephanie Weckend, Programme Officer, KPFC, IRENA,
- Andreas Wade, Vice-Chair Strategy Committee SolarPower Europe / Deputy Operating Agent IEA-PVPS Task 12

13:40 - 14:00

**Official Launch of the IRENA IEA PVPS Task 12 Report “End-of-Life Management: Solar Photovoltaic Panels”**

- Henning Wuester, Director, Knowledge Policy and Finance Centre, IRENA (10 min)
- Stefan Nowak, Chair, IEA PVPS (10 min)

14.00 - 14:30

**Main findings of the Report – Waste projections, Panel compositions, Waste classification (25 min presentation, 5 min Q&A)**

- Dr. Karsten Wambach (bifa)
- Andreas Wade



14:30 - 15:45

**Panel Discussion – Country/Regional Approaches to PV Waste Management – Examples from the Report**

Moderator: Stephanie Weckend

(15 min presentation, 15 min Q&A at the end)

- EU (Alexandre Roesch, SolarPower Europe, Belgium)
- Japan (Keiichi Komoto, Mizuho Information & Research Institute, Japan)
- US (Prof. Vasilis Fthenakis, Brookhaven National Laboratories, USA)
- Germany (representative from the BMU – tbc)

15:45 - 17:00

**Panel Discussion – Emerging Opportunities for the Private Sector**

Moderator: Andreas Wade

(10 min presentation, 20 min Q&A at the end)

- Perspectives from a pan European Producer Compliance Scheme (Jan Clyncke, PV CYCLE, Belgium)
- Perspectives from a recycling technology solution provider (Dr. Wolfram Palitzsch, Loser Chemie, Germany)
- Perspectives from a PV Producer & Recycler (Andreas Wade, First Solar)
- Perspectives from the Glass/Metals Recycling Industry (tbc)

17:00 - 17:10

**Closing Remarks**

**Solar PV: Changing our energy system**

jointly with IRENA – International Renewable Energy Agency

**Day:** Wednesday, 22 June 2016

**Time:** 08:30 - 12:30

**Site:** Ground Floor, Auditorium Room 4

**Access:** Open to all registered Conference participants of the EU PVSEC 2016

Solar PV has become a key energy technology. Continuous innovation and deployment have seen deployment levels grow from 38 GW to more than 230 GW in the last five years, driven by solar PV module price declines of up to 80% between the end of 2009 and 2015. In both developed and developing countries, large-scale utility-scale solar PV systems have beaten new gas- or coal-fired power stations in terms of costs. Rooftop solar PV systems provide households with cheaper electricity than buying electricity from the grid. Innovative solutions like solar lights and solar home systems are providing cheap electricity to non-electrified regions in Africa and Asia

Solar PV is truly changing our energy system. However, with this transformation comes new challenges that need to be addressed if the rapid growth in solar PV is to continue. How do we ensure that solar PV becomes the preferred power source to satisfy future electricity demand? Solar PV has the potential (1550 GW by 2030 in the latest IRENA vision), but it is by no means a certainty and for its potential to be fully realized policy makers, regulators and investors need to set and operate in the right business, legal and regulatory environment.

Part of the solution must also be continued rapid technology progress and innovation, both learning-by-doing for monocrystalline and polycrystalline cell production and performance, as well as new technologies and materials based on fundamental R&D efforts. Systems integration and sector coupling creates new technology challenges such as the need for greater system flexibility, while electricity storage will become important early for islands and other small isolated networks and could be important in the longer term for large integrated networks as well. This will be happening against a backdrop where localised electricity production by solar PV systems will likely be cheaper than electricity from centralised power stations further away, pushing today's utility model to its limit.

IRENA has undertaken analysis to provide a solid and compelling outlook for solar PV, and inform policy makers and the general audience of the transformative power provided by solar PV, as well as many of the many technology innovations needed. The scope of analysis is global, but is centered on two questions:

- What are the opportunities and challenges for solar PV in electricity systems with stagnating versus expanding electricity needs?
- What will the importance be of distributed versus centralised solar PV systems within these different constituencies?

Join the IRENA / EU PVSEC Parallel Event to hear about recent research and work by IRENA and others into the issues facing the continued accelerated installation of solar PV, with a focus on:

- The evolution of Solar PV in growing and stagnating electricity markets
- Recent and future trends in innovation for solar PV and the enabling technologies for high shares of variable renewables
- The right enabling policies to support solar PV, the transition to a sustainable energy sector, as well as the regulatory and market changes required



## Programme Outline

08:30 - 08:45

### Welcome and Introduction

- Dolf Gielen, Director of IRENA Innovation and Technology Centre, IRENA

08:45 - 09:30

### Solar PV: A tale of two markets

Opportunities and challenges for solar PV in electricity systems with stagnating versus expanding electricity needs, the importance be of distributed versus centralised solar PV systems.

