# Content

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chairmens’ Messages</td>
<td>4</td>
</tr>
<tr>
<td>Committees</td>
<td>6</td>
</tr>
<tr>
<td>Scientific Program</td>
<td>8</td>
</tr>
<tr>
<td>Monday, April 03, 2017</td>
<td>8</td>
</tr>
<tr>
<td>Tuesday, April 04, 2017</td>
<td>18</td>
</tr>
<tr>
<td>Wednesday, April 05, 2017</td>
<td>28</td>
</tr>
<tr>
<td>Thursday, April 06, 2017</td>
<td>39</td>
</tr>
<tr>
<td>Technical Tour</td>
<td>42</td>
</tr>
<tr>
<td>Conference Dinner</td>
<td>43</td>
</tr>
<tr>
<td>General Information</td>
<td>44</td>
</tr>
<tr>
<td>Poster Plan</td>
<td>46</td>
</tr>
</tbody>
</table>
I'm happy to welcoming you here to the 7th International Conference on Crystalline Silicon Photovoltaics in Freiburg, Germany, April 3-5, 2017.

PV has undergone tremendous development throughout the past 15 years with a cumulated annual growth of more than 30% per year and a cost reduction of PV modules of more than 80%. But can we take it for granted that it will be a major source of future worldwide electricity supply? No, we cannot but it is highly likely due to the abundance of solar radiation, the speed of construction and the potential to further reduce the levelized cost of solar electricity. Yes, crystalline silicon has been the dominant photovoltaic material so far but can we take it for granted that it will remain this way for the next 20 years or more? No, we cannot but it seems highly likely. Most reasons are obvious and unchanged: efficiency potential, abundant raw material supply, non-toxicity and the availability of scalable technologies.

If these developments are not yet certain, what conditions have to be fulfilled to meet the foreseeable success? Obviously we can secure a bright future for crystalline Si photovoltaics by supporting further cost reduction and by enhancing sustainability. It is a responsibility of our scientific community to support such progress in silicon photovoltaics. In my view SiliconPV is the ideal event to attend for sharing and understanding current developments and upcoming trends. SiliconPV covers short-, mid- and long-term issues in silicon photovoltaics including:

- processing and characterization of multi- and mono-crystalline silicon including defect passivation as well as locally contacted dielectrically passivated solar cells and modules,
- solar cells based on selective contacts and advanced interconnection and encapsulation technologies as well as
- crystalline silicon based tandem solar cells shifting the efficiency limit beyond the single-junction.

All these topics will be covered following the successful format established by these conferences; a blind review process for abstract evaluation, plenary presentations, a common day with the overlapping nPV Workshop and many breaks for networking and exchange. The seventh conference comes back to the Green City Freiburg, close to the Black Forest with its mountains and creeks and the home of Europe’s largest solar energy research institute, Fraunhofer ISE. Come and join us to gain a thorough understanding of the latest and leanest production technologies with record device efficiencies.

The conference program will cover publications on two new efficiency world records, for both mono- and multi-crystalline silicon.

Come to SiliconPV 2017 and join more than 300 registered attendees!

Ralf Preu
Dear PV-friend,

It is my great pleasure to welcome you to the 7th nPV workshop in Freiburg, Germany. Like the three previous editions, this event is coupled to the SiliconPV conference with one overlapping day. The focus during the first day (April 5th) will be on more scientific aspects of n-type crystalline Si PV technology and the second day (April 6th) will be on applications of novel technologies in an industrial environment. The current edition of the nPV workshop covers the entire field from n-type Si material up to and including module technologies and system applications! We are glad to announce many interesting talks on the latest results from industry, but also to have some more visionary presentations to discuss future PV aspects including novel hybrid tandems consisting of a perovskite top cell and a silicon bottom one.

The progress in PV technology development and cost reduction is exceeding all expectations! In the Middle-East a PV power plant will be installed which will produce solar electricity at costs well below the ones for conventional primary energy sources: a bid of below 3 $ct/kWh LCOE. And be aware, we are just at the beginning! The potential for further efficiency improvement and cost reduction is huge, especially for n-type crystalline Si technology. The highest cell efficiencies (above 26%) have been reached with this type of material; already on large area using industrial process steps. The same holds for PV modules with n-type cells: module efficiencies above 22% have been recorded with an impressive independently confirmed record efficiency of 24.1% (aperture area) for a SunPower rooftop PV panel.

I am looking forward to meeting you during the workshop. Enjoy nPV 2017!

On behalf of the organizing committee,

Arthur Weeber
Committees SiliconPV

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Hanwha Q-Cells, Germany: Fabian Fertig, Ansgar Mette, Jörg Müller, Stefan Peters, Kai Petter
Helmholtz-Zentrum Berlin (HZB), Germany: Lars Korte
Heraeus, Germany: Matthias Hörteis
imec, Belgium: Ivan Gordon, Jonathan Govaerts, Joachim John, Jozef Szlufcik, Loic Tous, Eszter Voroshazy
Institute for Energy Technology, Norway: Halvard Haug, Erik Marstein
ISC Konstanz e.V., Germany: Jan Lossen

Submit your paper now!

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the new journal for advances in photovoltaics and solar energy research
ISFH, Germany: Thorsten Dullweber, Marc Köntges, Byungsul Min, Jan Schmidt, Henning Schulte-Huxel
Jiaotong University Shanghai, China: Wenzhong Shen
Lightdrop Harvest, LLC, USA: Daniel Meier
Max Planck Institute of Microstructure Physics, Germany: Otwin Breitenstein, Jan Bauer
Merck, Germany: Oliver Doll
Meyer Burger, Switzerland: Thomas Söderström
MIT, USA : Marius Peters
NREL, USA: Sarah Kurtz, David Young
pccl Leoben, Austria: Gernot Oreski
PV Crystalox Solar Silicon, Germany: Oliver Anspach
PV Lighthouse, Australia: Malcolm Abbott, Keith McIntosh
Sinton Instruments, USA: Ronald A. Sinton
Solarworld Innovations, Germany: Eric Schneiderlöcher
SunPower, Germany: Nils Harder
Tempress, The Netherlands: Martijn Lenes
tf rinnovabili, Italy: Thomas Friesen
Toyo Aluminium K.K, Japan: Marwan Dhamrin
Trina Solar, China: Pietro Altermatt, Pierre Verlinden
TU Eindhoven, The Netherlands: Erwin Kessels
TÜV Rheinland Energy, Germany: Ulrike Jahn
UL, Germany: Bengt Jäckel
University of Konstanz, Germany: Giso Hahn, Axel Herguth, Barbara Terheiden
University of Ljubljana, Slovenia: Marko Topič
University of New South Wales, Australia: Brett Hallam, Bram Hoex
University of Stuttgart, Germany: Jürgen Werner
US Dept of Energy, Germany: Paul Basore
Voltech Solar, France: Lucas Weiss
Westfälische Hochschule, Germany: Andreas Schneider
ZHAW School of Engineering, Switzerland: Hartmut Nussbaumer
Zhejiang University, China: Deren Yang

Committees nPV Workshop

Chair of nPV Workshop
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Monday, April 03, 2017

07:30 - 08:30 Registration

08:30 - 08:45 Opening Session
08:45 Rolf Böhme Saal
08:30 Opening
Ralf Preu, Fraunhofer Institute for Solar Energy Systems ISE

08:45 - 10:15 Session 1: Tandem Cells
09:00 Rolf Böhme Saal
Chairs: Christophe Ballif (EPFL) and Peter Wilshaw (University of Oxford)

08:45 23.6%-Efficient Monolithic Perovskite/Silicon Tandem Cell
Zhengshan Yu1, Kevin Bush2, Axel Palmstrom2, Mathieu Boccard1, Peter Firth1, Stacey Bent2, Michael McGehee2, Zachary Holman1
1 Arizona State University; 2 Stanford University

08:45 23.6%-Efficient Monolithic Perovskite/Silicon Tandem Cell
Zhengshan Yu1, Kevin Bush2, Axel Palmstrom2, Mathieu Boccard1, Peter Firth1, Stacey Bent2, Michael McGehee2, Zachary Holman1
1 Arizona State University; 2 Stanford University

09:00 Si-based Dual Junction Solar Cells Enabling 1-sun Efficiency Above 30%
Christophe Allebé1, Stephanie Essig2, John Geisz3, Jérémie Werner4, David Young1, Loris Barraud1, Myles Steiner1, Matthias Bräuninger2, Scott Ward3, Antoine Descoeudres1, Arnaud Walter1, Florent Sahli2, Davide Sacchetto1, Bertrand Paviet-Salomon1, Soo-Jin Moon2, Sylvain Nicolay1, Bjorn Niesen1, Matthieu Despeisse1, Adele Tamboli2, Christophe Ballif1
1 CSEM; 2 EPFL/IMT/PV-Lab; 3 NREL

09:15 Crystalline Silicon Solar Cell with Front and Rear Poly-Si Passivating Contacts as Bottom Cell in Hybrid Tandems
Stefan Luxembourg1, Dong Zhang2, Yu Wu1, Wiljan Verhees2, Sjoerd Veenstra2, Bart Geerlings1
1 ECN Solar Energy; 2 ECN-Solliance

09:30 Monolithic III-V//Si Tandem Solar Cells with > 30% Efficiency Enabled by Wafer-bonding
Romain Cariou1, Jan Benick1, Paul Beutel1, Martin Graf1, Nico Tucker1, David Lackner1, Martin Hermle1, Stefan Glunz1, Andreas W. Bett1, Frank Dimroth1
1 Fraunhofer Institute for Solar Energy Systems ISE

09:45 - 10:15 Coffee Break
10:15 - Session 2: Modules

Rolf Böhme Saal

Chairs: Romain Couderc (CETHIL/Apollon Solar) and Ulrich Eitner (Fraunhofer ISE)

10:15 Minimizing the Potential Induced Degradation Through Polarization in PV Modules by Modification of the Dielectric Antireflection and Passivation Stack

Gaby Janssen1, Maciej Stodolny1, Bas Van Aken1, Kees Tool1, Machteld Lamers1, Ingrid Romijn1, Jochen Loffler1, Hongna Ma2, Dongsheng Zhang3, Jinchao Shi2

1 ECN-Solar Energy; 2 Yingli Energy Co.

10:30 Potential Induced Degradation of n-Type Crystalline Silicon Solar Cells

Soohyun Bae1, Wonwook Oh2, Yoonmook Kang3, Hae-Seok Lee1

1 Korea University; 2 Korea Electronic Technology Institute

10:45 Nondestructive Quantitative Analysis of Single Solar Cells in Modules

Jan Bauer1, Felix Frühauf1, Otwin Breitenstein1

1 Max Planck Institute of Microstructure Physics

11:00 System Performance Loss due to LeTID

Friederike Kersten1, Fabian Fertig1, Kai Petter1, Bernhard Klüter1, Johannes Heitmann2, Jörg W. Müller2

1 Hanwha Q Cells GmbH; 2 TU Bergakademie Freiberg

11:15 Ultra-soft Wires for Direct Soldering on Finger Grids of Solar Cells

Li Carlos Rendler1, Johann Walter1, Achim Kraft2, Christian Ebert2, Steffen Wiese3, Ulrich Eitner1

1 Fraunhofer Institute for Solar Energy Systems ISE; 2 SCHMID Group Gebr. SCHMID GmbH; 3 Saarland University
12:30 - 14:00

Poster Session 1

The poster topics are labeled with the following letters:

A Advanced characterization and simulation
B Advanced light management
C Cleaning, etching, surface morphology and associated passivation
D High efficiency devices
E Junction formation
F Module processing and materials
G Module reliability and production yield
H Novel cell structures, e.g. applying tandems, new material combinations or nanostructures
I Process integration
J Silicon material and wafering technologies
K Structuring and contact formation

1-A-mon Optical and Electrical Characterization of Poly-Si/SiO$_2$ Contacts and their Implications on Cell Design
Frank Feldmann$^1$, Martin Hermle$^1$, Ralph Müller$^1$, Massimo Nicolai$^1$, Christian Reichel$^1$
$^1$ Fraunhofer Institute for Solar Energy Systems ISE

