SiliconPV 2019

9th International Conference
on Crystalline Silicon Photovoltaics

npworkshop

Leuven 2019

Advanced technologies, materials and concepts for crystalline Si solar cells and modules

PROGRAM

April 8-11, 2019
Leuven, Belgium

www.siliconpv.com
www.npv-workshop.com

We thank our Sponsors!

In becoming sponsors of SiliconPV, the following companies and institutions have helped to make the conference possible, and in doing so have made a very important contribution to scientific exchange and the fostering of international collaboration in the field of silicon photovoltaics.

SILVER SPONSORS

JOLYWOOD

TALESUN

Heraeus

BRONZE SPONSOR

SWISS MADE INDEOtec PLASMA PROCESS EQUIPMENT

HOSTED BY

imec embracing a better life

ORGANIZED BY

PSE Powering Scientific Exchange

MEDIA PARTNERS

Solar Power Management A GLOBAL BUSINESS JOURNAL

crystals an Open Access Journal by MDPI

Photon

pv magazine group

Content

To get the latest version of the scientific program on your cell phone please scan the QR-code or enter the URL:

https://cms2019.siliconpv.com/program

Filming or taking pictures is not allowed during all conference sessions!
Publishing data from the conference is against the law.

Chairmen‘s Messages

Dear Colleagues, Dear Friends of SiliconPV,

Prof. Jef Poortmans
imec
Conference Chair
SiliconPV 2019

A very warm welcome to the 9th SiliconPV Conference, taking place in Leuven from April 8-10, 2019!

PV is being developed and deployed at high pace. Worldwide already 500 GWp of PV-capacity has been installed, a number 10 times higher as compared to 2011 when the series of SiliconPV conferences started. When just looking to the ITRPV-scenarios, preparing for 1TWp/year scenarios is no longer to be considered as science-fiction and is rather to be viewed as an absolute necessity if one aims at fully decarbonizing the power and transport sector. PV has so many assets – scalability and modularity - which make it the technology of choice to reach the ambitious targets for CO_2-emission reduction in the next decade to keep the earth’s temperature increase below the cap of 2°C. Thanks to its scalability, PV is in many regions with high solar irradiance already the cheapest source of electricity with electricity priced as low as 2 cent/kWh.

This being said, it must be emphasized that crystalline Si based solar cell technology was the workhorse of this rapid expansion of the PV installed base and it is expected to remain the technology of choice for the further growth in the foreseeable future. Bringing cells and modules closer to their ultimate efficiency limits with scalable technologies remains obviously a challenge to be tackled. When overviewing the abstracts received for the conference this year, the PV R&D-community is massively geared towards attacking the last remaining source of substantial recombination in high-efficiency solar cell designs which is taking place at the contacts. The conference this year features a high number of excellent presentations and posters on the subject of passivated contacts. This will provide the attendees an excellent view on what for sure will be implemented in the cell manufacturing lines in the next years and the understanding of the transport mechanisms ruling the behavior of these passivated contact structures. New analytical techniques as well as innovative process technologies and materials provide visibility to the future of crystalline Si solar cells and modules for the next decades. Last but not least, the conference will show different flavors of tandem cells which will allow to break the magic 30% efficiency barrier.

In view of the practical realization of TWp-scenarios, a need for further and broadened R&D-activities for crystalline Si solar cells and modules automatically pops up. I sincerely wish the conference will act as a unique platform to refine ideas on reducing further the CO_2-footprint of Si-substrates, to avoid the use of rare metals in the manufacturing of cells and modules and to implement, more generally speaking, the concept of circular economy in the context of crystalline Si based PV.

At the occasion of the SiliconPV 2019 Conference I also invite you to visit the new facilities in EnergyVille, Genk. In 2017 a new laboratory was built in Genk to house the technology development activities on PV-modules and batteries. This new laboratory environment allows us to prepare our societies even better for the upcoming massive deployment of PV.

I wish you all an exciting and interesting conference and enjoy the atmosphere of the city of Leuven with its numerous opportunities to combine the useful with the pleasant!

Prof. Jef Poortmans

SiliconPV 2019 Conference Chair
Program Director Energy@imec; Part-time Professor at KULeuven and UHasselt

Dear PV-friend, Welcome to the nPV Workshop 2019 in Leuven, Belgium

Dr. Joachim John
imec
Chairman nPV Workshop 2019

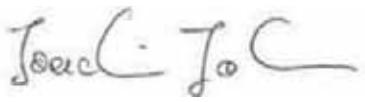
Photovoltaic cells and modules experienced considerable reductions in manufacturing costs coupled with technological improvements, bringing PV to low levelized cost of electricity (LCOE) in 2018 and in a lot of countries the cheapest source of energy. This is highlighted by several PV power plant power purchase agreements below 5 $cts/kWh, and by records below 2 $cts/kWh, placing PV as ultra-competitive compared to other energy sources. Since a few years, the silicon PV community is further witnessing a strong dynamism in the improvement of conversion efficiency with potential for further lowering LCOE. The PERC concept has taking over in mass manufacturing from the standard Al-BSF cell. The introduction of new materials, processes and concepts, is triggering the introduction of advanced technologies in production. In that context, high efficiency n-type silicon technologies are developing with impressive dynamics! At R&D level, ultra-high efficiency was achieved by Kaneka, Japan, using back-contacted silicon heterojunction, with up to 26.7% and 24.37% demonstrated at cell and module levels respectively. Continuous progress is being made with HJT, n-PERT and IBC technologies, driving towards an increasing mass production of highly efficient n-type devices, as highlighted by the introduction of 2 GW n-PERT production capacity by Jolywood in 2017, and in collaboration with imec 21.9% (front side efficiency) bifacial n-PERT cells are reported.