- **Solar PV market expert** (confirmed)  
Gaëtan Masson, Founder & Director, Becquerel Institute
- **Innovation and cost reduction potential of solar PV to 2025**  
Michael Taylor, Senior Analyst, IRENA (confirmed)

09:30 - 09:50 Coffee Break

09:50 - 10:45

### Innovation has delivered: Solar PV competitiveness has arrived

Solar PV is one of the most innovative renewable power generation technologies. Continuous investment in R&D, commercialisation of new materials and manufacturing processes has delivered real cost reductions. Hear about the state of today's technology and the potential for the future

- **Solar PV Japanese market expert**  
Keiji Kimura, Senior Analyst, Renewable Energy Institute Japan (confirmed)
- **Enabling grid and advanced storage technologies for solar PV**  
Sin Taek Yim, Senior Manager, Samsung SDI (confirmed)
- **Commercialization of Solar PV mini-grid and cost**  
Konstantinos Vergos, Senior Manager, DHYBRID (confirmed)
- **Emerging market overview, Brazil**  
Camila Ramos, Managing Director, Clean Energy Latin America (confirmed)

10:45 - 11:30

### Facilitating policy and infrastructure:

Solar PV faces challenges in continuing its growth as renewables continue to challenge the incumbent's entrenched positions. Support policies need to recognise the changing nature of the challenge facing growth in variable renewables and adapt more rapidly, while at the same time taking a holistic approach to the electricity system and market frameworks? What needs to be done, by whom?

- **Renewable energy policy expert**  
Henning Wuester, Director of Knowledge, policy and finance, IRENA (invited)

11:30 - 12:00

### Panel Discussion and Q & A time

How to prepare for the future?

How can the expectations and challenges facing solar PV in existing and new markets be addressed by policy makers, regulators and industry? Where does the responsibility lie to push forward a more integrated policy and market framework for the integration of variable renewables? Are there prerequisites for success (e.g. market reform) and the sequence of policy implementation? Are the lessons that have been learned from front-runners in PV deployment transferable to new markets? Join our panellists to discuss these topics.

Moderation by

Dolf Gielen, Director of IRENA Innovation and Technology Centre, IRENA

Panellists: All speakers

**PV Production, Quality, and Innovation Forum**

jointly produced by SOLARUNITED and the Becquerel Institute

**Day:** Wednesday, 22 June 2016**Time:** 13:30 - 17:45**Site:** Ground Floor, Auditorium Room 11**Access:** Open to all registered Conference participants of the EU PVSEC 2016

PV Production, Quality and Innovation Forum will be led by top-level managers, chief developing engineers of SOLARUNITED member companies and further industry experts from manufacturers and suppliers of PV production equipment and related raw materials. In three dedicated sessions the latest status and outlook on changing dynamics, processes, and production technology steps in the PV manufacturing supply chain will be presented.

**Programme Outline****Market Session**

13:30 - 13:40

**Welcome and Introduction** – Bryan Ekus, Director, SOLARUNITED

13:40 - 14:10

**PV Trends & Market Overview** by – Gaëtan Masson, Director, Becquerel Institute**Technology & Innovation**

14:10 - 15:00

**Panel Session – Technology development: will heterojunction revolutionize the industry?**

A moderated panel session that will debate the possible market emergence of Multi-junction (MJ) technology, as to how likely, and when it will disrupt the conventional c-Si marketplace? This panel of leading PV manufacturers will also discuss what the PV market looks like today; where they see the technology going tomorrow; the pitfalls and obstacles in future manufacturing; and how ML technologies will impact the conventional c-Si energy market.

Session Moderator – Nabih Cherradi, CEO, Desert Technologies and Co-Chair of the SOLARUNITED Quality Committee

#### Panelist

- Prof. Christophe Ballif, Vice President, CSEM PV-Center
- Jens Eckstein, Managing Director, SINGULUS TECHNOLOGIES
- Dr. Christian Buchner – CEO at Schmid Technology GmbH
- Dr. Jan M. Kroon, Senior Researcher Solar Energy, ECN Solar Energy
- Dr. Jochen Rentsch, Head of Department “Wet Chemical and Plasma Technologies / Cell Process Transfer” Division PV Production Technology and Quality Assurance, Fraunhofer Institute for Solar Energy Systems (ISE)
- Benjamin Strahm, R&D Manager Meyer Burger Research AG, Hauerive (NE)– Meyer Burger
- Wim C. Sinke – Manager Program Development, ECN Solar Energy & Vice Chair, PV Technology Platform

15:00 - 15:15 Coffee Break

### Quality Session

15:15 - 16:00

#### Panel Session – The Quality Challenge: how to collect reliable and accurate standardized data from the field?

Two moderated panel sessions that will scrutinize the aspect of the Quality Challenge, which is how to collect reliable and accurate standardized data from the field? This panel of principal experts will share their insights as to the magnitude of module failures, and analyze methods of how to counteract future reliability glitches in the field, while ensuring a proper communication between the downstream and upstream parts of the PV value chain.

Session Introduction by: Laura Azpilicueta, Sr. VP – Global Sales & Business Development at EVASA and Chairwomen of the SOLARUNITED Quality Committee & Ulrike Jahn, TÜV Rheinland Energie und Umwelt GmbH

16:00 - 16:45

#### Quality Session Part A

Viewpoints from testing labs, material providers, and industry trade associations

Session Moderator – Laura Azpilicueta, Sr. VP – Global Sales & Business Development at EVASA and Chairwomen of the SOLARUNITED Quality Committee

#### Panelist

- Ioannis-Thomas Theologitis, Senior Advisor, Solar Power Europe
- Dr. Stefan Padlewski, Marketing Manager, DuPont Photovoltaic Solutions
- Ulrike Jahn, TÜV Rheinland Energie und Umwelt GmbH
- Roland Roesch, Senior Program Officer, IRENA – International Renewable Energy Agency
- Invited Speaker – Flex

16:45 - 17:30

#### Quality Session Part B

Viewpoints from banking, finance, O&M, and insurance underwriters

Session Moderator – Gaëtan Masson, Director, Becquerel Institute

#### Panelist

- Matthias Graf von Armanberg, Partner, Accelios Solar
- Thomas Schätz, Project Manager, AdlerSolar
- David Moser, Group leader. Institute for Renewable Energy
- Michael Schrempp, Head of Green Tech Solutions, Munich Re