4-A-mon Aspects of Bifacial Cell Efficiency
Gaby Janssen$^1$, Anna Carr$^1$, Eric Kossen$^1$, Ingrid Romijn$^1$, Kees Tool$^1$, Bas Van Aken$^1$
$^1$ ECN-Solar Energy

7-A-mon CELLO Photo-impedance-spectroscopy on PERC Solar Cells: Separation of Bulk and Rear Surface Defects
Andreas Schütt
CELLOscan GbR

10-A-mon Comparison of Line Wise PL Imaging and Area Wise PL Imaging
Hannes Höfler$^1$, Andreas Brand$^1$, Jonas Haunschmidt$^1$, Hans Schremmer$^2$
$^1$ Fraunhofer Institute for Solar Energy Systems ISE; $^2$ Hennecke-Systems GmbH

13-A-mon Temperature Dependent Photoluminescence Imaging Calibrated by Photoconductance Measurements
Halvard Haug$^1$, Erik Stensrud Marstein$^1$, Rune Søndénå$^1$, Marie Syre Wiig$^1$
$^1$ Institute for Energy Technology
<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
<th>Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>16-A-MON</td>
<td>Modeling of Recombination Strength at Grainboundaries after Phosphorus Diffusion Gettering and the Effect of Hydrogen Passivation</td>
<td>Marie Syre Wiig, Halvard Haug, Rune Søndenå</td>
<td>Institute for Energy Technology</td>
</tr>
<tr>
<td>19-A-MON</td>
<td>Extraction of Individual Components of Series Resistance Using TCAD Simulations Meeting the Requirements of 2- and 3-dimensional Carrier Flow of PERX and IBC Solar Cells</td>
<td>Gabriel Micard, Giso Hahn, Daniel Sommer, Barbara Terheiden</td>
<td>University of Konstanz</td>
</tr>
<tr>
<td>22-A-MON</td>
<td>Investigation of Phosphorous Diffusion Gettering in High Performance Multicrystalline Silicon Using Laser Ablation ICPMS</td>
<td>Sagnik Chakraborty, Maria Luz Loria Manalo, Jaffar Moideen</td>
<td>NUS Graduate School for Integrative Sciences and Engineering; SERIS</td>
</tr>
<tr>
<td>34-A-MON</td>
<td>On the Meaning(fullness) of the Intensity Unit ‘suns’ in Light Induced Degradation Experiments</td>
<td>Axel Herguth</td>
<td>University of Konstanz</td>
</tr>
<tr>
<td>Session</td>
<td>Title</td>
<td>Authors</td>
<td>Affiliations</td>
</tr>
<tr>
<td>---------</td>
<td>----------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>37-B-MON</td>
<td>Quantifying and Controlling the Radiative Emissivity of Crystalline Silicon Solar Cells</td>
<td>Alexander Mellor¹, Diego Alonso-Alvarez¹, Daniel Chemisana², Nicholas Ekins-Daukes¹, Lourdes Ferre-Llin¹, Ilaria Guarracino¹, Christos Markides¹, Douglas Paul¹, Alba Ramos-Cabal¹, Alberto Riverola-Lacastra¹, Stephen Thoms³</td>
<td>¹ Imperial College London; ² Universitat de Lleida; ³ University of Glasgow</td>
</tr>
<tr>
<td>43-C-MON</td>
<td>Advances in PassDop Technology: Recombination and Optics</td>
<td>Bernd Steinhauser¹, Jan Benick¹, Andreas Büchler¹, Simon Gutscher¹, Martin Hermle¹, Sven Kluska¹, Pierre Saint-Cast¹</td>
<td>¹ Fraunhofer Institute for Solar Energy Systems ISE</td>
</tr>
<tr>
<td>46-C-MON</td>
<td>Intricacies of Super Acid Passivation for Determining the Bulk Lifetime in Crystalline Silicon Wafers</td>
<td>Nicholas Grant¹, James Bullock², John Murphy¹</td>
<td>¹ University of Warwick; ² University of California</td>
</tr>
<tr>
<td>49-C-MON</td>
<td>Atomic Layer Deposited Dielectric and/or Semiconducting Oxide Multilayers for Crystalline Silicon Surface Passivation</td>
<td>Jagannath Panigrahi¹, Vandana Panwar¹, CMS Rauthan¹, Rajbir Singh¹, P.K. Singh¹</td>
<td>¹ National Physical Laboratory</td>
</tr>
<tr>
<td>52-C-MON</td>
<td>Efficient Surface Passivation of Black Silicon Using Spatial ALD</td>
<td>Ismo T. S. Heikkinen¹, Ville Malinen¹, Toni Pasanen², Päiviikki Repo², Hele Savin², Ville Vähänissi²</td>
<td>¹ Beneq Oy; ² Aalto University</td>
</tr>
<tr>
<td>55-C-MON</td>
<td>ONO for Silicon Solar Cell</td>
<td>Teng Kho</td>
<td>Australian National University</td>
</tr>
<tr>
<td>58-C-MON</td>
<td>Investigation of Nano-scaled Quasi Pyramid Texture for HIT Solar Cells Using n-Type High Performance Multicrystalline Silicon</td>
<td>Song Zhang², Zhengxin Liu², Fanying Meng², Rune Søndenå³, Gabriella Tranell¹</td>
<td>¹ NTNU; ² SIMIT; ³ IFE</td>
</tr>
<tr>
<td>61-C-MON</td>
<td>A Comparison Study of Boron Emitter Passivation by Silicon Dioxide and a PECVD Silicon Nitride Stack</td>
<td>Barbora Mojrova¹, Haifeng Chu², Radovan Kopecek², Jan Lossen², Valentin Dan Mihaietchi², Christoph Peter², Pirmin Preis²</td>
<td>¹ UMEL FEKT VUT v Brne; ² ISC Konstanz</td>
</tr>
</tbody>
</table>
Parameter Influences on Etching Silicon Wafers with HF-HCl-Cl₂-Mixtures

André Stapf¹, Christoph Gondek¹, Edwin Kroke¹, Peter Nattrodt¹
¹ TU Bergakademie Freiberg

Towards an Optimum Silicon Heterojunction Solar Cell Configuration for High Temperature and High Light Intensity Environment

Amir Abdallah
Qatar Environment and Energy Research Institute

Analysis of Contact Recombination at Rear Local Back Surface Field Via Boron Laser Doping and Screen-printed Aluminum Metallization on p-Type PERC Solar Cells

Yuka Tomizawa¹, Yoshinori Ikeda¹, Haruhiko Itoh¹, Jochen Loffler², Petra Manshanden², Ingrid Romijn², Takashi Shiro¹
¹ Teijin Ltd.; ² ECN Solar Energy

Defect Equilibration in Silicon Heterojunction Solar Cells

Loris Barraud¹, Christophe Allebé¹, Christophe Ballif², Gabriel Christmann¹, Antoine Descoeudres¹, Matthieu Despeisse¹, Antonin Faes¹, Jacques Levrat¹, Sylvain Nicolay², Bertrand Paviet-Salomon¹
¹ CSEM

Boron-diffusion During Formation of Passivating Hole-contacts

Franz-Josef Haug¹, Christophe Allebé¹, Christophe Ballif², Jörg Horzel², Andrea Ingenito¹, Phillip Löper¹, Gizem Nogay¹
¹ EPFL; ² CSEM

Effective Passivation of Crystalline Silicon Surfaces by Ultrathin Atomic-layer-deposited TiOₓ Layers

Valeriya Titova¹, Jan Schmidt¹, Dimitrij Startsev¹, Boris Veith-Wolf¹
¹ Institut für Solarenergieforschung GmbH

Dependence of n-cSi/MoOₓ Heterojunction Performance on cSi Doping Concentration

Hisham Nasser¹, Gamze Kökbudak¹, Haris Mahmood¹, Rasit Turan¹
¹ The Center for Solar Energy Research and Applications (GÜNAM)-Middle East Technical University (METU)

Solder Joint Stability Study of Wire-based Interconnection Compared to Ribbon Interconnection

Johann Walter¹, Ines Dürr¹, Christian Ebert², Ulrich Eitner¹, Achim Kraft¹, Rendler Li¹
¹ Fraunhofer Institute for Solar Energy Systems ISE; ² SCHMID Group Gebr. SCHMID GmbH
88-F-MON  Thermomechanical Stress Analysis of PV Module Production Processes by Raman Spectroscopy and FEM Simulation

Andreas Joachim Beinert¹, Jarir Aktaa², Andreas Büchler¹, Ulrich Eitner¹, Viola Haueisen¹, Pascal Romer¹
¹ Fraunhofer Institute for Solar Energy Systems ISE; ² Karlsruhe Institute of Technology (KIT)

91-G-MON  Investigation of Efficiency for PID-affected Module at Non-standard Conditions

Hong Yang¹, Jipeng Chang¹, Shuwen Guo¹, Weijing Huang², He Wang¹
¹ Xi'an Jiaotong University; ² Xi'an Huanghe Photovoltaic Technology Co., Ltd.

94-H-MON  Towards Short Circuit Current Densities of 43 mA/cm² with Microcrystalline Silicon Carbide in Heterojunction Solar Cells

Manuel Pomaska¹, Kaining Ding¹, Friedhelm Finger¹, Do Yun Kim¹, Vladimir Smirnov¹, Alexandr Zamchiy²
¹ Forschungszentrum Jülich GmbH, IEK-5 Phtovoltaik; ² Novosibirsk State University

97-H-MON  Fabrication of Si Tunnel Diodes for c-Si Based Tandem Solar Cells Using Proximity Rapid Thermal Annealing

Alain Fave¹, Jean-François Lelievre¹, Mustapha Lemiti¹
¹ INL

100-I-MON  Hybrid Front / Rear Contacted Solar Cell

Olindo Isabella¹, Fabio Roberto De Simone¹, Hao Ge¹, Gianluca Limodio¹, Guangtao Yang¹, Miro Zeman¹
¹ Delft University of Technology

103-J-MON  The Role of Cu in Microstructural Root Cause Diagnostics of Light Induced Degradation in Multi-crystalline PERC Solar Cells

Tabea Luka¹, Stephan Großer¹, Christian Hagendorf¹, Christian Kranert², Sylke Meyer¹, Marko Turek¹
¹ Fraunhofer Center for Silicon Photovoltaics CSP; ² Fraunhofer Technology Centre Semiconductor Materials THM

106-J-MON  The Influence of Residence Time on Thermal Decomposition of Monosilane

Guro Marie Wyller¹, Hallgeir Klette¹, Erik Marstein¹, Trygve Mongstad¹, Ørnulf Nordseth¹, Thomas Preston¹
¹ IFE

109-J-MON  Bulk and Surface Instabilities in Boron Doped Float-zone Samples During Light Induced Degradation Treatments

David Sperber¹, Alexander Graf¹, Giso Hahn¹, Adrian Heilemann¹, Axel Herguth¹
¹ University of Konstanz
Grain Boundaries and Dislocations in Si-bricks: Inline Characterization on As-cut Wafers

Theresa Strauch¹, Matthias Demant¹, Stefan Rein¹
¹ Fraunhofer Institute for Solar Energy Systems ISE

Controlling Surface Contamination Issues in the Fabrication Environment of High Efficiency Crystalline Silicon-based Homojunction Solar Cells

Hélène Lignier¹, Sébastien Dubois¹, Erwann Picard¹
¹ CEA

New Methods to Evaluate Cleaning Processes by Detecting the Particle Load on Surfaces of Diamond Wire Sawn Silicon Wafers

Lydia Lottspeich¹, Thomas Kaden¹, Hubertus Richter¹
¹ Fraunhofer Technology Centre Semiconductor Materials THM

Local Optimization of Graphite Heater to Save a Power Consumption of Czochralski Si Ingot Grower for PV Application

Wooseok Nam¹, Boram Lee¹, Gyungho Seo¹
¹ Woongjinenergy Co.