In such exciting context, we are happy to welcome you at the nPV Workshop to discover what is next to come in 2019! Exceptionally, this year we invite you to start already on Tuesday afternoon with a visit of our new labs in EnergyVille (please check this option on your registration form). On Tuesday evening we invite you to the conference dinner in a medieval environment. Wednesday is traditionally coupled to SiliconPV for in-depth presentations of latest developments in n-type technologies at R&D level. Thursday will be dedicated to n-PV industry, providing the platform to highlight and discover industrial progress in n-type technologies, from wafer to cell and module technologies, and to discuss and debate the development and market roadmaps for n-PV technologies.

The nPV Workshop is a unique occasion to update yourself on n-type Silicon PV technologies and industrial developments, and to discuss it with scientists and industrials from all over the world in a great atmosphere!

I am welcoming you in Leuven, Belgium, enjoying 2019 nPV Workshop!

On behalf of the organizing committee



Dr. Joachim John

Chairman nPV Workshop 2019
imec

Committees SiliconPV

Scientific Chair

imec, Belgium: Jef Poortmans

Executive Committee

Amrock Pty Ltd, Australia: Pierre Verlinden
CEA, France: Sébastien Dubois
ECN part of TNO, The Netherlands: Arthur Weeber
EPFL STI IMT PV-LAB, Switzerland: Christophe Ballif
Fraunhofer ISE, Germany: Stefan Glunz
imec, Belgium: Jef Poortmans
ISFH, Germany: Rolf Brendel
University of Konstanz, Germany: Giso Hahn

Conference Organization

imec: Joachim John, Jef Poortmans, Nadia Van de Maele
PSE Conferences & Consulting GmbH: Beatrix Feuerbach, Maria Hemming, Stefanie Hermann

Reviewing Committee

ALD Vacuum Technologies GmbH, Germany: Henrik Franz
Amrock Pty Ltd, Australia: Pierre Verlinden
CEA-INES, France: Sébastien Dubois, Eric Gerritsen
CENER, Spain: Ana Lagunas
CSEM, Switzerland: Antoine Descoeudres, Joerg Horzel, Hengyu Li
Dow Corning, Belgium: Guy Beaucarne
DSM Advanced Surfaces, The Netherlands: Ian Bennett
ECN part of TNO, The Netherlands: Gianluca Coletti, Bonna Newman, Arthur Weeber
EPFL, Switzerland: Mathieu Boccard
Fraunhofer CSP, Germany: Marko Turek
Fraunhofer ISE, Germany: Benedikt Bläsi, Florian Clement, Andreas Fell, Hubert Hauser, Martin Hermle, Henning Nagel, Jochen Rentsch, Martin Schubert, Andreas Wolf
Hanwha Q CELLS, Germany: Fabian Fertig, Ansgar Mette, Stefan Peters
HZB, Germany: Lars Korte
IFE, Norway: Halvard Haug, Erik Marstein
imec, Belgium: Ivan Gordon, Jonathan Govaerts, Jef Poortmans, Jozef Szlufcik, Loic Tous, Eszter Voroshazi
ISC Konstanz e.V., Germany: Jan Lossen
ISFH, Germany: Thorsten Dullweber, Marc Köntges, Jan Schmidt, Henning Schulte-Huxel
Jiaotong University Shanghai, China: Wenzhong Shen
KAUST, Saudi Arabia: Stefaan De Wolf
MIT, USA: Marius Peters
NREL, USA: David Young
PV Crystalox Solar Silicon, Germany: Oliver Anspach
PV Lighthouse, Australia: Malcolm Abbott, Keith McIntosh
Sinton Instruments, USA: Ronald A. Sinton
SunPower, France: Nils Harder
Tempress, The Netherlands: Martijn Lenes
Trina Solar, China: Pietro Altermatt
TU Eindhoven, The Netherlands: Erwin Kessels
TÜV Rheinland Energy, Germany: Ulrike Jahn
University of Konstanz, Germany: Giso Hahn, Axel Herguth, Barbara Terheiden
University of Ljubljana, Slovenia: Marko Topič
University of New South Wales, Australia: Bram Hoex
University of Stuttgart, Germany: Jürgen Werner
US Dept of Energy, USA: Paul Basore