17:30 - 17:45

#### Meeting summaries and open discussions with all participants

Moderated by: Jo-Anne Duff, Head of Event Content, Solar Media Limited

17:45

Meeting ends

More information available at [www.solar-united.org](http://www.solar-united.org)

We reserve the right to make changes without prior notice

**PHOTOVOLTAICS | FORMS | LANDSCAPES****Beauty and power of designed Photovoltaics**

jointly with the European Commission, DG JRC, ENEA and  
ETA-Florence Renewable Energies

**Day:** Wednesday, 22 June 2016

**Time:** 13:30 - 18:30

**Site:** Ground Floor, Auditorium Room 4

**Access:** Open to all registered Conference participants of the  
EU PVSEC 2016

Photovoltaics | Forms | Landscapes is a series of annual events (1st edition Hamburg, 26th EUPVSEC; 2nd edition: Frankfurt, 27th EUPVSEC; 3rd edition Paris, 28th EUPVSEC, 4th edition Amsterdam 29th EUPVSEC, 5th edition Hamburg 31st EUPVSEC) serving as a discussion framework to investigate the new phenomena associated with the rapid spread of large photovoltaic systems. It promotes reflection on the implications for our way of living and on what new issues of design could arise. This is done on all scales: from modules, to buildings, to cities, to landscapes.



**etaflorence** \* **renewableenergies**

[www.pv-landscapes.com](http://www.pv-landscapes.com)

## 7th International Workshop on CIGS Solar Cell Technology (IW-CIGSTech 7)

jointly organized by Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (HZB) and Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

**Day:** Thursday, 23 June 2016

**Time:** 08:30 - 18:00

**Site:** Ground Floor, Auditorium Room 4

**Access:** Open to all registered Conference participants of the EU PVSEC 2016

7th International Workshop on CIGS Solar Cell Technology (IW-CIGSTech 7)

jointly organized by Helmholtz-Zentrum Berlin für Materialien und Energie GmbH (HZB) and Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW)

IW-CIGSTech 7 will be an international workshop focusing on CIGS solar cell technology, combining scientific and technological aspects with their industrial applications. The workshop will consist of invited talks, discussions and poster presentations. The organizers would be delighted to welcome you in Munich for a day of lively discussions of CIGS technology topics. Further details will be published soon.

### THE LOW COST HIGH EFFICIENCY PHOTOVOLTAICS TECHNOLOGY

Photovoltaics (PV) today are dominated by crystalline silicon (c-Si) technology. Among alternative, thin-film technologies, CIGS is the most advanced and the most efficient. The PV modules with CIGS (Cu(In,Ga)(Se,S)<sub>2</sub>) absorbers are very effective in converting light directly into electricity. They are very well positioned in the field of PV technologies with present record efficiencies for small cells of 22.3 % and for production size modules of 16.5 %.

The recent progress at the cell level paves the way for progress at the mini module level (currently 18.7%, aiming at > 21%) and towards total area module efficiencies of 18%. The latter is expected to be realized in the near future through transfer and adaptation of laboratory technology. Low cost CIGS PV modules can provide electricity below € 0.05 / kWh (LCOE) and contribute to CO<sub>2</sub> reduction in a significant manner.



**Programme Outline****INTRODUCTION and OVERVIEW**

8:30

**Welcome**

Prof. Dr. Rutger Schlatmann, HZB (DE)  
 Prof. Dr. Michael Powalla, ZSW (DE)

8:40

**Role of CIGS in future PV - The CIGS white paper**

Prof. Dr. Ayodhya N. Tiwari, EMPA (CH)

9:00

**ETIP PV views on trends and challenges for CIGS technology**

Prof. Dr. Marko Topič, University of Ljubljana (SVN)

9:20

**Discussion**

9:30 Coffee Break

**PRODUCTION of CIGS MODULES**

9:50

**Recent research progress of high-efficiency CIGS solar cell in Solar Frontier**

Dr. Takuya Kato, Solar Frontier (JPN)

10:10

**Avancis: [Company contribution]**

N.N., Avancis GmbH (DE)

10:30

**Stion:[Company contribution]**

Alex M. Schwarz, Stion Corp. (USA)

**RESEARCH on CIGS MODULES**

10:50

**Recent Progress in R&D at Solibro Research**

Dr. Olle Lundberg, Solibro Research AB (SE)

11:10

**Atmospheric Pressure In-Line RTP for CIGS**

Dr. Sebastian Schmidt, HZB (DE)

11:30

**Discussion and Poster Presentations**

12:10 Lunch Break / Poster Presentations

**FLEXIBLE CIGS MODULES**

13:30

**Commercial flexible CIGS technology**

Dr. Urs Schoop, Global Solar Energy (USA)

13:50

**MiaSolé [Company contribution]**

Atiye Bayman Ph.D., Miasolé Hi-Tech (USA)

**CIGS EQUIPMENT SUPPLIERS**

14:10

**Manz CIGSfab: Current Status and Outlook**

Dr. Kay Orgassa, Manz CIGS Technology GmbH (DE)

14:30

**Equipment to enable GW-scale Production of Highly Efficient CIGS Modules**

Dirk Beisenherz / Stefan Zorn, Singulus Technologies AG (DE)