Low Temperature Gettering for Improved Multicrystalline Silicon

John Murphy¹, Mohammad Al-Amin¹
¹ University of Warwick

Growth Uniformity of Epitaxy Silicon Grown at 200 °C Using 60 MHz Very High Frequency Plasma Enhanced Vapor Phase Epitaxy

Ka-Hyun Kim¹, Ji-Eun Hong¹, YimHyun Jo¹, Dong Suk Kim¹, Hyun Yoon¹
¹ Korea Institute of Energy Research

Mg’nificent Electron Contacts for n-Type Silicon Solar Cells: Metal, Oxide, and Fluoride

Yimao Wan¹, Thomas Allen¹, James Bullock², Andres Cuevas¹, Jie Cui¹, Mark Hettick¹, Ali Javey², Jun Peng¹, Christian Samundsett¹, Di Yan¹
¹ Australian National University; ² University of California, Berkeley

Benefits of Different Process Routes for Industrial Direct Front Side Plating

Norbert Bay¹, Andreas Brand¹, John Burschik¹, Andreas Büchler¹, Pysch Damian¹, Sven Kluska¹, Holger Kuehnlein¹, Sieber Markus¹, Michael Passig¹
¹ RENA Technologies GmbH; ² Fraunhofer Institute for Solar Energy Systems ISE
139-K-MON Low Activity Tabbing Pastes for Passivated Surface
Yi Yang, Chilong Chen, Lindsey Karpowich, Maryam Kazemzadeh Dehdashti, Guang Zhai
1 Heraeus Precious Metals

14:00 - 14:15 Short Coffee Break

14:15 - **Invited Talk**
14:45 - **Session 3: PERC Cells and Passivation**

**14:45 - Session 3: PERC Cells and Passivation**
Rolf Böhme Saal

**14:45**
An Enhanced Alneal Process to Produce Surface Recombination Velocities Below 1 cms⁻¹
1 University of Oxford; 2 The Australian National University

15:00 Structure and Composition of Phosphosilicate Glass Layers Formed by POCl₃ Diffusion
*Sabrina Werner*, Wasan Hasan, Stefan Maiert, Anamaria Moldovan, Samer Mourad, Andreas Wolf, Martin Zimmer
1 Fraunhofer Institute for Solar Energy Systems ISE; 2 Energy and Minerals Regulatory Commission

---

Prof. Henry Snaith FRS is a professor of physics at Oxford University and is CSO and Founder of Oxford PV Ltd. His research is focused on developing new materials for photovoltaics and understanding and controlling the optoelectronic processes occurring within the devices and at heterojunctions. He has made a number of significant contributions to the field of photovoltaics research, with the most notable being the discovery of the remarkable PV properties of metal halide perovskites. He was awarded the Institute of Physics Patterson Medal in 2012, named as one of “nature’s ten” people who mattered in 2013, received the Materials Research Society Outstanding Young Investigator award in 2014, elected as a member of the Royal Society in 2015, assessed to be the 2nd “most influential scientific mind” in 2016 and will be awarded the Royal Society Kavli Medal and Lecture in 2017.
<table>
<thead>
<tr>
<th>Time</th>
<th>Session Title</th>
<th>Authors</th>
<th>Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:15</td>
<td>Passivation of Black Silicon Phosphorus Emitters with ALD SiO$_2$/Al$_2$O$_3$ Stacks</td>
<td>Toni Pasanen$^1$, Hele Savin$^1$, Ville Vähänissi$^1$</td>
<td>Aalto University</td>
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<td>15:30</td>
<td>Mass Production of p-Type Cz Silicon Solar Cells Approaching Average Stable Conversion Efficiencies of 22%</td>
<td>Fabian Fertig$^1$, Matthias Bartzsch$^1$, Janko Cieslak$^1$, Klaus Duncker$^1$, Andreas Eidner$^1$, Steffen Geißler$^1$, Angelika Hofmann$^1$, Stefan Hörnlein$^1$, Enrico Jarzembowski$^1$, Daniel J.W. Jeong$^1$, Matthias Junghänel$^1$, Maximilian Kauert$^1$, Friederike Kersten$^1$, Christian Klenke$^1$, Ronny Lantzsch$^1$, Ansgar Mette$^1$, Andreas Mohr$^1$, Jörg W. Müller$^1$, Larissa Niebergall$^1$, Stefan Peters$^1$, Tomasz Rudolph$^1$, Martin Schaper$^1$, Axel Schwabedissen$^1$, Antje Schönmann$^1$, Matthias Schütze$^1$, Anika Weihrauch$^1$, Dirk Wissen$^1$</td>
<td>$^1$ Hanwha Q Cells GmbH</td>
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<td>15:45</td>
<td>Development and Characterization of Multifunctional Passdop Layers for Local P+-laser Doping</td>
<td>Mohammad Hassan Norouzi$^1$, Jan Benick$^2$, Bernd Bitnar$^2$, Marc Hofmann$^1$, Elmar Lohmüller$^1$, Pierre Saint-Cast$^1$, Bernd Steinhauser$^1$, Sabrina Werner$^1$, Andreas Wolf$^1$</td>
<td>Fraunhofer Institute for Solar Energy Systems ISE; $^2$ Solar World Innovations GmbH</td>
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<td>16:00</td>
<td>Insights into the Reliability of Ni/Cu Plated p-PERC Silicon Solar Cells</td>
<td>Chi Dang$^1$, Filip Duerinckx$^1$, Riet Labie$^1$, Robert Mertens$^1$, Jef Poortmans$^1$, Richard Russell$^1$, Eddy Simoen$^1$, Loïc Tous$^1$</td>
<td>$^1$ KU Leuven / imec</td>
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<td>16:15 - 16:45</td>
<td>Coffee Break</td>
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<td>16:45 - 18:00</td>
<td>Session 4: Modeling and Simulation</td>
<td>Rolf Böhme Saal</td>
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<td>16:45</td>
<td>The Concept of Skins for (Silicon) Solar Cell Modelling</td>
<td>Andreas Fell$^1$, Stefan Glunz$^1$, Martin Schubert$^1$</td>
<td>Fraunhofer Institute for Solar Energy Systems ISE</td>
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<tr>
<td>17:00</td>
<td>CASSANDRA – A Tool for Analysis and Prediction of Time Resolved BO Defect Dynamic on Lifetime and Cell Level</td>
<td>Axel Herguth$^1$, Svenja Wilking$^1$</td>
<td>University of Konstanz</td>
</tr>
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</table>
17:15 Experimental Verification of Internal Resistance Models for PERT-type Solar Cells
Sebastian Meier\textsuperscript{1}, Andreas Brand\textsuperscript{1}, Tobias Fellmeth\textsuperscript{1}, Stefan Glunz\textsuperscript{1}, Jan Hofmann\textsuperscript{1}, Simon Unmüßig\textsuperscript{1}, Andreas Wolf\textsuperscript{1}
\textsuperscript{1} Fraunhofer Institute for Solar Energy Systems ISE

17:30 Metamodeling of Numerical Device Simulations to Rapidly Create Efficiency Optimization Roadmaps of Monocrystalline Silicon PERC Cells
Sven Wasmer\textsuperscript{1}, Andreas Brand\textsuperscript{1}, Johannes Greulich\textsuperscript{1}, Elmar Lohmüller\textsuperscript{1}
\textsuperscript{1} Fraunhofer Institute for Solar Energy Systems ISE

17:45 Accurate Opto-electrical Modelling of IBC Solar Cells Based on Poly-Si Carrier-selective Passivating Contacts
Paul Procel\textsuperscript{1}, Felice Crupi\textsuperscript{2}, Andrea Ingenito\textsuperscript{1}, Olindo Isabella\textsuperscript{1}, Guangtao Yang\textsuperscript{1}, Miro Zeman\textsuperscript{1}
\textsuperscript{1} TU Delft; \textsuperscript{2} Universita Della Calabria

18:30 Technical Tour

Tuesday, April 04, 2017

08:00 - 08:30 Registration

08:30 - 10:00 Session 5: Defects in Mono-crystalline Silicon
Rolf Böhme Saal
Chair: Stefan Rein (Fraunhofer ISE) and Jan Schmidt (ISFH)

08:30 Multiple Pathways for Permanent Deactivation of Boron-oxygen Defects in p-Type Silicon
Nitin Nampalli\textsuperscript{1}, Malcolm Abbott\textsuperscript{1}, Brett Hallam\textsuperscript{1}, Moonyong Kim\textsuperscript{1}, Hongzhao Li\textsuperscript{1}, Bruno Stefani\textsuperscript{1}, Stuart Wenham\textsuperscript{1}
\textsuperscript{1} UNSW Australia

08:45 New Insights into Boron-oxygen Related Degradation
Brett Hallam\textsuperscript{1}, Malcolm Abbott\textsuperscript{1}, Moonyong Kim\textsuperscript{1}, Nitin Nampalli\textsuperscript{1}, Tine Nærland\textsuperscript{2}, Bruno Stefani\textsuperscript{1}, Stuart Wenham\textsuperscript{1}
\textsuperscript{1} UNSW Australia; \textsuperscript{2} Arizona State University

09:00 On the Equilibrium Concentration of Boron-oxygen Defects in Crystalline Silicon
Dominic Walter\textsuperscript{1}, Thomas Pernau\textsuperscript{2}, Jan Schmidt\textsuperscript{1}
\textsuperscript{1} Institute for Solar Energy Research Hamelin (ISFH); \textsuperscript{2} centrotherm photovoltaics AG
09:15 On the Defect Responsible for the Carrier Injection-induced Degradation of Uncompensated n-Type Czochralski Silicon

Eléonore Letty1, Mickael Albaric1, Adrien Danet1, Wilfried Favre1, Mustapha Lemiti2, Jordi Veirman1
1 CEA INES; 2 INL

09:30 Controlling Impurity Distribution in Quasi-mono Crystalline Si Ingot by Seed Manipulation for Artificially Controlled Defect Technique

Yusuke Hayama1, Isao Takahashi1, Noritaka Usami1
1 Nagoya University

10:00 - 10:30 Coffee Break

10:30 - 12:00 Session 6: Defects in Multi-crystalline Silicon

Rolf Böhme Saal

Chairs: Giso Hahn (University of Konstanz) and Andreas Bett (Fraunhofer ISE)

10:30 Kinetics of Carrier-induced Degradation at Elevated Temperature in Multicrystalline Silicon Solar Cells

Wolfram Kwapil1, Tim Niewelt1, Martin C. Schubert1
Presented by Tim Niewelt1
1 Fraunhofer Institute for Solar Energy Systems ISE

10:45 Light-induced Lifetime Degradation in Multicrystalline Silicon: Detailed Kinetics of the Defect Activation

Dennis Bredemeier1, Jan Schmidt1, Dominic Walter1
1 Institute for Solar Energy Research Hamelin (ISFH)

11:00 Impact of Annealing on the Formation and Mitigation of Carrier-induced Defects in Multi-crystalline Silicon

Tsun Hang Fung
University of New South Wales

11:15 Recovery of LeTID by Low Intensity Illumination: Reaction Kinetics, Completeness and Threshold Temperature

Axel Herguth1, Christian Derricks1, Philipp Keller1, Barbara Terheiden1
1 University of Konstanz

11:30 Firing Temperature Profile Impact on Light Induced Degradation in Multicrystalline Silicon

Rebekka Eberle1, Stefan Glunz1, Wolfram Kwapil1, Florian Schindler1, Martin Schubert1
1 Fraunhofer Institute for Solar Energy Systems ISE
11:45 Increasing Yield of Cast-silicon Ingots Via Tabula Rasa Anneal

Hannu Laine¹, Antti Haarahiltunen¹, Morten Lindeberg¹, Zhengjun Liu¹, Hele Savin¹, Ville Vähänissi¹, Marko Yli-Koski¹

¹ Aalto University

12:00 - Lunch Break

13:00 - 14:30 Poster Session 2

The poster topics are labeled with the following letters:

A Advanced characterization and simulation
B Advanced light management
C Cleaning, etching, surface morphology and associated passivation
D High efficiency devices
E Junction formation
F Module processing and materials
G Module reliability and production yield
H Novel cell structures, e.g. applying tandems, new material combinations or nanostructures
I Process integration
J Silicon material and wafering technologies
K Structuring and contact formation

2-A-TUE Identifying the Location of Recombination from Voltage-dependent Quantum Efficiency Measurements

Byungsul Min¹, Karsten Bothe¹, Rolf Brendel¹, Christian Kruse¹, Matthias Müller², Hendrik Sträter²