Committee nPV Workshop

Chair of nPV Workshop

imec, Belgium: Joachim John

Program Committee

CEA-INES, France: Delfina Muñoz
CSEM, Switzerland: Matthieu Despeisse
ECN part of TNO, The Netherlands: Arthur Weeber
Fraunhofer ISE, Germany: Stefan Glunz
imec, Belgium: Joachim John
ISC Konstanz e.V., Germany: Radovan Kopecek
ISFH, Germany: Jan Schmidt

Sunday, April 07, 2019

13:00 **Tutorial 1 - Tutors: University of Konstanz/ISFH**

The Role of H in Passivating Silicon Defects (advanced)

13:40 **Tutorial 2 - Tutors: CEA/ISC Konstanz**

Bifacial Cell Architectures and Technologies (advanced)

14:20 **Tutorial 3 - Tutors: ISFH/Fraunhofer ISE**

Passivating Contacts Beyond a-Si:H/c-Si Heterojunctions (advanced)

15:10 - 15:30 Break

15:30 **Tutorial 4 - Tutors: imec/CSEM**

Heterojunction and Tandem Perovskite/Silicon Solar Cells (advanced)

16:10 **Tutorial 5 - Tutors: imec/ECN part of TNO**

Advanced Interconnect Technologies for Si Solar Cells (beginner)

17:00 - 19:00 Welcome Reception SiliconPV at “De Hoorn”

Monday, April 08, 2019

07:45 Registration

08:30 - 08:45 Opening Session Silicon PV

Welcome to SiliconPV

Jef Poortmans, imec

08:45 - 09:15 Keynote

Upscaling 2-Terminal Perovskite-Silicon Tandems: Adaptation of Industrial Technologies Towards Commercialization

Brett Kamino[1], Soo-Jin Moon[1], Arnaud Walter[1], Adriana Paracchino[1], Juan Diaz-Leon[1], Gabriel Christmann[1], Marion Dussouillez[1], Bertrand Paviet-Salomon[1], Nicolas Badel[1], Antonin Faes[1], Gianluca Cattaneo[1], Jacques Levrat[1], Matthieu Despeisse[1], Christophe Ballif[1], Sylvain Nicolay[1]

[1] *CSEM*

Dr. Brett Kamino

Brett Kamino completed his doctorate in Chemical Engineering at the University of Toronto working on inorganic-organic semiconducting materials for OPV and OLED devices. He then joined OxfordPV in Oxford, England as a Marie Curie postdoctoral fellow from the start of their perovskite activities. Here he was responsible for a number of key patents in the field of perovskites related to their stability and deposition for high efficiency tandem device structure. He currently works at the Centre Suisse Electronique et Microtechnique (CSEM) in Switzerland where he is working towards the industrialization of perovskite-silicon tandem cells with various commercial partners. His current focus is on integrating perovskite-silicon tandem solar cells into existing crystalline silicon processes.

09:15 - 10:00 Session 1: Different Flavors of Tandem Cell Architectures

Chairs: Stefan Glunz (Fraunhofer ISE) & Pierre Verlinden (Amrock)

09:15 27% Efficient 4-T Tandem with Highly Transparent Perovskite Top Cell and Back-Contacted Si Heterojunction Bottom Cell

Dong Zhang[1], Mehrdad Najafi[1], Jürgen Hüpkes[2], Valerio Zardetto[3], Gianluca Coletti[4], Sjoerd Veenstra[1], Ronn Andriessen[1]

[1] E*CN part of TNO - Solliance;* [2] *Forschungszentrum Jülich GmbH;* [3] *TNO - Solliance*; [4] ECN part of TNO

09:30 Fully Textured Perovskite/Silicon Monolithic Tandem and Triple-Junction Solar Cells

Fan Fu[1], Florent Sahli[1], Jérémie Werner[1], Terry Chien-Jen Yang[1], Peter Fiala[1], Matthias Braeuninger[1], Brett Kamino[2], Raphaël Monnard[1], Bertrand Paviet-Salomon[2], Laura Ding[2], Juan Diaz Leon[2], Gianluca Cattaneo[2], Arnaud Walter[2], Soo-Jin Moon[2], Gizem Nogay[1], Andrea Ingenito[1], Mathieu Boccard[1], Mathieu Despeisse[2], Bjoern Niesen[2], Sylvain Nicolay[2], Quentin Jeangros[1], Franz-Josef Haug[1], Christophe Ballif[1]

[1] *EPFL*; [2] *CSEM*

09:45 Monolithic CZTS-on-Silicon Tandem Solar Cells: Prospects and Challenges

Alireza Hajijafarassar[1], Filipe Martinho[1], Denver Shearer[1], Andrea Crovetto[1], Stela Canulescu[1], Beniamino Iandolo[1], Mungunshagai Gansukh[1], Simón López Mariño[1], Moises Espindola Rodriguez[1], Sara Lena Josefin Engberg[1], Jørgen Schou[1], Ole Hansen[1]

[1] *Technical University of Denmark (DTU)*

10:00 - 10:30 Coffee Break

10:30 - 12:00 Session 2: Advanced Analysis for Material Defects and Metal Impurities in Si

Chairs: Ron Sinton (Sinton Instruments) & Ferenc Korsós (Semilab Co. Ltd.)