14:50 **Discussion**

15:00 Coffee Break

**FUTURE PERSPECTIVES & RESEARCH I**

15:15

**The prospect and current status of CIGS thin-film solar cells in China**

Prof. Yun Sun, Institute of Photo- Electronic Thin Film Device and Technology, Nankai University (CHN)

15:45

**Innovative Approaches for CIGS solar cells**

Prof. Dr. Daniel Lincot, IRDEP/IVPF (F)

16:05

**Overview of R&D on CIGS solar cells in Japan / The NEDO CIGS consortium**

Dr. Shigeru Niki, AIST (JPN)

16:25

**Roadmap CIGS towards 25% efficiency**

Dr. Stefan Paetel, ZSW (DE)

16:45 Coffee Break

**FUTURE PERSPECTIVES & RESEARCH II**

17:00

**Interface Characterization to aid in the Development of alternative Buffer Layers**

Prof. Dr. Clemens Heske, KIT (DE)

17:20

**CIGS-based Tandems**

N.N., EMPA (CH)

17:40

**Summary – Outlook – Good-bye**

Workshop Committee

18:00 ff: Joint relocation to dinner event by public transport



## GENERAL INFORMATION

For more information please refer to  
[www.photovoltaic-conference.com/general-information](http://www.photovoltaic-conference.com/general-information)

**VENUE OF EU PVSEC 2016**

ICM – International Congress Center Munich, Germany  
Messe München Locations  
Messegelände/ Entrance west  
81823 Munich  
Germany

Telephone : +49 89 949-23023

<http://www.icm-muenchen.de>

*For detailed Travel and Transport Information please visit  
[www.photovoltaic-conference.com/general-information](http://www.photovoltaic-conference.com/general-information)*



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Find here a general overview of the EU PVSEC 2016 ticketing categories and registration benefits:

### EU PVSEC 2016 Registration Benefits

Registration Category	Conference Sessions	Parallel Events	Intersolar Europe Exhibition	Information Material	Proceedings	EU PVSEC Dinner	Networking Lunch	Welcome Reception
Full Conference Week	✓	✓	✓	✓	✓			✓
One Day Admission *	✓	✓	✓	✓	✓			✓
Two Days Admission *	✓	✓	✓	✓	✓			✓
Students	✓	✓	✓	✓	✓			✓
Networking Lunch (from Mon - Thu)							✓	
EU PVSEC Dinner (Wednesday)						✓		

\* on registered day/s only

## ACCESS

### EU PVSEC Conference

Upon arrival at ICM - International Congress Center Munich, Conference participants should proceed to the Conference Registration Desk at the main entrance to check in and pick up their badge.

#### Opening hours of the Conference Registration Desk:

Sun	19 June 2016	16:00 – 18:00
Mon	20 June 2016	07:30 – 19:00
Tue – Thu	21 -23 June 2016	08:00 – 19:00
Fri	24 June 2016	08:00 – 12:00

### Conference Badge

Your personalised Conference badge authorises you to visit:

- all EU PVSEC Conference sessions on day/s registered
- all EU PVSEC Parallel Events on day/s registered
- the Intersolar Europe Exhibition on all days

*Kindly note, that your badge is not transferable to another person. We ask for your understanding that your personalised admission might be controlled by our staff. In case of loss or find a badge, please inform our staff immediately. Kindly note that lost badges cannot be replaced.*

### Intersolar Europe Exhibition

The Exhibition is open to all Conference Delegates.

Opening hours are from:

Wed	22 June 2016	09:00 – 18:00
Thu	23 June 2016	09:00 – 18:00
Fri	24 June 2016	09:00 – 17:00

### EU PVSEC Parallel Events

All EU PVSEC Parallel Events are open to Conference Delegates on day/s registered.

For further information about the EU PVSEC Parallel Events see page 261.



## CONFERENCE PROCEEDINGS

The EU PVSEC 2016 Proceedings contain all scientific papers presented at the EU PVSEC 2016 and submitted for publication.

They constitute a comprehensive source of state-of-the-art information and vital point of reference for researchers, technologists, decision-makers, entrepreneurs and all involved in the global PV sector.

The EU PVSEC 2016 Proceedings include full presented papers, slides presentations and poster presentations (if available).

A digital identifier (DOI code) has been assigned to each paper to ensure unequivocal and permanent identification and citation capability of the online publication. This identification system is administered by the German National Library of Science and Technology.

Conference participants will have immediate and free access to the EU PVSEC 2016 Proceedings right after publication.

The EU PVSEC Proceedings are available on [www.eupvsec-proceedings.com](http://www.eupvsec-proceedings.com).

Authors are requested to submit their manuscript for publication in the Conference Proceedings (see page 297)

## COOPERATION WITH 'PROGRESS IN PHOTOVOLTAICS'

After a peer review process, a selected number of the highest ranked papers from every Conference subject will be published - in addition to the EU PVSEC Proceedings 2016 - on the website and in a digital special issue of the renowned scientific journal 'Progress in Photovoltaics'.



## PRIZES & AWARDS

### European Becquerel Prize for Outstanding Merits in Photovoltaics

The European Becquerel Prize for Outstanding Merits in Photovoltaics will be awarded during the Conference. This prize was established by the European Commission in 1989 to mark the 150th anniversary of Alexandre-Edmond Becquerel's discovery of the photovoltaic effect in 1839, which laid the foundation of both, photovoltaics and photography. The Becquerel Prize will be awarded on Monday, 20 June 2016 during the Opening Ceremony in the Main Auditorium Room 1.