¹ Institute for Solar Energy Research Hamelin (ISFH); ² Solar World Innovations GmbH


Fabien Lebreton

Total GRP - New energies

8-A-TUE Effect of Annealing on the Defect Causing Copper-related Light-induced Degradation in p-Type Silicon

Henri Vahlman¹, Antti Haarahiltunen¹, Alessandro Inglese¹, Wolfram Kwapi³, Hele Savin¹, Jonas Schön³

¹ Aalto University; ² Fraunhofer Institute for Solar Energy Systems ISE
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<th>Session</th>
<th>Title</th>
<th>Authors</th>
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<tr>
<td>11-A-TUE</td>
<td>Stability of AlOx Surface Passivation Schemes Under In-field Application Conditions</td>
<td>Tim Niewelt¹, Wolfram Kwapi³, Martin C. Schubert², Marisa Selinger³</td>
<td>¹ Freiburg Materials Research Center; ² Fraunhofer Institute for Solar Energy Systems ISE</td>
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<td>14-A-TUE</td>
<td>Comparing Impact of Temperature and Humidity on CdTe and Silicon Solar Cells Globally</td>
<td>Ian Marius Peters¹, Tonio Buonassisi², Haohui Liu²</td>
<td>¹ Massachusetts Institute of Technology; ² Solar Energy Research Institute of Singapore (SERIS)</td>
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<td>17-A-TUE</td>
<td>Enabling Stress Determination on Random Pyramid Textured Silicon using Raman Spectroscopy</td>
<td>Andreas Büchler¹, Andreas Beinert¹, Viola Haueisen¹, Friedemann Heinz², Sven Kluska¹, Martin Schubert¹</td>
<td>¹ Fraunhofer Institute for Solar Energy Systems ISE</td>
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<td>20-A-TUE</td>
<td>Replacing NRA by Fast GD-OES Measurements as Input to a Model Based Prediction of Hydrogen Diffusion in A-Si</td>
<td>Jonathan Steffens¹, Sebastian Gerke³, Giso Hahn¹, Sebastian Joos¹, Barbara Terheiden¹</td>
<td>¹ University of Konstanz; ² IBM Research - Zurich</td>
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<tr>
<td>23-A-TUE</td>
<td>Fast Large Area Reflectivity Scans of Wafers and Solar Cells with High Spatial Resolution</td>
<td>Andreas Schütt¹, Jens Hirsch¹, Dominik Lausch³, Sylke Meyer³, Stefanie Wahl¹</td>
<td>¹ CELLOscan GbR; ² Hochschule Anhalt; ³ Fraunhofer Center for Silicon Photovoltaics CSP</td>
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<td>26-A-TUE</td>
<td>Interfacial Workfunction and its Impact on Open-circuit Voltage in Transition-metal-oxide/silicon-oxide Contact Stacks</td>
<td>Takefumi Kamioka¹, Yutaka Hayashi¹, Lee Hyunju¹, Yuki Isogai¹, Kyotaro Nakamura¹, Yoshio Ohshita¹, Fumihiko Yamada¹</td>
<td>¹ Toyota Technological Institute; ² Meiji University</td>
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<td>29-A-TUE</td>
<td>Light Induced Degradation of High-performance Multicrystalline Silicon Solar Cells</td>
<td>Marko Turek¹, Christian Kranert², Kai Petter¹, Kai Sporleder¹</td>
<td>¹ Fraunhofer Center for Silicon Photovoltaics CSP; ² Fraunhofer Technology Centre Semiconductor Materials THM; ³ Hanwha Q Cells GmbH</td>
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<td>32-A-TUE</td>
<td>Loss Analysis of 22% Efficient Industrial PERC Solar Cells</td>
<td>Matthias Müller¹, Bernd Bitnar², Gerd Fischer², Christian Kusterer², René Köhler², Maria Mühlbauer², Dirk-Holger Neuhaus², Alexander Oehlke², Phedon Palinginis², Philipp Richter², Roman Schiepe², Stefan Steckemetz², Hendrik Sträter², Matthias Wagner², Franziska Wolny²</td>
<td>¹ TU Bergakademie Freiberg; ² Solar World Innovations GmbH</td>
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<td>35-A-TUE</td>
<td>Distributed Series Resistance in a One-dimensional Two-diode Model Revisited</td>
<td>Jan-Martin Wagner¹, Otwin Breitenstein², Jürgen Carstensen¹, Sven Rißland², Andreas Schütt¹</td>
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<td>¹ University of Kiel; ² Max Planck Institute of Microstructure Physics</td>
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<td>41-A-TUE</td>
<td>Fundamental Consideration About Junction Formation Strategies for Phosphorus-doped Emitters with ( j_{0e} &lt; 10 \text{ fA/cm}^2 )</td>
<td>Byungsul Min¹, Karsten Bothe¹, Rolf Brendel¹, Jan Krügener², Matthias Müller³</td>
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<td>¹ Institute for Solar Energy Research Hamelin (ISFH); ² Institut für Materialien und Bauelemente der Elektronik; ³ Solar World Innovations GmbH</td>
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<td>44-A-TUE</td>
<td>Oxygen-related Defects in n-Type Czochralski Silicon Wafers Studied by Hyperspectral Photoluminescence Imaging</td>
<td>Torbjørn Mehl¹, Ingunn Burud¹, Espen Olsen¹</td>
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<td>¹ Norwegian University of Life Sciences</td>
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<td>47-B-TUE</td>
<td>Rear Passivated mc-Si Solar Cells Textured by Atmospheric Pressure Dry Etching</td>
<td>Pierre Saint-Cast¹, Lorent Clochard², Timo Freund¹, Marc Hofmann¹, Bishal Kafle¹, Rahul Pandey¹, Michael Pittroff¹, Ralf Preu¹, Ahmed Ismail Ridoy¹, Thomas Schwarze³</td>
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<td>¹ Fraunhofer Institute for Solar Energy Systems ISE; ² Nines Photovoltaics; ³ Solvay Fluor GmbH</td>
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<td>50-B-TUE</td>
<td>Optical Properties of Metal Nanoparticles Integrated Silicon Wafers of Different Thickness: Role of Light Incident Angle in Plasmonic Light Trapping</td>
<td>Piyush Kumar Parashar¹, Rampal Sharma³</td>
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<td>¹ Indian Institute of Technology Delhi</td>
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<td>53-C-TUE</td>
<td>Shielded Hydrogen Passivation – A Novel Method for Introducing Hydrogen into Silicon</td>
<td>Gabrielle Bourret-Sicotte¹, Ruy S Bonilla¹, Katherine A Collett¹, Phillip Hamer¹, Peter R Wilshaw¹</td>
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<td>¹ University of Oxford</td>
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<td>56-C-TUE</td>
<td>Improvement in the a-Si/c-Si Interface Passivation Using Cyclic Hydrogen Plasma Treatment During the a-Si Deposition</td>
<td>Aldrin Antony¹, Anishkumar Soman¹</td>
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<td>¹ Indian Institute of Technology Bombay</td>
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Silicon Oxide and Silicon Carbide Thin Films as n-Doped Front Surface Field Layers in Bifacial Silicon Heterojunction Solar Cells

Oleg Sergeev¹, Carsten Agert¹, Alex Neumueller¹, Ivan Shutsko¹, Martin Vehse¹
¹ NEXT ENERGY EWE-Forschungszentrum für Energietechnologie e. V. at Carl von Ossietzky University Oldenburg

Analysis of Full-wafer Size Co-diffused BC-BJ Silicon Solar Cells Using a Novel Screen-printing Boron Doping Paste

Jonas D. Huyeng
Fraunhofer Institute for Solar Energy Systems ISE

Ion Implanted Gallium Doped PolySi:Ga/SiO₂ Passivated Contacts to n-Cz Wafers with iVoc >720 mV

David Young¹, Vincenzo LaSalvia¹, Benjamin Lee¹, William Nemeth¹, Matthew Page¹, Pauls Stradins¹, San Theingi¹, Matthew Young¹
¹ NREL

Introducing Pinhole Magnification by Selective Etching: Application to Poly-Si on Ultra-thin Silicon Oxide Films

Dominic Tetzlaff¹, Marvin Dzinnik¹, Uwe Höhne², Jan Krügener¹, Jan-Dirk Kähler¹, Yevgeniya Larionova¹, Robby Peibst¹, Sina Reiter¹, Mircea Turcu¹, Tobias F. Wietler¹
¹ Leibniz Universität Hannover, Institute of Electronic Materials and Devices; ² centrotherm photovoltaics AG; ³ Institute for Solar Energy Research Hamelin (ISFH)

Effects of Different Al Pastes with Different Particle Sizes on Rear Local Contact and Passivated Emitter and Rear Cell Performance

Supawan Joonwichien¹, Toshimitsu Mochizuki¹, Katsuhiko Shirasawa¹, Hidetaka Takato¹
¹ National Institute of Advanced Industrial Science and Technology (AIST)

Understanding of Annealing Impact on Tunnel Oxide Passivated Contacts Solar Cells

Hyunjung Park¹, Ji Yeon Hyun¹, Yoonmook Kang¹, Hyunho Kim², Jaeeun Kim¹, Hae-Seok Lee¹, Hyomin Park¹, Se Jin Park¹, In Seoul Song¹, Jee Woong Yang²
¹ Korea University; ² LG Electronics; ³ KU-KIST Green School, School of Energy and Environment, Korea University

Sputter-deposited WO₃ and MoO₃ for Hole Selective Contacts

Martin Bivour¹, Martin Hermle¹, Paul Ndione¹
¹ Fraunhofer Institute for Solar Energy Systems ISE
80-F-TUE  Ribbon Interconnection of 6” BC-BJ Solar Cells  
Johann Walter¹, Ulrich Eitner¹, Andreas Halm², Achim Kraft¹, Valentin Mihailetchi², Li Rendler¹  
¹ Fraunhofer Institute for Solar Energy Systems ISE; ² ISC Konstanz

83-G-TUE  Qualification of Conductive Adhesives for Photovoltaic Application – Accelerated Ageing Test Design  
Ines Dürr¹, Torsten Geipel¹, Achim Kraft¹, Daniel Philipp¹  
Presented by Luciana Pitta Bauermann¹  
¹ Fraunhofer Institute for Solar Energy Systems ISE

86-G-TUE  Study on Power Degradation of Crystalline Silicon Solar Modules  
He Wang¹, Wenshuang He¹, Jingsheng Huang², Ao Wang¹, Hong Yang¹, Junjun Zhang²  
¹ Xi’an Jiaotong University; ² China Electric Power Research Institute

89-G-TUE  Performance of Light and Dark Current-voltage Characteristics for PID-affected Monocrystalline Silicon Photovoltaic Modules  
Hong Yang¹, Jipeng Chang¹, Shiyu Sang², He Wang¹, Pan Zhao¹  
¹ Xi’an Jiaotong University; ² Institute of Electrical Engineering of the Chinese Academy of Sciences

92-H-TUE  Self-catalyzed High-quality Core-shell GaAsP NWs and the Application on Photovoltaics  
Yunyan Zhang¹, Martin Aagesen², Huiyun Liu¹, Ana Sanchez³  
¹ University College London; ² Gasp Solar ApS; ³ Department of Physics, University of Warwick

95-H-TUE  Donor and Acceptor Levels in Impurity-doped Semiconducting BaSi Thin Films for Solar Cells Application  
Muhammad Ajmal Khan¹, Takashi Suemasu²  
¹ National Institute of Technology, Fukushima College; ² Institute of Applied Physics, University of Tsukuba

98-I-TUE  Influence of Nitride and Nitridation on the Doping Properties of PECVD-deposited BSG Layers  
Friedrich Lottspeich¹, René Köhler¹, Phedon Palinginis¹, Eric Schneiderlöchner¹  
¹ SolarWorld Industries Sachsen GmbH