10:30 Accounting for Coil Sensitivity Dependence on Sample Thickness in High-Accuracy Inductively Coupled Photoconductance Measurements

Lachlan Black[1], Erwin Kessels[2]

[1] *The Australian National University;* [2] *Eindhoven University of Technology*

10:45 Lifetime Spectroscopy with High Spatial Resolution Based on Temperature- and Injection Dependent PL Imaging

Halvard Haug[1], Marie Syre Wiig[1], Amalie Berg[1], Rune Søndenå[1]

[1] *Institute for Energy Technology (IFE)*

11:00 Comparison of Magnetic Field Imaging (MFI) and Magnetic Field Simulations of Silicon Solar Cells

Dominik Lausch[1], Ulli Zeller[2], Markus Patzold[1], Chia Mei Lin[1], Matthias Pander[2], Sebastian Slaby[2], Kai Kaufmann[1]

[1] *DENKweit GmbH;* [2] *Fraunhofer Center for Silicon Photovoltaics CSP*

11:15 A Study of Metal Contamination on n-Type Silicon Cell Material

Joachim John

imec

11:30 Transition Metal - Hydrogen Reactions in Silicon - The Role of Optical Excitation

Anthony Peaker[1], Jack Mullins[1], Vladimir Markevich[1], Ian Hawkins[1], Matthew Halsall[1]

[1] University of Manchester

11:45 New Insights Into the Thermally Activated Defects in n-Type Float-Zone Silicon

Yan Zhu[1], Fiacre Rougieux[1], Nicholas Grant[2], Jack Mullins[3], Joyce Ann De Guzman[3], John Murphy[4], Vladimir Markevich[3], Gianluca Coletti[5], Anthony Peaker[3], Ziv Hameiri[1]

[1] *University of New South Wales (UNSW);* [2] *University of Warwick;* [3] *The University of Manchester;* [4] *University of New South Wales (UNSW) / University of Warwick;* [5] *ECN part of TNO*

12:00 - 13:00 Lunch Break

13:00 - 14:00 Poster Session 1: Novel Characterization and Modelling *(blue session)*

Chairs: Andreas Schütt (CELLOscan) & Dominic Walter (ISFH)

S1-01 Optical Models for Lambertian Light Trapping in Textured Si Solar Cells

Luigi Abenante
ENEA - Portici Research Center

S1-02 Impact of Excess Carrier Profiles in the Luminescent Emission and Detection of Silicon Solar Cells

Nekane Azkona[1], Federico Recart[1], Pedro Rodriguez[1], Vanesa Fano[1], Aloña Otaegi[1], Juan Carlos Jimeno[1]
[1] *Institute of Microelectronic Technology - University of the Basque Country (UPV/EHU)*

S1-03 New Characterization Method for Determination of Surface Recombination Rate of Carrier Selective Junctions

Andrej Campa[1], Franc Smole[1], Marko Topič[1]
[1] *University of Ljubljana, Faculty of Electrical Engineering*

S1-04 A Novel Approach for the Evaluation of a Phosphorus Diffusion Design of Experiment

Gerd Fischer[1], Amir Dastgheib-Shirazi[2], Barbara Terheiden[2], Matthias Müller[3]
[1] *Hochschule Zittau/Görlitz;* [2] *University of Konstanz;*
[3] *TU Bergakademie Freiberg / Institute of Applied Physics*

S1-05 GD-OES Depth Profiling and Calibration of B Doped Dielectric Layers

Fabian Geml[1], Josh Engelhardt[1], Jonathan Steffens[1], Luis-Frieder Reinalter[1], Gabriel Micard[1], Giso Hahn[1]
[1] *University of Konstanz*

S1-06 Enhanced Series Resistance of a-Si:H/c-Si Heterojunction (SHJ) Solar Cells Under Illumination

Moustafa Ghannam[1], Yaser Abdulraheem[1]
[1] *Kuwait University*

S1-07 Investigating the Effect of the Perovskite Absorber Material Thickness on the Performance of 4-Terminal Mechanically-Stacked Perovskite/Silicon Tandem Solar Cell

Ali Hajjiah[1], Fahad Parmouneh[1], Badran Hussein[1], Afshin Hadipour[2], Manoj Jaysankar[2], Tom Aernouts[2]
[1] *Kuwait University;* [2] *imec*

S1-08 Electrical and Optical Analysis of a Spray Coated Transparent Conductive Adhesive for Two-Terminal Silicon Based Tandem Solar Cells

Ulrike Heitmann[1], Oliver Höhn[1], Sven Kluska[1], Jonas Bartsch[1], Stefan Janz[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S1-09 Fundamental Errors Using Calibrated Photoluminescence Imaging for Extracting Dark Saturation Current Densities