Congratulations to the Becquerel Prize Winner 2016:

#### Prof. Christophe Ballif

Director EPFL "Photovoltaics and Thin Film Electronics Laboratory" and "CSEM PV- Center", Neuchatel, Switzerland

He receives the award in honour of his scientific merits in the development of silicon heterojunction solar cells. The decision of the Becquerel Prize Committee is based in particular on the outstanding work of Prof. Ballif on silicon thin-film and silicon wafer solar cells and the transfer of PV-technologies to industry. His research on tandem solar cells with a focus on silicon/perovskite and silicon/III-V compounds is highly recognized.

Prof. Ballif is one of the pioneers in the development of high efficiency crystalline solar cells with heterojunctions and passivated contacts. His work spans the field from fundamentals to novel manufacturing processes, pilot tools and production lines.

Prof. Ballif has published very extensively, and is one of the most highly cited researchers in the field of solar cells. His unwavering enthusiasm has energized dozens of PhD students and postdoctoral fellows. His passionate promotion of solar energy technology as the main electricity source for the future of humankind has contributed enormously to its acceptance by society.

### Awards for Outstanding Visual Presentations

This award is one of the highlights of the Closing Session: The most outstanding Visual Presentations of each topic (Topic 1 to 7) will be awarded.

A jury of experts judges the quality of the contents reported and the quality of the presentation. The awards will be announced and delivered as part of the Conference Closing on Friday, 24 June 2016. The winners will be invited on stage and the winning posters will be projected in the Auditorium.

## EU PVSEC Student Awards

Following the success of previous years and to encourage high-quality work among young researchers, the EU PVSEC Student Awards will be delivered in recognition of the most remarkable and outstanding research work in the field of PV on the occasion of the EU PVSEC 2016.

41 applications for the EU PVSEC Student Awards have been received. They have been reviewed and scored by the international Scientific Committee, made up of more than 200 leading research and industry experts from the global PV community.

The prizes will be awarded during the Conference Closing Session on Friday, 24 June 2016.

Take the chance to attend the presentation of their outstanding work in the following Oral sessions:

### Monday, 20 June 2016

**Mr. Francois Gibelli**  
CNRS, Chatou, France

1AO.1.5 Different Electron and Hole Thermodynamics from Hot Carrier Solar Cell Modeling

**Mr. Antonio David Utrilla**

UPM - Technical University of Madrid, Madrid, Spain

1AO.3.3 Thin GaAsSb Capping Layers for Improved Performance of InAs/GaAs Quantum Dot Solar Cell

### Tuesday, 21 June 2016

**Mr. Thomas Allen**

ANU - The Australian National University, Canberra, Australia

2BP.1.3 Calcium Contacts to n-Type Crystalline Silicon Solar Cells

Above programme may be subject to adaptation.

### Wednesday, 22 June 2016

**Mr. Gilbert El Hajje**

CNRS Centre National de la Recherche Scientifique, Chatou, France

3CO.5.2 Quantitative Mapping of Interface Defects in Cu(In,Ga)Se<sub>2</sub> Solar Cells Using Photoluminescence-Based Methods

**Mr. Jens Czolk**

KIT Karlsruher Institut für Technologie, Karlsruhe, Germany

3CO.8.5 Highly Efficient, All-Solution Processed, Mechanically Flexible, Semi-Transparent Organic Solar Modules

**Mr. Blaž Kirn**

University of Ljubljana UL-FE, Ljubljana, Slovenia

5CO.16.1 Combining Solar Irradiance Databases and PV Performance Model for PV System Performance Analysis

### Thursday, 23 June 2016

**Mr. Mohsen Goodarzi**

ANU - The Australian National University, Canberra, Australia

2DO.4.1 Modelling and Characterization of Multicrystalline Silicon Blocks by Quasi-Steady-State Photoconductance

**Mr. Dominic C. Walter**

ISFH Institut für Solarenergieforschung GmbH, Emmerthal, Germany

2DO.1.1 Ultrafast Lifetime Regeneration in an Industrial Belt-Line Furnace Applying Intense Illumination at Elevated Temperature





## NETWORKING

### Coffee Breaks (for Conference Delegates)

Coffee Breaks are included in the Conference fee. They will be served in hall B0.

### Catering / Restaurants

A special dedicated Networking Lunch could be booked prior to the event. Tickets are not available on-site. The Networking Lunch will be served in a dedicated networking area in exclusive ambiance, directly in the ICM Munich. For those who did not include Networking Lunch tickets in their registration, there is a wide range of cafés and restaurants around ICM and numerous snack bars in the exhibition halls.

### Welcome Reception

On Monday, 20 June, there will be a Welcome Reception for all Conference participants, from 18:30 in hall B0. Come and meet your colleagues of the PV community and celebrate the EU PVSEC 2016 as a major networking platform for the global PV Solar sector.

## EU PVSEC Dinner

The EU PVSEC 2016 Conference Dinner takes place on Wednesday evening, 22 June 2016 in the Restaurant Hirschau which is located in the idyllic landscape of Munich's green lung, the "English Garden". Hirschau is renowned for its upscale traditional cuisine with Bavarian specialties.

You will be welcomed with an aperitif on the big (covered) terrace in this early summer full moon night. Afterwards, a 3-courses-menu will be served in relaxed atmosphere (vegetarian, gluten- or lactosefree menu is possible).

The EU PVSEC Dinner will be a most captivating social event of the EU PVSEC week:

- Meet professionals from the PV world
- Enjoy excellent Cuisine
- Relax and network in pleasant ambiance

### Wednesday 22 June from 19:30 - 22:30 at Restaurant Hirschau

Free Bus Shuttle starting at around 18:45 - 19:00 at the ICM and going back at 22:30.