101-I-TUE  High-throughput Front and Rear Side Metallization of Silicon Solar Cells Using Rotary Screen Printing  
Andreas Lorenz¹, Heinz Brocker², Florian Clement¹, Roland Greutmann², Martin Lehner³, Anna Münzer¹, Maximilian Pospischil¹, Holger Reinecke⁴  
Presented by Anna Münzer¹  
¹ Fraunhofer Institute for Solar Energy Systems ISE; ² Gallus Ferd. Ruesch AG; ³ Lehner Engineering GmbH; ⁴ Albert-Ludwigs-Universität
104-I-TUE  High Efficiency n-PERT Solar Cells by B/P Co-diffusion Method  
Sanyang Zhang\textsuperscript{1}, Weifei Lian\textsuperscript{1}, Xiaorui Liu\textsuperscript{1}, Junyu Lu\textsuperscript{1}, Zhichun Ni\textsuperscript{1}, Qingzhu Wei\textsuperscript{1}, Chenyang Wu\textsuperscript{1}, Shuanglong Yu\textsuperscript{2}  
\textsuperscript{1} Zhongli Talesun Solar Co., Ltd, Research and Development Department; \textsuperscript{2} Nanjing University of Aeronautics & Astronautics

107-J-TUE  Two-stage Permanent Deactivation of the Boron-oxygen-related Recombination Center in Crystalline Silicon  
Verena Steckenreiter\textsuperscript{1}, Jan Schmidt\textsuperscript{1}, Dominic C. Walter\textsuperscript{1}  
\textsuperscript{1} Institute for Solar Energy Research Hamelin (ISFH)

110-J-TUE  Temperature Dependent Degradation and Regeneration of Differently Doped mc-Si Materials  
Jakob Fritz\textsuperscript{1}, Giso Hahn\textsuperscript{1}, Daniel Skorka\textsuperscript{1}, Annika Zuschlag\textsuperscript{1}  
\textsuperscript{1} University of Konstanz

113-J-TUE  Thin Silicon Solar Cells: Pathway to Cost-effective and Defect-tolerant Cell Design  
Andre Augusto\textsuperscript{1}, Stuart Bowden\textsuperscript{1}, Tonio Buonassisi\textsuperscript{2}, Carlos Canizo\textsuperscript{1}, Erin Looney\textsuperscript{2}  
\textsuperscript{1} Arizona State University; \textsuperscript{2} Massachusetts Institute of Technology; \textsuperscript{3} Universidad Politecnica de Madrid

116-J-TUE  Minority Carrier Lifetimes in Cz-Si Wafers with Intentional V-I Transitions  
Rune Søndenå\textsuperscript{1}, Mari Juel\textsuperscript{2}, Birgit Ryningen\textsuperscript{2}  
\textsuperscript{1} IFE; \textsuperscript{2} SINTEF

119-J-TUE  Optimization and Ultraviolet Stability of Thermally Deposited Al\textsubscript{2}O\textsubscript{3} on Crystalline Silicon Solar Cells  
In Seol Song  
Korea University

122-J-TUE  CVD Silicon Film Growth on Powder Substrates Using an Inline Optical System  
Filipe Serra\textsuperscript{1}, José A. Silva\textsuperscript{1}, João M. Serra\textsuperscript{1}, António M. Vallera\textsuperscript{1}  
Presented by José A. Silva\textsuperscript{1}  
\textsuperscript{1} Instituto Dom Luiz, Faculdade de Ciências, Universidade de Lisboa

125-K-TUE  Challenges for Lowly-doped Phosphorus Emitters in Silicon Solar Cells with Screen-printed Silver Contacts  
Sabrina Werner\textsuperscript{1}, Elmar Lohmüller\textsuperscript{1}, Stefan Maier\textsuperscript{1}, Samer Mourad\textsuperscript{1}, Andreas Wolf\textsuperscript{1}  
\textsuperscript{1} Fraunhofer Institute for Solar Energy Systems ISE
Contact Resistivity Reduction on Lowly-doped n-Type Si Using a Low Work Function Metal and a Thin TiO$_x$ Interfacial Layer for Doping-free Si Solar Cells

Jinyoun Cho$^1$, Twan Bearda$^2$, Maarten Debucquoy$^1$, Miha Filpic$^2$, Ivan Gordon$^1$, Shuja Malik$^1$, Jef Poortmans$^2$, Maria Recaman Payo$^2$, Hariharusdan Sivaramakrishnan Radhakrishnan$^2$, Jozef Szlufcik$^2$

$^1$ KU Leuven / imec; $^2$ imec

Co-diffused Bi-facial PERT Solar Cells

Tobias Fellmeth$^1$, Florian Clement$^1$, Sebastian Meier$^1$, Andreas Wolf$^1$

$^1$ Fraunhofer Institute for Solar Energy Systems ISE

Decoupling the Metal Layer of Back Contact Solar Cells – Optical and Electrical Benefits

Udo Römer$^1$, Alison Lennon$^1$, Zhongtian Li$^1$, Yang Li$^1$, Yuan ShengZhao$^1$, Ning Song$^1$, Pierre J. Verlinden$^1$, XueLing Zhang$^2$

$^1$ School of Photovoltaics and Renewable Energy Engineering; $^2$ State Key Laboratory of PV Science and Technology

Exploiting Bifacial Deposition of Ald AIo$_x$ for p-Type PERC Solar Cells

Alexander To$^1$, Bram Hoex$^1$, Xiang Li$^2$, Wei Min Li$^2$

$^1$ UNSW Australia; $^2$ Leadmicro Nano-Equipment Technology Ltd

Short Coffee Break

Session 7: Characterization

Rolf Böhme Saal

Comparison of Iron-related Recombination Centers in Boron, Gallium and Indium Doped Silicon Analyzed by Defect Parameter Contour Plotting

Tine Naerland$^1$, Simone Bernardini$^1$, Mariana Bertoni$^1$

$^1$ Arizona State University

Implementing Correlative Microscopy Techniques to Detect and Quantitatively Map Oxygen-related Defects

Amanda Youssef$^1$, Tony Buonassisi$^1$, Mallory Jensen$^1$, Barry Lai$^2$, Hannu Laine$^1$, Erin Looney$^1$, Ashley Morishige$^1$

$^1$ MIT; $^2$ Argonne National Laboratory
15:15 Light Beam Induced Current of Light-induced Degradation in High-performance Multicrystalline Al-BSF Cells
Jeanette Lindroos¹, Kai Petter¹, Markus Rinio³, Kai Sporleder⁴, Marko Turek⁴
¹ University of Konstanz; ² Hanwha Q Cells GmbH; ³ Karlstad University; ⁴ Fraunhofer Center for Silicon Photovoltaics CSP

15:30 Fast Optical Measurement System: Enabling Ultrafast External Quantum Efficiency Measurements on c-Si Solar Cells
Jimmy Melskens¹, Stefaan Heirman¹, Remko Koornneef¹, Marc Schouten¹
¹ Delft Spectral Technologies B.V.

15:45 Extension of the Fuyuki Approximation for Luminescence Image Evaluation
Otwin Breitenstein¹, Karsten Bothe², Felix Frühauf², David Hinken²
¹ Max Planck Institute of Microstructure Physics; ² Institute for Solar Energy Research Hamelin (ISFH)

16:00 Impact of Contacting Geometries on Measured Fill Factors
Christian Kruse¹, Karsten Bothe¹, Rolf Brendel¹, David Hinken¹, Carsten Schinke¹, Martin Wolf¹
¹ Institute for Solar Energy Research Hamelin (ISFH)

16:15 - 16:45 Coffee Break

16:45 - 18:00 Session 8: Optics: Cells and Modules
Rolf Böhme Saal

Chairs: Gaby Janssen (ECN) and Pietro Altermatt (Trinasolar)

16:45 Comprehensive Analysis of Optical Texture Properties on Solar Cell and Module Level Using the OPTOS Formalism
Nico Tucher¹, Benedikt Bläsi¹, Johannes Eisenlohr¹, Habtamu Gebrewold³, Jan Christoph Goldschmidt¹, Hubert Hauser¹, Oliver Höhn¹
¹ Fraunhofer Institute for Solar Energy Systems ISE

17:00 PV Module Current Gains due to Structured Backsheets
Malte Ruben Vogt¹, Susanne Blankemeyer¹, Karsten Bothe¹, Rolf Brendel¹, Patrice Bujard¹, Hendrik Holst¹, Jan-Bernd Kues¹, Marc Köntges¹, Henning Schulte-Huxel¹
¹ Institute for Solar Energy Research Hamelin (ISFH); ² BASF Schweiz AG; ³ BASF Coatings GmbH
17:15 Encapsulant for Glass/Glass PV Modules for Minimum Optical Losses: Gas or EVA
Romain Couderc¹, Mohamed Amara², Julien Degoulange³, Roland Einhaus³, Frédéric Madon³
¹ CETHIL/Apollon Solar; ² CETHIL; ³ Apollon Solar

17:30 Enhancing Optical Performance of Glass-glass Bifacial PV Modules
Yong Sheng Khoo¹, Min Hsian Saw¹, Jai Prakash Singh¹, Yan Wang¹
¹ Solar Energy Research Institute of Singapore (SERIS)

17:45 Near-field Partial Shading on Rear Side of Bifacial Modules
Bas Van Aken¹, Koen de Groot¹
¹ ECN Solar Energy

19:00 - 19:30 Dinner Reception
19:30 Dinner

Wednesday, April 05, 2017

08:00 - 08:30 Registration

08:30 - 08:45 Opening Session nPV
08:45 Opening
Arthur Weeber, ECN

08:45 - 09:15 Invited Talk
09:15 Exceeding Conversion Efficiency of 26% by Silicon Heterojunction Technology
Kunta Yoshikawa, Kaneka Corporation
Dr. Kunta Yoshikawa received his Bachelor, Master and Ph.D. degree of Physical Science at the Hiroshima University in 2003, 2004 and 2006 respectively. In 2006, he joined Kaneka Corporation (Japan), and initially worked on thin film silicon photovoltaic research. In 2009, he was assigned to the Kaneka European Photovoltaic laboratory which was established at the imec premises (Belgium), where he worked mainly on crystalline silicon solar cells such as heterojunction solar cells and homojunction interdigitated back contact cells. In 2013, he went back to Japan, assigned to the Photovoltaic & Thin Film Device Research Laboratories and has been leading the R&D of the next generation high efficiency silicon solar cells at Kaneka.

09:15 - Session 9: IBC Cells
10:15

Rolf Böhme Saal

Chairs: Jef Poortmans (imec) and Stefan Glunz (Fraunhofer ISE)

09:15 Improvement of the SRH Bulk Lifetime Upon Formation of n-Type Polo Junctions for 25% Efficient Si Solar Cells

Jan Krügener1, Rolf Brendel2, Felix Haase2, H. Jörg Osten1, Robby Peibst2, Michael Rienäcker2

1 Institute of Electronic Materials and Devices; 2 Institute for Solar Energy Research Hamelin (ISFH)

09:30 Poly-Si(02) Passivating Contacts for High-efficiency C-Si IBC Solar Cells

Guangtao Yang1, Andrea Ingenito1, Olindo Isabella1, Gianluca Limodio1, Arthur Weeber1, Miro Zeman1

1 Delft University of Technology

09:45 Simple Interdigitated Back-contacted Silicon Heterojunction Solar Cells with an Interband Silicon Tunnel Junction

Andrea Tomasi1, Nicolas Bade1, Christophe Ballif1, Loris Barraud2, Gabriel Christmann1, Stefaan De Wolf1, Antoine Descoeudres2, Antonin Faes2, Jonas Geissbuhler1, Jan Haschke1, Quentin Jeangros1, Damien Lachenal1, Despeisse Matthieu2, Sylvain Nicolas2, Bertrand Pavet-Salomon2, Johannes Seif3, Benjamin Strahm3

1 EPFL - PV-Lab; 2 CSEM; 3 Meyer Burger Research
10:00  Impact of the Homogeneous Junction Breakdown in IBC Solar Cells on the Passivation Quality of Al₂O₃ and SiO₂: Degradation and Regeneration Behaviour

Ralph Müller
Fraunhofer Institute for Solar Energy Systems ISE

Coffee Break

10:45  Session 10:
Selective Contacts with Silicon Oxide

Rolf Böhme Saal

Chairs: Rolf Brendel (ISFH) and Oliver Schultz-Wittmann (OSW-Photovoltaics)