David Herrmann[1], Sabrina Lohmüller[1], Hannes Höffler[1], Andreas Fell[1], Andreas Wolf[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S1-10 Effect of Hydrogen on Bulk Properties of Sputtered ITO

Nimish Juneja[1], Leonard Tutsch[1], Frank Feldmann[1], Martin Bivour[1], Martin Hermle[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S1-11 Effect of a-Si:H and µc-Si:H Junction on Hydrogen Transport During Plasma Exposure

Fatiha Kail[1], Siham Djoumi[1], Pere Roca i Cabarrocas[2], Larbi Chahed[1]

[1] *LPCMME, University Oran1;* [2] *LPICM, CNRS, Ecole Polytechnique*

S1-12 Powerful Topographic Analysis Method Using Fast Fourier Transformation for c-Si Solar Cells and Emerging Technologies

Karolien Saliou[1], Guilaume Fischer[1], Florian Hilt[2], Pierre-Philippe Grand[3], Etienne Drahi[4]

[1] *IPVF;* [2] *Total;* [3] *EDF R&D;* [4] *Total SA - GRP*

S1-13 Interface Engineering of Ultra-Thin AlO_x/ PEDOT:PSS Carrier Selective Contacts for Low-Cost, High-Efficiency Si-Solar Cells

Gurleen Kaur[1], Zhi Peng Ling[2], Rolf Stangl[2], Aaron J. Danner[1]

[1] *National University of Singapore;* [2] *Solar Research Institute of Singapore (SERIS)*

S1-14 Accurate Contact and Contactless Methods for Emitter Sheet Resistance Testing of PV Wafers

Ferenc Korsós[1], Péter Tütt[1], Ilias Saegh[1], Krisztián Kis-Szabó[1], Attila Tóth[1]

[1] *Semilab Co. Ltd.*

S1-15 A High-Accuracy Calibration Method for Temperature Dependent Photoluminescence Imaging

Sissel Tind Kristensen[1], Shuai Nie[2], Marie Syre Wiig[3], Halvard Haug[3], Charly Berthod[1], Rune Strandberg[1], Ziv Hameiri[2]

[1] *University of Agder;* [2] *University of New South Wales (UNSW);* [3] *Institute for Energy Technology (IFE)*

S1-16 Effect of Amorphous Silicon Film Thickness on Heterojunction Band Alignment

Martin Ledinsky[1], Paul Procel[2], Martin Muller[1], Jakub Holovsky[1], Aleksei Vetusko[1], Olindo Isabella[2], Miro Zeman[2], Antonin Fejfar[1]

[1] *Institute of Physics AS CR;* [2] *Delft University of Technology*

S1-17 Investigation of Injected Charge by Using Novel Plasma Charging System for Field-Effect Passivation on Boron-Doped Silicon Surface

Kwan Hong Min[1], Young-Woo Ok[2], James Hwang[3], Hee-eun Song[4], Sungeun Park[4], Jeong In Lee[4], Donghwan Kim[1], Ajeet Rohatgi[2], Hea-Seok Lee[1], Yoonmook Kang[1]

[1] *Korea University;* [2] *Georgia Institute of Technology;* [3] *Amtech System Inc.;* [4] *Korea Institute of Energy Research*

S1-18 Numerical Simulation of an Ozone-Based Wet-Chemical Etching

Lena Mohr[1], Tobias Krick[1], Martin Zimmer[1], Anamaria Moldovan[1], Andreas Fischer[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S1-19 Study of Anomalous S-Shape Behaviour in Current Density-Voltage Characteristics of Carrier Selective Contact Molybdenum Oxide and Amorphous Silicon Based Heterojunction Silicon Solar Cells

Sapna Mudgal[1], Mrutyunjay Nayak[1], Sonpal Singh[1]

[1] *Indian Institute of Technology Delhi*

S1-20 On the Different Explanations of the Recombination Currents with High Ideality Factor in Silicon Solar Cells

Aloña Otaegi[1], Vanesa Fano[1], Nekane Azkona[1], Lourdes Pérez[1], Eneko Cereceda[1], José Rubén Gutierréz[1], Juan Carlos Jimeno[1]

[1] *Institute of Microelectronic Technology / University of the Basque Country (UPV/EHU)*

S1-21 Understanding the Effect of Hetero-Interfaces Transport on Contact Resistance for c-Si Carrier Selective Contacts

Paul Procel[1], Haiyuan Xu[1], Luana Mazzarella[1], Guangtao Yang[1], Gianluca Limodio[1], Olindo Isabella[1], Miro Zeman[1]

[1] TU Delft

S1-22 Bottom Cell Light Management Strategies for Mechanically Stacked Perovskite/c-Si Tandem Devices

Arsalan Razzaq[1], Valerie Depauw[2], Filip Duerinckx[2], Ivan Gordon[2], Jozef Szlufcik[2], Jef Poortmans[3]

[1] *KU Leuven / imec;* [2] *imec;* [3] *KU Leuven / imec / U Hasselt / EnergyVille*