Delegates, Intersolar Europe Exhibitors and Visitors interested are welcome to take part in the EU PVSEC Dinner.

### Networking Lunch

A networking lunch will be available for interested delegates from Monday to Thursday, 20 – 23 June in a dedicated networking area in exclusive ambiance, directly in the ICM Munich.

This avoids queueing up in lunch periods and provides a networking environment. The networking lunch will be served in buffet style, and is convenient for both meat lovers and vegetarians. Tickets can be bought via the Conference registration area and may become subject to availability and need to be paid in advance. Tickets will not be sold on-site. Access to the networking lunch will be granted upon presentation of a lunch voucher which you will receive at the registration desk on-site along with your registration documents. Lost tickets will not be replaced.

## SERVICES

## EU PVSEC Personal Programme Planner

We recommend using the EU PVSEC Personal Programme Planner in order to most successfully schedule your EU PVSEC week.

The EU PVSEC Personal Programme Planner provides a quick and detailed general synopsis of all events, sessions and presentations of the EU PVSEC 2016. It provides targeted search e.g. by speakers, organisations, topics, product categories, keywords, time and location.

Create your personal, clearly laid out agenda. See at a glance where and when your chosen presentations / sessions take place and get detailed information about the respective topics. You may save and modify your agenda at any time.

Please use the online version at [www.eupvsec-planner.com](http://www.eupvsec-planner.com), or the mobile version at [www.mobile.eupvsec-planner.com](http://www.mobile.eupvsec-planner.com).

The mobile version is web-based and can be used by all kinds of smartphones. All you need is your smartphone's browser and internet connection.

## Press Centre

A fully-equipped press centre is at the disposal of press and media representatives throughout the event. Computers, free internet access, background information and press kits are available. The Press Centre is located in room 2 right next to the 'delivery of manuscript' desks.

The official Press Conference is scheduled to take place on Monday, 20 June at 12:30.



## INSTRUCTIONS FOR AUTHORS AND PRESENTERS

## Plenary / Oral Presentations

Speakers of Plenary and Oral presentations **hand in their presentation/s at the Presenters' Desk (room 2, ground floor)**. A technician will control the correct functionality and transfer the presentation to the respective auditorium. Further details regarding Plenary/Oral Presentations can be found in the *Notes for Authors* available on the EU PVSEC website.

Opening hours of Presenters' Desk (room 2, ground floor)

Sun	19 June 2016	16:00 – 18:00
Mon	20 June 2016	07:30 – 19:00
Tue – Thu	21 – 23 June	08:00 – 19:00
Fri	24 June 2016	08:00 – 12:00

Speakers and Chairpersons of Plenary and Oral sessions **meet 15 minutes prior to the start of their session** in the respective auditorium in order to be briefed and to become acquainted with audio-visual aids.

## Visual Presentations

Authors of Visual presentations are requested to **set up their posters** on the allotted boards as early as possible on **Monday morning, 20 June** and to **take them down on Thursday, 23 June, after the last session at 18:30**. All Visual presentations should be presented through the full 4 days from Monday to Thursday in the Poster Area. Please find all detailed guidelines in the *Notes for Authors of Visual Presentations*.

Authors of posters are requested to be in situ at their posters at the session time indicated in the Programme Brochure, in order to present their paper to the audience and to create a Q&A session.

In order to be **published in the EU PVSEC 2016 Proceedings**, authors need to **deliver their manuscript at the Delivery of Manuscripts Desk (room 2, ground floor)**. If the manuscript is not delivered during the Conference, your paper cannot be published in the Proceedings. The Instructions for Preparation of Papers are available for download on the EU PVSEC website.

Opening hours of the Delivery of Manuscripts Desk (room 2):

Sun	19 June 2016	14:00 – 18:30
Mon	20 June 2016	07:30 – 19:00
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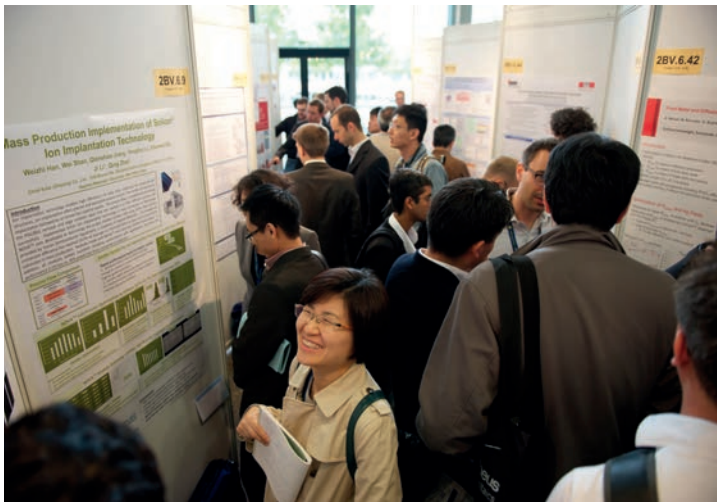
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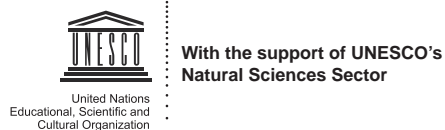
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# Conference Programme Outline

## Monday, 20 June

08:30	Opening Scientific Opening 1/AP.1 Auditorium Room 1
10:00	Opening Addresses Moderated Opening Panel Bequeierl Prize Ceremony