10:45  Silicon Solar Cells with Passivated Rear Contacts: Influence of Wafer Resistivity and Thickness
Armin Richter¹, Jan Benick¹, Frank Feldmann¹, Andreas Fell¹, Stefan W. Glunz¹, Martin Hermle¹
¹ Fraunhofer Institute for Solar Energy Systems ISE

11:00  Effect of the SiO₂ Interlayer Properties with Solid-source Hydrogenation on Passivated Contact Performance and Surface Passivation
Bill Nemeth¹, Steve Harvey¹, Vincenzo LaSalvia¹, Benjamin Lee¹, Jian Li¹, Matthew Page¹, Paul Stradins¹, Ajay Upadhyaya², David Young¹
¹ NREL; ² Georgia Institute of Technology

11:15  Boron-doped Silicon Carbide for Passivating Rear Contacts
Gizem Nogay¹, Christophe Allebe², Christophe Ballif³, Fabien Debrot², Matthieu Despeisse², Franz-Josef Haug³, Quentin Jeangros¹, Philipp Loeper¹, Xavier Niquille¹, Josua Stuckelberger¹, Philippe Wyss³
¹ EPFL - PV-Lab; ² CSEM PV-Center; ³ EPFL

11:30  A Simple Method for Pinhole Detection in Carrier Selective POLO-junctions for High Efficiency Silicon Solar Cells
Dominic Tetzlaff¹, Rolf Brendel², Felix Haase², Uwe Höhne³, Jan Krügener¹, Jan Dirk Kährler¹, Yevgenia Larionova², Robby Peibst², Sina Reiter², Mircea Turcu², Tobias Wietler¹
¹ Leibniz Universität Hannover, Institute of Electronic Materials and Devices; ² Institute for Solar Energy Research Hamelin (ISFH); ³ centrotherm photovoltaics AG

11:45  How to Achieve Efficiencies Exceeding 22% with Multicrystalline n-Type Silicon Solar Cells
Florian Schindler¹, Jan Benick¹, Patricia Krenkel¹, Bernhard Michl¹, Stephan Riepe¹, Martin Schubert¹
¹ Fraunhofer Institute for Solar Energy Systems ISE
12:00 - 13:00  Lunch Break

13:00 - 14:00  Poster Session 3

The poster topics are labeled with the following letters:
A  Advanced characterization and simulation
B  Advanced light management
C  Cleaning, etching, surface morphology and associated passivation
D  High efficiency devices
E  Junction formation
F  Module processing and materials
G  Module reliability and production yield
H  Novel cell structures, e.g. applying tandems, new material combinations or nanostructures
I  Process integration
J  Silicon material and wafering technologies
K  Structuring and contact formation

nPV  Posters of nPV Workshop

3-A-wed  Local Efficiency Analysis of Inhomogeneous Solar Cells Based on Lock-in Thermography, Luminescence Imaging and Griddler Simulation
Felix Frühauf1, Otwin Breitenstein1, Johnson Wong2
1 Max Planck Institute of Microstructure Physics; 2 Solar Energy Research Institute of Singapore (SERIS)

6-A-wed  Profilometry of Amorphous Silicon Films on Textured Substrate by Raman Spectroscopy
Martin Ledinsky1, Christophe Ballif2, Stefaan De Wolf3, Matthieu Despeisse2, Antonin Fejfar1, Jonas Geissbühler2, Bertrand Paviet-Salomon1, Andrea Tomasi4, Aliaksei Vetushka1
1 Institute of Physics, AS CR; 2 PV-Center, Centre Suisse d'Électronic et de Microtechnique; 3 King Abdullah University of Science and Technology (KAUST); 4 EPFL

9-A-wed  Flyscan Accelerates Synchrotron-based Characterization of Silicon Materials for Photovoltaics
Hannu Laine1, Tonio Buonassisi2, Friedemann Heinz2, Mallory Jensen2, Wolfram Kwapil1, Barry Lai4, Joel Li5, Erin Looney5, Ashley Morishige3, Hele Savin1, Martin Schubert1, Jonas Schön4, Stefan Vogt4
1 Aalto University; 2 Massachusetts Institute of Technology; 3 Fraunhofer Institute for Solar Energy Systems ISE; 4 Argonne National Laboratory; 5 Solar Energy Research Institute of Singapore (SERIS)
<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
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</table>
| 12-A-wed  | Understanding the Rear-side Layout of p-Doped Bifacial PERC Solar Cells with Simulation Driven Experiments | Nico Wöhre\(^1\), Aina Alapont Sabater\(^4\), Tobias Fellmeth\(^1\), Johannes Greulich\(^1\), Stefan Rein\(^1\)  
\(^1\) Fraunhofer Institute for Solar Energy Systems ISE |
| 15-A-wed  | Combining Ray Tracing with Device Modeling to Evaluate Experiments for an Optical Loss Analysis of Crystalline Si Solar Cells and Modules | Yang Yang\(^1\), Malcolm Abbott\(^2\), Pietro Altermatt\(^3\), Weiwei Deng\(^1\), Zhiqiang Feng\(^1\), Ruimin Liu\(^1\), Keith McIntosh\(^2\), Ben Sudbury\(^2\), Pierre Verlinden\(^1\), Feng Ye\(^1\)  
\(^1\) Trina Solar; \(^2\) PV Lighthouse |
| 18-A-wed  | Development of a New Experimental Set-up Allowing Electro-thermal Characterization of Silicon-based Solar Cells | Benoit Guillo Lohan\(^1\), Mohamed Amara\(^1\), Romain Couderc\(^1\), Anne Kaminski Cachopo\(^2\), Mustapha Lemiti\(^3\)  
\(^1\) Centre d’Energétique et de Thermique de Lyon / INSA de Lyon; \(^2\) IMEP-LaHC / Grenoble-INP; \(^3\) Institut des Nanotechnologies de Lyon / INSA de Lyon |
| 21-A-wed  | Temperature Dependence of the Radiative Recombination Coefficient in Crystalline Silicon | Rudolf Brüggemann\(^1\), José Alvarez\(^1\), Mohamed Bouthchich\(^1\), Jean-Paul Kleider\(^1\), Ming Xu\(^1\)  
\(^1\) GeePs (Group of Electrical Engineering – Paris), UMR CNRS 8507 |
| 24-A-wed  | Analytical Modelling of Via-associated Recombination Losses in MWT Solar Cells | Arsalan Razzaq\(^1\), Jia Chen\(^2\), Filip Duerinckx\(^2\), Ivan Gordon\(^2\), Jef Poortmans\(^2\), Jozef Szlufcik\(^2\)  
\(^1\) KU Leuven / imec; \(^2\) imec; \(^3\) KU Leuven / imec / University Hasselt |
| 27-B-wed  | Modeling the Light-trapping Properties of Silicon Solar Cells with Honeycomb Front Surface Structures | Josefine Krogh Selj\(^1\), Sean Erik Foss\(^1\), Erik Marstein\(^1\)  
\(^1\) IFE |
| 30-B-wed  | Texturing Optimization for Bifacial nPERT: Are Pyramids and/or Black Silicon the Way to Go for Thinner Devices? | Rafaël Peyronnet\(^1\), Thomas Blévin\(^1\), Etienne Drahi\(^2\), Guillaume Fischer\(^1\), Martin Foldyna\(^3\), Erik Johnson\(^3\), Mustapha Lemiti\(^4\), Yves Marot\(^1\), Gilles Poulain\(^2\), Sylvain Pouliquen\(^5\)  
\(^1\) IPVF; \(^2\) Total GRP - New energies; \(^3\) LPICM - CNRS; \(^4\) INL; \(^5\) Air Liquide |
33-C-WED  Boron Emitter Passivation by Thermal Oxidation of Industrial n-Type PERT Solar Cell

Chenyang Wu
Zhongli Talesun Solar Co., Ltd, Research and Development Department

36-C-WED  Temporal Stability of a-Si:H and a-SiNx:H on Crystalline Silicon Wafers

Xuemei Cheng, Halvard Haug, Marisa Di Sabatino Lundberg, Erik Stensrød Marstein, Changchuan You
1 Norwegian University of Science and Technology; 2 IFE; 3 Institute for Energy Technology

42-D-WED  Polyimide for Double Sided Texturing in Silicon Solar Cells

Ngwe Zin, Chog Barugkin, Andrew Blakers, Kylie Catchpole, Kris Davis, Kean Fong, Evan Franklin, Teng Kho, Keith McIntosh, Winston Schoenfeld, Matthew Stocks, Yimao Wan, Er-Chien Wang, Soe Zin
1 University of Central Florida; 2 Australian National University; 3 PV Lighthouse

45-D-WED  Recent Developments in the Industrial Silicon Heterojunction Process Chain Enabling Efficiencies Up to 22.7%

Anamaria Moldovan, Martin Bivour, Sourav Bose, Florian Clement, Tobias Dannenberg, Denis Erath, Andreas Fischer, Martin Hermle, Laurent Kroely, Andreas Lorenz, Jochen Rentsch, Detlef Sontag, Jan Temmler, Arne Wissen, Winfried Wolke, Martin Zimmer
1 Fraunhofer Institute for Solar Energy Systems ISE; 2 Meyer Burger (Germany) AG

48-D-WED  Optimised Metallisation for Interdigitated Back Contact Silicon Heterojunction Solar Cells

Johann-Christoph Stang, Thijs Franssen, Jan Haschke, Lars Korte, Agnes Merkle, Mathias Mews, Robby Peibst, Bernd Rech
1 Institute of Silicon-Photovoltaics/Helmholtz-Zentrum Berlin; 2 École Polytechnique Fédérale de Lausanne (EPFL); 3 Institute for Solar Energy Research Hamelin (ISFH)

51-D-WED  High-efficiency Multicrystalline n-Type Silicon Solar Cells

Jan Benick, Hubert Hauser, Martin Hermle, Patricia Krenckel, Ralph Müller, Armin Richter, Stephan Riepe, Florian Schindler, Martin Schubert
1 Fraunhofer Institute for Solar Energy Systems ISE

54-E-WED  Comparative Study of Differently Grown Tunnel Oxides for p-Type Passivated Contacts