S1-23 Evaluation of Localized Vertical Current Formation in Carrier Selective Passivation Layers of Silicon Solar Cells by TEM and Conductive AFM

Susanne Richter[1], Yevgeniya Larionova[2], Stephan Großer[1], Angelika Hähnel[1], Christian Hagendorf[1]

[1] *Fraunhofer Center for Silicon Photovoltaics CSP;* [2] *Institute for Solar Energy Research in Hamelin (ISFH)*

S1-24 Characterization of Atomic Layer Deposition Alumina Thin Films on Black Silicon Textures Using Helium Ion Microscopy

Tudor Emilian Scheul[1], Edris Khorani[1], Tasmiat Rahman[1], Stuart Boden[1]

[1] *University of Southampton*

S1-25 Light Trapping Analysis by IR Thermal Imaging of Partial Transparent Bifacial Solar Cell

Suhaila Sepeai[1], Hatim Rohaizar[1], N.A. Ludin[1], M.A. Ibrahim[1], K. Sopian[1], Saleem H. Zaidi[1]

[1] *Solar Energy Research Institute (SERI)*

S1-26 Characterization of Sputtered A-Si:H Passivated Silicon Surface by Temperature- and Injection-Dependent Lifetime Spectroscopy

Krishna Singh[1], Sourav Mandal[1], Sonpal Singh[1]

[1] *Indian Institute of Technology Delhi*

S1-27 Injection Dependent Spatially Resolved Lifetime Mapping Using Photoluminescence

Daniel Skorka[1], Giso Hahn[1]

[1] *University of Konstanz*

S1-28 Demonstrating a Web-Based PV Simulation Platform (Targeting at Machine Learning & Advanced Device and Process Simulation to Support Process Optimization)

Rolf Stangl[1], Gautam Anand[1], Rahul Jaiswal[1], Cangming Ke[1], Zekun Ren[2], Tonio Buonassisi[3]

[1] Solar Research Institute of Singapore (SERIS);
[2] *Singapore-MIT Alliance for Research and Technology (SMART);*
[3] *Singapore-MIT Alliance for Research and Technology (SMART) & Massachusetts Institute of Technology*

S1-29 Edge Recombination Analysis of Silicon Solar Cells Using Photoluminescence Measurements

Hannah Stolzenburg[1], Andreas Fell[1], Friedemann D. Heinz[1], Florian Schindler[1], Wolfram Kwapil[1], Armin Richter[1], Puzant Baliozian[1], Martin C. Schubert[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S1-30 Excess Charge Carrier Injection Densities in PERC Solar Cells at Open-Circuit Voltage and Maximum Power Point

Maksym Tratnikov[1], Matthias Müller[1], Johannes Heitmann[1]

[1] *TU Bergakademie Freiberg / Institute of Applied Physics*

S1-31 Low-Temperature Silicon Surface Passivation for Bulk Lifetime Studies Based on Corona-Charged Al_2O_3

Boris Veith-Wolf[1], Jan Schmidt[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH)*

S1-32 Three-Terminal Perovskite Silicon Tandem Solar Cells with Top and Interdigitated Rear Contacts

Philipp Wagner[1], Philipp Tockhorn[1], Johann-Christoph Stang[1], Lukas Kegelmann[2], Mathias Mews[1], Steve Albrecht[2], Lars Korte[1]

[1] *Helmholtz-Zentrum Berlin, Institute of Silicon Photovoltaics;* [2] *Young Investigator Group Perovskite Tandem Solar Cells, Helmholtz-Zentrum Berlin*

S1-33 Averaging the Unaverageable: Defining a Meaningful Local Series Resistance for Large-Area Silicon Solar Cells

Jan-Martin Wagner[1], Koundinya Upadhyayula[1], Jürgen Carstensen[1], Rainer Adelung[1]

[1] *University of Kiel*

S1-34 A Simple Method with Analytical Model to Extract Heterojunction Solar Cell Series Resistance Components and to Predict the A-Si:H(i/p) Contact Resistivity

Er-Chien Wang[1], Anna Belen Morales-Vilches[1], Sebastian Neubert[1], Alexandros Cruz[1], Bernd Stannowski[1]

[1] *Helmholtz-Zentrum Berlin, PVcomB*

S1-35 Simulation of Solar Cell Performance Based on in the Field Measured Ambience Parameters

Gustav Wetzel[1], Jan Krügener[1], Robby Peibst[2], André Dietrich[1], Bernard Nacke[1], Hans-Jörg Osten[1]

[1] *Leibniz Universität Hannover;* [2] *Institute for Solar Energy Research in Hamelin (ISFH)*

S1-36 The Numerical Analysis of ZnO Nanoparticle Based Down-Converting Layer‘s Influence on Solar Cell Efficiency

Katarzyna Znajdek[1], Natalia Szczecinska[1], Aleksandra Sosna-Glebska[1], Przemyslaw Czarnecki[1], Maciej Sibinski[1]