13:30	Lunch
15:00	1AO.1 T1.1 Audit. Room 5
15:15	3AO.4 T3.2 Audit. Room 1
16:45	5AO.7 T5.1 Audit. Room 13b
17:00	Break
18:30	1AO.3 T1.2 Audit. Room 5
	3AO.6 T3.2 Audit. Room 1
	5AO.9 T5.3 Audit. Room 13b

15:15	2AV.1 T2.2 Poster Area
16:45	5AO.8 T5.1 Audit. Room 5
17:00	Break
18:30	1AO.3 T1.2 Audit. Room 5
	3AO.6 T3.2 Audit. Room 1
	5AO.9 T5.3 Audit. Room 13b

15:15	2AV.1 T2.2 Poster Area
16:45	5AO.8 T5.1 Audit. Room 5
17:00	Break
18:30	1AO.3 T1.2 Audit. Room 5
	3AO.6 T3.2 Audit. Room 1
	5AO.9 T5.3 Audit. Room 13b

EU PVSEC Welcome Reception

## Tuesday, 21 June

10:30	2BO.1 T2.1 Audit. Room 1
10:30	3BO.5 T3.1 Audit. Room 13b
10:30	5BO.9 T2.4 Audit. Room 5
12:00	2BP.1 Audit. Room 1 10:30 - 12:00

10:30	Lunch
13:30	2BO.2 T2.1 Audit. Room 1
13:30	3BO.6 T3.1 Audit. Room 13b
13:30	5BO.10 T5.4 Audit. Room 5
15:00	2BO.2 T2.1 Audit. Room 1
15:00	3BO.6 T3.1 Audit. Room 13b
15:00	5BO.10 T5.4 Audit. Room 5
16:45	2BO.3 T2.2 Audit. Room 1
16:45	3BO.7 T3.3 Audit. Room 13b
16:45	5BO.11 T5.4 Audit. Room 5
18:30	2BO.4 T2.2 Audit. Room 1
18:30	3BO.8 T3.2 Audit. Room 13b
18:30	5BO.12 T1.3 Audit. Room 5

13:30	2BO.2 T2.1 Audit. Room 1
13:30	3BO.6 T3.1 Audit. Room 13b
13:30	5BO.10 T5.4 Audit. Room 5
15:00	2BO.2 T2.1 Audit. Room 1
15:00	3BO.6 T3.1 Audit. Room 13b
15:00	5BO.10 T5.4 Audit. Room 5
16:45	2BO.3 T2.2 Audit. Room 1
16:45	3BO.7 T3.3 Audit. Room 13b
16:45	5BO.11 T5.4 Audit. Room 5
18:30	2BO.4 T2.2 Audit. Room 1
18:30	3BO.8 T3.2 Audit. Room 13b
18:30	5BO.12 T1.3 Audit. Room 5

13:30	2BO.2 T2.1 Audit. Room 1
13:30	3BO.6 T3.1 Audit. Room 13b
13:30	5BO.10 T5.4 Audit. Room 5
15:00	2BO.2 T2.1 Audit. Room 1
15:00	3BO.6 T3.1 Audit. Room 13b
15:00	5BO.10 T5.4 Audit. Room 5
16:45	2BO.3 T2.2 Audit. Room 1
16:45	3BO.7 T3.3 Audit. Room 13b
16:45	5BO.11 T5.4 Audit. Room 5
18:30	2BO.4 T2.2 Audit. Room 1
18:30	3BO.8 T3.2 Audit. Room 13b
18:30	5BO.12 T1.3 Audit. Room 5

## Wednesday, 22 June

09:30	3CO.1 T2.1 Audit. Room 1
09:30	3CO.5 T3.2 Audit. Room 13b
09:30	3CO.9 T1.2 Audit. Room 13a
11:50	5CO.13 T5.4 Audit. Room 5
11:50	4CP.1 Audit. Room 1
12:10	4CP.2 Audit. Room 1

09:30	Lunch
10:30	2CO.2 T2.2 Audit. Room 1
10:30	4CO.6 T4.1/2 Audit. Room 13b
10:30	1CO.10 T1.2 Audit. Room 13a
10:30	5CO.14 T5.2 Audit. Room 5
12:10	3CV.2 T3.2 Poster Area

10:30	2CO.2 T2.2 Audit. Room 1
10:30	4CO.6 T4.1/2 Audit. Room 13b
10:30	1CO.10 T1.2 Audit. Room 13a
10:30	5CO.14 T5.2 Audit. Room 5
12:10	3CV.2 T3.2 Poster Area

10:30	2CO.2 T2.2 Audit. Room 1
10:30	4CO.6 T4.1/2 Audit. Room 13b
10:30	1CO.10 T1.2 Audit. Room 13a
10:30	5CO.14 T5.2 Audit. Room 5
12:10	3CV.2 T3.2 Poster Area

EU PVSEC Dinner

## Thursday, 23 June

08:30	2DO.1 T2.1 Audit. Room 5
08:30	6DO.5 T6.3 Audit. Room 13a
08:30	9DO.9 T9.3 Audit. Room 13a
11:20	7DO.13 T7.1 Audit. Room 13b
11:20	3DV.1 T3.1 Poster Area
11:20	5DP.1 Audit. Room 1
11:20	6DP.2 Audit. Room 1
12:10	Lunch
12:10	2DO.2 T2.2 Audit. Room 5
12:10	6DO.6 T6.1 Audit. Room 13a
12:10	5DO.10 T5.4 Audit. Room 1
12:10	7DO.14 T7.1 Audit. Room 13b
12:10	3DV.2 T3.3 Poster Area