Rik van der Vossen, Frank Feldmann, Martin Hermle, Anamaria Moldovan
1 Fraunhofer Institute for Solar Energy Systems ISE
<table>
<thead>
<tr>
<th>Session</th>
<th>Title</th>
<th>Authors</th>
<th>Affiliations</th>
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<tbody>
<tr>
<td>57-E-WED</td>
<td>Heteroepitaxially Grown Gap as Electron Selective Contact for c-Si Solar Cells</td>
<td>Martin Bivour$^1$, Frank Dimroth$^1$, Markus Feifel$^1$, Martin Hermle$^1$, Stefan Janz$^2$, David Lackner$^1$, Jens Ohlmann$^1$</td>
<td>$^1$ Fraunhofer Institute for Solar Energy Systems ISE</td>
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<td>60-E-WED</td>
<td>Spin-on Dopants Enabling Low-cost Interdigitated Back Passivated Contact (IBPC) Solar Cells</td>
<td>Benjamin Lee$^1$, Derek Fogel$^1$, Vincenzo LaSalvia$^1$, William Nemeth$^1$, Matthew Page$^1$, Paul Stradins$^1$, San Theingi$^1$, David Young$^1$</td>
<td>$^1$ NREL</td>
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<td>63-E-WED</td>
<td>n-Type Bifacial Solar Cell Using Oxidation Etched Back Selective BSF Process</td>
<td>Chen-Hsun Du$^1$, Shih-Peng Hsu$^1$</td>
<td>$^1$ Industrial Technology Research Institute</td>
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<tr>
<td>66-G-WED</td>
<td>Comparison of Drone-based IR-imaging with Module Resolved Monitoring Power Data</td>
<td>Janine Teubner$^1$, Christoph Brabec$^1$, Claudia Buerhop-Lutz$^1$, Christian Camus$^1$, Jens Hauch$^1$, Ingmar Kruse$^2$</td>
<td>$^1$ Bavarian Center for Applied Energy Research; $^2$ Sunsniffer</td>
</tr>
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<td>69-G-WED</td>
<td>Abnormal Phenomenon of Potential Induced Degradation of Crystalline Silicon Solar Modules in Photovoltaic Power Plant</td>
<td>Hong Yang$^1$, Dengyuan Song$^2$, Fumei Wang$^1$</td>
<td>$^1$ Xi’an Jiaotong University; $^2$ Yingli Group Co., Ltd.</td>
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<td>72-G-WED</td>
<td>Characterization of Soiling on PV Modules in the Atacama Desert, Chile</td>
<td>Douglas Olivares$^1$, Enrique Cabrera$^2$, Camila De Matos$^1$, Jaime Llanos$^4$, Carlos Portillo$^1$</td>
<td>$^1$ Universidad de Antofagasta; $^2$ ISC Konstanz; $^3$ Laborelec Chile; $^4$ Universidad Católica del Norte</td>
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<td>75-H-WED</td>
<td>Material Properties of LPCVD Processed n-Type Polysilicon Passivating Contact and Application in Perpoly Industrial Bifacial Solar Cells</td>
<td>Maciej Stodolny$^1$, Bart Geerligs$^2$, Olindo Isabella$^2$, Gaby Janssen$^1$, Martijn Lenes$^3$, Jan-Marc Luchies$^1$, Jimmy Melkens$^4$, Ingrid Romijn$^1$, Rudi Santbergen$^2$, Jurriaan Schmitz$^2$, Bas van de Loo$^4$</td>
<td>$^1$ ECN Solar Energy; $^2$ Delft University of Technology; $^3$ Tempress Systems; $^4$ Eindhoven University of Technology; $^5$ University of Twente</td>
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<td>78-H-WED</td>
<td>Demonstrating the High $V_{oc}$ Potential of PEDOT:PSS/c-Si Heterojunctions on Solar Cells</td>
<td>Ralf Gogolin$^1$, Christophe Ballif$^2$, Antoine Descoeudres$^2$, Matthieu Despeisse$^2$, Jan Schmidt$^1$, Dimitri Zielke$^1$</td>
<td>$^1$ Institute for Solar Energy Research Hamelin (ISFH); $^2$ CSEM, PV-Center</td>
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| 81-H-wed | Hybrid Silicon Solar Cells with Heterojunction Emitters and Laser Processed Base Contacts | Chen Jin\(^1\), Ramon Alcubilla\(^1\), Gema Lopez\(^1\), Isidro Martin\(^1\), Gerard Masmitja\(^1\), Pablo Ortega\(^1\)  
\(^1\) Universitat Politecnica de Catalunya |
| 84-H-wed | GaAs on Silicon Tandem Solar Cells                                  | Ian Marius Peters\(^1\), Tonio Buonassisi\(^1\), Zhe Liu\(^2\), Haohui Liu\(^2\),  
Zekun Ren\(^2\), Chuan Seng Tan\(^4\)  
\(^1\) Massachusetts Institute of Technology; \(^2\) Solar Energy Research Institute of Singapore (SERIS); \(^3\) Singapore MIT Alliance for Research and Technology; \(^4\) Nanyang Technological University |
| 87-H-wed | Nanocrystalline Silicon Oxide Based Silicon Heterojunction Solar Cells and their Performance Under Extended Light Exposure | Alexei Richter\(^1\), Kaining Ding\(^1\), Bart Pieters\(^1\), Uwe Rau\(^1\)  
Presented by Kaining Ding\(^1\)  
\(^1\) Forschungszentrum Jülich GmbH |
| 90-H-wed | Low Temperature Perovskite Solar Cells for Perovskite Silicon Tandem Solar Cells | Alexander Jürgen Bett\(^1\), Martin Bivour\(^2\), Stefan W. Glunz\(^1\), Jan Christoph Goldschmidt\(^1\), Martin Hermle\(^1\), Markus Kohlstädt\(^1\), Seunghun Lee\(^2\), Simone Mastroianni\(^2\), Laura E. Mundt\(^1\), Markus Mundus\(^1\), Paul Ndione\(^1\), Christian Reichel\(^1\), Martin C. Schubert\(^1\), Patricia S. C. Schulze\(^1\), Nico Tucher\(^1\), Clemens Veit\(^1\), Welmoed Veurman\(^1\), Karl Wienands\(^4\), Kristina Winkler\(^1\), Uli Würfel\(^1\)  
\(^1\) Fraunhofer Institute for Solar Energy Systems ISE; \(^2\) Korea University; \(^3\) NREL; \(^4\) Albert-Ludwigs-Universität Freiburg |
| 93-H-wed | Investigation of Atomic-layer-deposited TiO \(_x\) as Selective Electron and Hole Contacts to Crystalline Silicon | Takuya Matsui\(^1\), Martin Bivour\(^2\), Martin Hermle\(^2\), Paul Hettich\(^2\),  
Paul Ndione\(^1\)  
\(^1\) AIST; \(^2\) Fraunhofer Institute for Solar Energy Systems ISE |
| 96-H-wed | Implantation-based c-Si Passivating Rear and Front Contacts (PeRFeCT) Solar Cell | Gianluca Limodio\(^1\), Andrea Ingenito\(^1\), Olinna Isabella\(^1\), Arthur Weebert\(^1\), Guangtao Yang\(^1\), Miro Zeman\(^1\)  
\(^1\) Delft University of Technology |
| 99-H-wed | Development of Spin-coated Copper Iodide Film on Silicon for Use in Hole-selective Contacts | Kazuhiro Gotoh\(^1\), Min Cui\(^1\), Yasuyoshi Kurokawa\(^1\), Isao Takahashi\(^1\), Noritaka Usami\(^1\)  
\(^1\) Nagoya University |
| 108-I-wed | Removing Barriers to Thin Crystalline Silicon Solar Cells          | Ashley E. Morishige\(^1\), Tonio Buonassisi\(^1\), Luke T. Meyer\(^4\), David Berney Needleman\(^3\), Emanuel T. Sachs\(^3\), Sarah Wieghold\(^4\)  
\(^1\) Massachusetts Institute of Technology |
111-I-WED Excellent Via Passivation and High Open Circuit Voltage for Large Area n-Type MWT-PERT Silicon Solar Cells

Jia Chen1, Emanuele Cornagliotti1, Stefan Dewallef2, Filip Duerinckx1, Ivan Gordon1, Jef Poortmans1, Arsalan Razzaq1, Richard Russell2, Sukhvinder Singh2, Jozef Szlufcik1, Loic Tous1, Angel Uruena1, Arvid van der Heide1

1 imec; 2 Soltech

114-J-WED Thermal Stress During RTP Process and its Possible Effect on Light Induced Degradation in Cz-Si Wafer

Yacine Kouhlane1, Djoudi Bouhafs1, Fahima Derkaoui2, Abdelkader Guenda3, Warda Hetatache1, Nabil Khelifati1, Salah Mezghiche1, Ogechi Vivian Nwadiaru4

1 Research Center in Semi-conductor Technology for the Energetic (CRTSE); 2 University of Blida; 3 University of Sétif; 4 Institute PanAfricaine, University of Tlemcen

117-K-WED Formation of AgAl Alloy in Context of PERC Solar Cell Metallization

Tobias Urban1, Johannes Heitmann2, Katharina Krügel2

1 TU Bergakademie Freiberg; 2 Technische Universität Bergakademie Freiberg, Institut für Angewandte Physik

120-K-WED Current-induced Metal Contact Formation on Boron-doped Emitter with High Sheet Resistance in Crystalline Silicon Solar Cells

Jae-Wook Choi1, Soohyun Bae1, Yoonmook Kang2, Seongtak Kim1, Donghwan Kim1, Hyomin Park1, Hyunjung Park1, Seung Hyun Shin1

1 Department of Materials Science and Engineering, Korea University; 2 KU-KIST Green School, School of Energy and Environment, Korea University

123-K-WED Screen Printed Metallization for All-polySi Solar Cells

Maciej Stodolny1, Hande Ciftpinar2, Bart Geerligs1, Gaby Janssen1, Martijn Lenes1, Jan-Marc Luchies3, Ingrid Romijn1, Yu Wu1

1 ECN Solar Energy; 2 Middle East Technical University; 3 Tempress Systems

126-K-WED Using Plasma Reduction of In for Seeding and Edge Isolation in Silicon Heterojunction Solar Cells with Plated Contacts

Stanislau Herasimenka

Arizona State University

129-K-WED Enablers for IBC: Integral IBC Cell and Module Development and Implementation in PV Industry

Ilkay Cesar1, A.R. Burgers1, N. Guillemin1, Agnes Mewe1, P. Spinelli1

1 ECN
Comparison of Innovative Metallization Approaches for
Silicon Heterojunction Solar Cells

Denis Erath\textsuperscript{1}, Florian Clement\textsuperscript{1}, Mike Jahn\textsuperscript{1}, Roman Keding\textsuperscript{1},
Igor-Clavau Lacmago Lontchi\textsuperscript{1}, Andreas Lorenz\textsuperscript{1}, Maximilian Pospischi\textsuperscript{1}

\textsuperscript{1}Fraunhofer Institute for Solar Energy Systems ISE

TCO Contacts for High Efficiency c-Si Solar Cells: Influence of Different Annealing Steps on the Substrates and Layers Properties

Thibaut Desruess\textsuperscript{1}, Elise Bruhat\textsuperscript{1}, Sébastien Dubois\textsuperscript{1}, Bernadette Grange\textsuperscript{1}, Hélène Lignier\textsuperscript{1}

\textsuperscript{1}CEA-INES

Progress in the Development of Industrial nPERT Cells

Florian Buchholz\textsuperscript{1}, Haifeng Chu\textsuperscript{1}, Jan Lossen\textsuperscript{1}, Pirmin Preis\textsuperscript{1}, Dominik Rudolph\textsuperscript{1}, Eckard Wefringhaus\textsuperscript{1}

\textsuperscript{1}ISC Konstanz

Investigation of Laser Contact Opening Pitch Affecting the Voids Formation on n-Type Rear Emitter Silicon Solar Cells

Zih-Wei Peng\textsuperscript{1}, Thomas Buck\textsuperscript{1}, Radovan Kopecek\textsuperscript{1}, Jens Theobald\textsuperscript{1}

\textsuperscript{1}ISC Konstanz

Control of Metal Coverage Area to Improve the Electrical Performance on n-Type Solar Cells

Gregory Becht

Heraeus Precious Metals

14:00 - 14:15
Short Coffee Break

14:15 - 15:45
Session 11: Silicon Hetero Junction and PERT Cells

Rolf Böhme Saal

Chairs: Kunta Yoshikawa (Kaneka) and Radovan Kopecek (ISC Konstanz)

14:15 High-mobility H-doped Zinc Oxide for Si Heterojunction Solar Cells

Bart Macco\textsuperscript{1}, Erwin Kessels\textsuperscript{1}, Harm Knoops\textsuperscript{1}, Jimmy Melskens\textsuperscript{1},
Bas van de Loo\textsuperscript{1}

\textsuperscript{1}Eindhoven University of Technology

14:30 Selective Plating Concept for Silicon Heterojunction Solar Cell Metallization

Rukmangada Rohit\textsuperscript{1}, Jonas Bartsch\textsuperscript{1}, Gisela Cimiotti\textsuperscript{1}, Markus Glatthaar\textsuperscript{1}, Andreas Rodolfi\textsuperscript{1}