[1] *Lodz University of Technology*

14:00 - 14:30 Keynote

Annealing Prior to Contact Firing: A Potential New Approach to Suppress LeTID

Chandany Sen[1], Catherine Chan[1], Alison Ciesla[1], Utkarshaa Varshney[1], Shaoyang Liu[1], Daniel Chen[1], Aref Samadi[1], CheeMun Chong[1], Brett Hallam[1], Malcolm Abbott[1]

[1] *University of New South Wales (UNSW)*

Chandany Sen

Chandany Sen completed her master's degree in renewable energy engineering in 2014 at Inha University, South Korea, where she had been working on improving the electrical and optical properties of the window layer of the tandem silicon solar cell. She has an intensive experience as a renewable energy project developer in Swiss and Japanese companies based in Cambodia. Since 2017, she is working as a PhD candidate in photovoltaic engineering at UNSW Sydney, Australia. Her primary focus is on applying advanced hydrogenation processes to passivate the defects in silicon. She has published scientific papers on the mitigation of the light and elevated temperature induced degradation in p-type multi-crystalline silicon solar cells.

14:30 - 15:30 Session 3: Growing Insights in Light- and Temperature Induced Degradation Mechanisms

Chairs: Giso Hahn (University of Konstanz) & Brett Hallam (University of New South Wales)

14:30 Impact of SiN_x:H Material Properties on Light and Elevated Temperature Induced Degradation (LeTID) in Mc-Si

Dennis Bredemeier[1], Dominic Walter[1], René Heller[2], Jan Schmidt[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH);*
[2] *Helmholtz-Zentrum Dresden-Rossendorf, Institute of Ion Beam Physics and Materials Research*

14:45 Excessive Light-Induced Degradation in Boron-Doped Cz Silicon PERC Triggered by Dark Annealing

Fabian Fertig[1], Ronny Lantzsch[1], Friederike Kersten[1], Felix Frühauf[1], Matthias Schütze[1], Jeanette Lindroos[1], Christian Taubitz[1], Jörg W. Müller[1]

[1] *Hanwha Q CELLS GmbH*

15:00 Controlling Light- and Elevated Temperature-Induced Degradation by Thin Film Barrier Layers

Utkarshaa Varshney[1], Malcolm Abbott[1], Alison Ciesla[1], Daniel Chen[1], Chandany Sen[1], Shaoyang Liu[1], Bram Hoex[1], Catherine Chan[1]

[1] *University of New South Wales (UNSW)*

15:15 Absence of Light and Elevated Temperature Induced Degradation (LeTID) of the Carrier Lifetime in Boron-Doped Cz-Silicon

Michael Winter[1], Dominic Walter[1], Dennis Bredemeier[1], Jan Schmidt[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH)*

15:30 - 16:00 Coffee Break

16:00 - 17:00 Poster Session 2: Improvements on Carrier Selective Contacts *(white session)*

Chair: Franz-Josef Haug (EPFL)

S2-01 Investigation of the Oxygen Content Effect on the Optoelectronic Properties of the Indium-Tin-Oxide Based Transparent Electrodes for Silicon Heterojunction Solar Cells

Brahim Aïssa[1], Jan Haschke[2], Jean Cattin[2], Mathieu Boccard[2], Christophe Ballif[2], Amir A. Abdallah[1]

[1] *Qatar Environment and Energy Research Institute QEERI;*
[2] *EPFL*

S2-02 Lifetime Drop Upon Electrode Deposition in Passivating Contacts Solar Cells: The Role of Localized High-Recombination Areas

Jean Cattin[1], Jan Haschke[1], Olivier Dupré[1], Mathieu Boccard[1], Christophe Ballif[1]

[1] *EPFL*

S2-03 Improved Passivation for SHJ Utilizing Dual Intrinsic a-Si:H Layers

Lara Bodlak

Fraunhofer Institute for Solar Energy Systems ISE

S2-04 Screen Printed Ag Contacts for n-Type Poly Silicon Passivated Contacts

Aditya Chaudhary[1], Jan Hoß[1], Jan Lossen[1], R.A.C.M.M. van Swaaij[2], Miro Zeman[2]

[1] *International Solar Energy Research Center (ISC) Konstanz;*
[2] *TU Delft*

S2-05 ALD-Grown Magnesium Oxide as a Material for Silicon Heterojunction Solar Cells

Ganna Chistiakova[1], Lars Korte[1]

[1] *Helmholtz Zentrum Berlin*

S2-06 MoO_x Integration with Printed Ag for Silicon Heterojunction Solar Cells and its Long-Term Stability at Module Level

Jinyoun Cho[1], Neerja Nawal[2], Afshin Hadipour[3], Maria Recaman Payo[3], Arvid van der Heide[3], Hariharsudan Sivaramakrishnan Radhakrishnan[3], Maarten Debucquoy[3], Ivan Gordon[3], Jozef Szlufcik[3], Jef Poortmans[1]

[1] *KU Leuven / imec / U Hasselt / EnergyVille;* [2] *imec;* [3] *imec (partner in EnergyVille)*