08:30	2DO.1 T2.1 Audit. Room 5
08:30	6DO.5 T6.3 Audit. Room 13a
08:30	9DO.9 T9.3 Audit. Room 13a
11:20	7DO.13 T7.1 Audit. Room 13b
11:20	3DV.1 T3.1 Poster Area
11:20	5DP.1 Audit. Room 1
11:20	6DP.2 Audit. Room 1
12:10	Lunch
12:10	2DO.2 T2.2 Audit. Room 5
12:10	6DO.6 T6.1 Audit. Room 13a
12:10	5DO.10 T5.4 Audit. Room 1
12:10	7DO.14 T7.1 Audit. Room 13b
12:10	3DV.2 T3.3 Poster Area

08:30	2DO.1 T2.1 Audit. Room 5
08:30	6DO.5 T6.3 Audit. Room 13a
08:30	9DO.9 T9.3 Audit. Room 13a
11:20	7DO.13 T7.1 Audit. Room 13b
11:20	3DV.1 T3.1 Poster Area
11:20	5DP.1 Audit. Room 1
11:20	6DP.2 Audit. Room 1
12:10	Lunch
12:10	2DO.2 T2.2 Audit. Room 5
12:10	6DO.6 T6.1 Audit. Room 13a
12:10	5DO.10 T5.4 Audit. Room 1
12:10	7DO.14 T7.1 Audit. Room 13b
12:10	3DV.2 T3.3 Poster Area

08:30	2DO.1 T2.1 Audit. Room 5
08:30	6DO.5 T6.3 Audit. Room 13a
08:30	9DO.9 T9.3 Audit. Room 13a
11:20	7DO.13 T7.1 Audit. Room 13b
11:20	3DV.1 T3.1 Poster Area
11:20	5DP.1 Audit. Room 1
11:20	6DP.2 Audit. Room 1
12:10	Lunch
12:10	2DO.2 T2.2 Audit. Room 5
12:10	6DO.6 T6.1 Audit. Room 13a
12:10	5DO.10 T5.4 Audit. Room 1
12:10	7DO.14 T7.1 Audit. Room 13b
12:10	3DV.2 T3.3 Poster Area

## Friday, 24 June

08:30	6EO.1 T6.4 Audit. Room 13b
08:30	7EO.2 T7.2 Audit. Room 4
08:30	5EO.3 T5.2 Audit. Room 5
10:00	Break
10:30	7EP.1 Auditorium Room 5

08:30	6EO.1 T6.4 Audit. Room 13b
08:30	7EO.2 T7.2 Audit. Room 4
08:30	5EO.3 T5.2 Audit. Room 5
10:00	Break
10:30	7EP.1 Auditorium Room 5

08:30	6EO.1 T6.4 Audit. Room 13b
08:30	7EO.2 T7.2 Audit. Room 4
08:30	5EO.3 T5.2 Audit. Room 5
10:00	Break
10:30	7EP.1 Auditorium Room 5

08:30	6EO.1 T6.4 Audit. Room 13b
08:30	7EO.2 T7.2 Audit. Room 4
08:30	5EO.3 T5.2 Audit. Room 5
10:00	Break
10:30	7EP.1 Auditorium Room 5

Closing Session / Audit. Room 5  
Key note, Highlights of the Conference, Poster Awards, Student Awards, Farewell

### 1 New Materials and Concepts for Solar Cells and Modules

- T1.1 Fundamental Studies
- T1.2 New Materials and Concepts for Cells
- T1.3 New Materials and Concepts for Modules

### 2 Wafer-Based Silicon Solar Cell and Materials Technology

- T2.1 Silicon Feedstock, Crystallisation and Wafering
- T2.2 Silicon Solar Cell Improvements and Innovation
- T2.3 Silicon Solar Cell Characterisation and Modelling
- T2.4 Manufacturing and Processing

### 3 Thin Film Solar Cells and Modules

- T3.1 Silicon-based Thin Film Solar Cells and Modules
- T3.2 CdTe, CIS and Related Thin Film Solar Cells and Modules
- T3.3 Perovskite, Organic and Hybrid devices

### 4 Concentrator and Space Applications

- T4.1 Ill-V-based Devices for Terrestrial and Space Applications
- T4.2 Concentrator and Space Systems

### 5 Operation, Performance, Reliability and Sustainability of PV

- T5.1 Solar Resource and Forecasting
- T5.2 Operation of PV Systems
- T5.3 Balance of System Components
- T5.4 PV Cells and Modules
- T5.5 Sustainability and Recycling

### 6 PV Applications and Integration

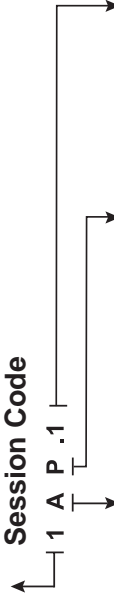
- T6.1 Grid and Energy System Integration
- T6.2 PV in Buildings and the Environment
- T6.3 Utility-Scale PV
- T6.4 PV Applications Without a Centralised Grid

### 7 PV Economics, Markets and Policies

- T7.1 PV Economics and Markets
- T7.2 PV Global Issues, Policies and Strategies

## Topics / Subtopics

### Session Code



### Day Codes

- A Monday, 20 June 2016
- B Tuesday, 21 June 2016
- C Wednesday, 22 June 2016
- D Thursday, 23 June 2016
- E Friday, 24 June 2016

### Session Type

- P Plenary Session
- O Oral Session
- V Visual Session

### Session Number

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