\textsuperscript{1}Fraunhofer Institute for Solar Energy Systems ISE
<table>
<thead>
<tr>
<th>Time</th>
<th>Title</th>
<th>Authors</th>
<th>Affiliations</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:45</td>
<td>Increasing the Efficiency of Silicon Heterojunction Solar Cells by Light Soaking</td>
<td>Eiji Kobayashi¹, Christophe Ballif², Gabriel Christmann², Stefaan De Wolf², Antoine Descoeudres², Matthieu Despeisse², Jacques Levrat², Sylvain Nicolay², Yoshimi Watabe⁴</td>
<td>¹ EPFL; ² CSEM PV-Center; ³ King Abdullah University of Science and Technology (KAUST); ⁴ Yamaguchi University</td>
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<tr>
<td>15:00</td>
<td>22% Bifacial n-PERT Cells with Ni/Ag Co-plated Contacts and ( V_{oc} \approx 690 \text{ mV} )</td>
<td>Loïc Tous¹, Patrick Choulat¹, Emanuele Cornagliotti¹, Filip Duerinckx¹, Michael Haslinger¹, Joachim John¹, Richard Russell¹, Jozef Szlufcik¹, Angel Uruena¹</td>
<td>¹ imec</td>
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<tr>
<td>15:15</td>
<td>High Efficiency n-Type Si Solar Cells with Local Al-p+ Emitter</td>
<td>Stefan Bordihn¹, Janko Cieslak¹, Stefan Hörnlein¹, Daniel J.W. Jeong¹, Verena Mertens¹, Jörg W. Müller¹</td>
<td>¹ Hanwha Q Cells GmbH</td>
</tr>
<tr>
<td>15:30</td>
<td>MoO(_x) and TiO(_x) Carrier Selective Contacts for Dopant-free SHJs</td>
<td>Davide Sacchetto¹, Christophe Ballif², Loris Barraud¹, Gabriel Christmann¹, Antoine Descoeudres¹, Matthieu Despeisse¹, Stephanie Essig², Jonas Geissbühler¹, Aicha Hessler-Weyser², Quentin Jeangros¹, Sylvain Nicolay¹</td>
<td>¹ CSEM; ² EPFL</td>
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<td>15:45 -</td>
<td>Coffee Break</td>
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<td>16:15 -</td>
<td>Session 12: Novel Selective Contacts</td>
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<td>17:30</td>
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<td>Rolf Böhme Saal</td>
<td>Chairs: Stefaan De Wolf (EPFL) and Erwin Kessels (Eindhoven University of Technology)</td>
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<tr>
<td>16:15</td>
<td>Excellent Passivation of c-Si Surfaces by Transparent Conductive Al- and B- Doped ZnO</td>
<td>Bas van de Loo¹, Erwin Kessels¹, Bart Macco¹, Jimmy Melskens¹</td>
<td>¹ Eindhoven University of Technology</td>
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<td>16:30</td>
<td>Passivating/Hole-selective Contacts Based on Transition Metal Oxides Deposited at Ambient Temperature</td>
<td>Luis Gerling¹, Ramón Alcubilla¹, Joaquim Puigdollers¹, Cristobal Voz¹</td>
<td>¹ Universitat Politècnica de Catalunya</td>
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<tr>
<td>16:45</td>
<td>Selectivity Issues of MoO(_x) and WO(_x) Based Hole Contacts</td>
<td>Martin Bivour¹, Martin Hermle¹, Paul Hettich¹</td>
<td>¹ Fraunhofer Institute for Solar Energy Systems ISE</td>
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</tbody>
</table>
17:00  Mitigating Transport and Visible-light-absorption Losses in MoO\textsubscript{x}, Hole-selective Contacts for Si Solar Cells

**Mathieu Boccard**, Christophe Ballif\textsuperscript{1}, Stefaan De Wolf\textsuperscript{3}, Laura Ding\textsuperscript{2}, Stephanie Essig\textsuperscript{1}, Zachary Holman\textsuperscript{2}, Sylvain Nicolay\textsuperscript{3}, Davide Sacchetto\textsuperscript{3}

\textsuperscript{1} EPFL; \textsuperscript{2} Arizona State University; \textsuperscript{3} CSEM

17:15  Self-aligned Carrier-selective PEDOT:PSS Contacts on Optically Highly Transparent Boron-emitters

**Markus Glatthaar**, Sybille Hopman\textsuperscript{1}, Ivona Kafedjiska\textsuperscript{1}

\textsuperscript{1} Fraunhofer Institute for Solar Energy Systems ISE

**17:30 - Closing Session SiliconPV**

**18:00**  Rolf Böhme Saal

17:30  Closing Remarks

17:40  SiliconPV Award Ceremony for the Best 10 Abstracts

*The ceremony is sponsored by Sinton Instruments*

*Thank you!*

17:50  SiliconPV 2018 Announcement

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**Thursday, April 06, 2017**

**08:00 - 08:30**  Registration

**08:30 - 08:40**  **Introduction Industry Day nPV**

**Runder Saal**

08:30  Summary n-Type Cells and Modules SiliconPV

**Arthur Weeber**, ECN/TU Delft

08:40 - **Session 1: Si Material**

**Runder Saal**

**08:40**

Chairs: Sebastian Dubois (CEA-INES) and Jan Schmidt (ISFH)

08:40  Mitigating the Effect of Defects and Impurities in n-Type Si Material

**Paula Bronsveld**, ECN
09:00  High Quality and Low-cost n-Type Wafers with CrystalMax Technology  
Lotfi Bounaas, ECM GREENTECH

09:30 - 10:00  Coffee Break

10:00 - Session 2: Future Aspects / Vision  
11:15  Runder Saal

Chairs: Christophe Ballif (EPFL) and Ingrid Romijn (ECN)

10:00  Towards the Industrialisation of Perovskite-Silicon Tandem Cells  
Daniel Kirk, Oxford PV

10:25  n-Type in ITRPV  
Axel Metz, ITRPV / h.a.l.m.

10:50  n-Type Cells and Modules with Passivating Contacts: High Efficiency, Low Cost Approaches and Beyond  
Christophe Ballif, EPFL

11:15 - Panel Discussion  
12:00  Runder Saal

Chair: Christophe Ballif (EPFL)

12:00 - 13:00  Lunch Break

13:00 - Session 3: Cells and Modules  
14:40  Runder Saal

Chairs: Matthieu Despeisse (CSEM) and Jan Lossen (ISC Konstanz)

13:00  Heterojunction Solar Cells  
Benjamin Strahm, Meyer Burger Research AG

13:20  Bifacial Silicon Heterojunction Modules to Reduce the Cost of Energy. The New Industrial Initiative of 3SUN to Compete with Mainstream PV Technologies  
Cosimo Gerardi, 3Sun

13:40  Cross Contamination Marathon Test in Octopus II- PECVD Reactor and Latest HJT Cells Results  
Omid Shojaei, IndeoTEC
<table>
<thead>
<tr>
<th>Time</th>
<th>Session</th>
<th>Location</th>
<th>Chairmen</th>
<th>Speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:00</td>
<td>Industrial LPCVD Phosphorus Doped Poly Silicon Rear Passivated Contact Solar Cells</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
<td>Ronald Naber, Tempress Systems</td>
</tr>
<tr>
<td>14:20</td>
<td>High-efficiency n-Type Solar Cells on Multicrystalline Silicon</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
<td>Jan Benick, Fraunhofer Institute for Solar Energy Systems ISE</td>
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<tr>
<td>14:40</td>
<td>Coffee Break</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
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<td>15:10</td>
<td>Session 4: Cells / Modules and Systems</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
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<td>15:10</td>
<td>IBC Cell Process for Mass-production Based on PANDA Cell Technology</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
<td>Ziqian Wang, YingLi Green Energy Holding Co.Ltd</td>
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<tr>
<td>15:30</td>
<td>Multi Busbar Interconnection and Atmospheric Pressure CVD Technology for n-Type</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
<td>Christian Buchner, Schmid Technology Systems GmbH</td>
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<tr>
<td>15:50</td>
<td>Double vs Single Sided Illumination Test Methods for Performance Characterization of n-Type Bifacial PV Modules</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
<td>Pepijn Veling, Eternal Sun</td>
</tr>
<tr>
<td>16:10</td>
<td>Bifaciality: Still an Argument for n-Type?</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
<td>Radovan Kopecek, ISC Konstanz</td>
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<tr>
<td>16:30</td>
<td>Closing</td>
<td>Runder Saal</td>
<td>Joachim John (imec) and Martin Hermle (Fraunhofer ISE)</td>
<td>Arthur Weeber, ECN</td>
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</table>
On Monday, April 03, SiliconPV will offer a site visit to the Fraunhofer Institute for Solar Energy Systems ISE, Europe’s largest solar energy research institute. The work ranges from the investigation of scientific and technological fundamentals for solar energy applications, through the development of production technology and prototypes, to the construction of demonstration systems.

Focusing on energy efficiency, energy conversion, energy distribution and energy storage, the Institute develops materials, components, systems and processes in five business areas and offers accredited testing facilities and other expert lab services to clients.

Date: Monday, April 03, 2017
Time: 18:30
Fee: 15 € - Capacity is limited, pre-registration required.
Meeting point: Bus transfer will be available. Meeting point in front of the conference venue at the buses. Buses will leave at 18:30.
Return: For return to the city or hotels tram tickets will be provided. From Fraunhofer ISE the city center can be reached with the city tram line 4 (pink). Get in at the stop „Elsässer Straße“→ Direction „Bertoldsbrunnen“.

Address:
Fraunhofer ISE
Heidenhofstraße 2
79110 Freiburg
Conference Dinner

The Conference Dinner will take place in the Freiburg Market Hall („Markthalle“), a popular lunchtime venue for the city’s residents in the old town of Freiburg. The former newspaper printroom has been converted into an attractive, multicultural market area full of stalls with food and drink from all over the world - including Germany of course, with a wide variety of local produce on offer! Feel free to taste the food from the country of your choice and try some typical local German specialties.

This uniquely attractive venue will provide the ideal environment for conference participants to maximise their networking in a relaxed and convivial atmosphere.

**Date:** Tuesday, April 04, 2017

**Time:**
- Dinner Reception starts 19:00
- Conference Dinner 19:30

**Fee:** Included in conference fee, but pre-registration required.

**Meeting Point:** Directly at the Market Hall.

**Access from:** Martinsgässle (directly at the Martinstor), Freiburg city center. See map below.
General Information

Registration
Each participant has to register in person at the registration desk to collect a conference bag and name badge before attending any sessions. Please make sure to wear your badge for admission to all sessions and side events. Participants who have lost their badge should report to the registration desk.
Registration times are on Sunday, April 2, from 17:00 – 19:00 at the Welcome Reception and during conference hours, starting on Monday, April 3 at 7:30 and the following days at 8:00 in the conference center.

Posters
See the poster plan on page 46 for more details on poster codes and their specific location. Please mount your poster before the start of the first poster session. Do not remove your poster until the end of the conference. The posters are an important part of the scientific program and should be displayed the whole time. Please remove your poster on Wednesday. Remaining posters will be discarded.

Speaker Information
All presentations must be handed in at the Media Upload Desk one hour before your presentation. You will not be able to display your presentation directly from your laptop computer or USB flash drive. Our technical support team will welcome you at the Media Upload Desk during all conference days, starting on Monday at 7:30 and the following days at 8:00. Please meet your session chairs inside the conference room at least 10 minutes prior to the beginning of your oral session to acquaint yourself with the technical equipment.

Certificate of Attendance
A certificate of attendance for participants will only be available on-site at the registration desk and cannot be issued after the conference.

Conference Proceedings
Accepted papers will be published online in Elsevier's Energy Procedia. Energy Procedia is an open-access online platform by Elsevier. All papers published in Energy Procedia feature individual DOI numbers and are therefore fully citable. Before publication, access to all non-reviewed papers will be available in the Download Area on the conference website, which is accessible to all conference participants with the login and password provided after their conference registration.
Full papers of the twenty best abstracts will be published in Elsevier's peer reviewed journal Solar Energy Materials & Solar Cells (SOLMAT).
List of Participants
Registered participants may download a list of participants on the conference website, www.siliconpv.com. The login and password sent to you during registration will be required to gain access to the download area.

Contact Participants
SiliconPV offers a contact opportunity for conference participants in its internal Download Area. Login with your password and contact other participants by e-mail.
All participants who want to use the contact feature can confirm their admission to send and receive e-mails to and from other conference participants in the Download Area. The first contact will occur indirectly via the conference system in the Download Area. No personal data will be handed out.

WiFi Access
WiFi access will be available free of charge in the whole conference area.
SSID: Konzerthaus Besucher
Password: April2017BE
Poster Plan

The poster topics are labeled with the following letters:

A  Advanced characterization and simulation
B  Advanced light management
C  Cleaning, etching, surface morphology and associated passivation
D  High efficiency devices
E  Junction formation
F  Module processing and materials
G  Module reliability and production yield
H  Novel cell structures, e.g. applying tandems, new material combinations or nanostructures
I  Process integration
J  Silicon material and wafering technologies
K  Structuring and contact formation
nPV  Posters of nPV Workshop

Poster Area