S2-07 E-Beam Evaporated p-Poly-$SiSiO_x$ Layers for Passivated Contact Silicon Photovoltaic Applications

Emine Hande Ciftpinar[1], Salar Habibpur Sedani[1], Rasit Turan[1]

[1] *METU-GUNAM (Center for Solar Energy Energy and Applications)*

S2-08 p-Type Silicon Front Emitters for Si Heterojunction Solar Cells

Marco Della Noce[1], Eugenia Bobeico[1], Laura Lancellotti[1], Lucia Vittoria Mercaldo[1], Iurie Usatii[1], Paola Delli Veneri[1]

[1] *ENEA - Portici Research Center*

S2-09 Integration Avenues in Solar Cells Implementing Passivating Contacts

Juan J Diaz Leon[1], Christophe Allebé[1], Joerg Horzel[1], Gizem Nogay[1], Antoine Descoeudres[1], Gabriel Christmann[1], Laura Ding[1], Nicolas Badel[1], Andrea Ingenito[2], Matthieu Despeisse[1], Sylvain Nicolay[1], Christophe Ballif[1]

[1] *CSEM;* [2] *EPFL PV-Lab*

S2-10 Characterization of Absorption Losses in Rear Side n-Type Polycrystalline Silicon Passivating Contacts

Meriç Fırat[1], Maria Recamán Payo[2], Filip Duerinckx[2], Martijn Lenes[3], Jan-Marc Luchies[3], Jef Poortmans[4]

[1] *KU Leuven / imec;* [2] *imec;* [3] *Tempress–Amtech Group;* [4] *imec / KU Leuven / UHasselt*

S2-11 Carrier Selective Contacts Based on Low Pressure Chemical Vapor Deposition on Planar and Black Silicon

Alireza Hajijafarassar[1], Denver Shearer[1], Rasmus Schmidt Davidsen[1], Jørgen Schou[1], Thomas Pedersen[1], Ole Hansen[1], Beniamino Iandolo[1]

[1] *Technical University of Denmark (DTU)*

S2-12 Comparison of nc-Si:H and a-Si:H as Hole Selective Contact Layers in Silicon Heterojunction Solar Cells

Jan Haschke[1], Raphaël Monnard[1], Olivier Dupre[1], Jean Cattin[1], Mathieu Boccard[1], Christophe Ballif[1]

[1] *PV-Lab, EPFL*

S2-13 Sputtering of Silicon Thin Films for Passivated Contacts

Jan Hoß[1], Jan Lossen[1], Eric Schneiderlöchner[2], René Köhler[2], Jens Baumann[2], Uwe Graupner[2], Martin Thumsch[2], Markus Berendt[2]

[1] *International Solar Energy Research Center (ISC) Konstanz;* [2] *VON ARDENNE GmbH*

S2-14 Silicon Films for Heterojunction Solar Cells by Hot-Wire CVD

Madeleine Justianto[1], Tino Harig[1], Markus Höfer[1], Volker Sittinger[1]

[1] *Fraunhofer-Institute for Surface Engineering and Thin Films IST*

S2-15 High Efficient Rear Emitter HIT Solar Cell Using Low Temperature Growth of p-Type Nano-Crystalline Silicon Oxide Layer

Sangho Kim[1], Young-Hyun Cho[1], Eun-Chel Cho[1], Youngkuk Kim[1], Jinjoo Park[1], Sunhwa Lee[1]

[1] *Sungkyunkwan University*

S2-16 Transparent Passivated Contact Optimization for Silicon Heterojunction Solar Cells

Malte Köhler[1], Alexandr Zamchiy[2], Manuel Pomaska[1], Andreas Lambertz [1], Vladimir Smirnov[1], Friedhelm Finger[1], Uwe Rau[1], Kaining Ding[1]

[1] *Forschungszentrum Jülich GmbH;* [2] *Novosibirsk State University*

S2-17 Disorder of Hydrogenated Amorphous Silicon Passivation Layer and its Influence on Silicon Heterojunction Solar Cell

Sunhwa Lee[1], Sangho Kim[1], Jinjoo Park[1], Youngkuk Kim[1], Young Hyun Cho[1], Eun-chel Cho[1]

[1] *Sungkyunkwan University*

S2-18 Carrier Selective Passivated Contact Using Hot-Wire CVD

Shenghao Li

IEK-5, Research Center Jülich

S2-19 Comparison of Low Damage Sputter Deposition Techniques to Enable the Application of Very Thin a-Si Passivation Films

Volker Linss[1], Hiroshi Iwata[2], Kai Ortner[3], Martin Bivour[4]

[1] *VON ARDENNE GmbH;* [2] *KEIHIN RAMTECH Co.,LTD.;* [3] *Fraunhofer Institute for Surface Engineering and Thin Films IST;* [4] *Fraunhofer Institute for Solar Energy Systems ISE*

S2-20 Hydrogen Passivation Effect on p-Type Poly-Si / SiO_x Stack for Crystalline Silicon Solar Cells

Mickael Lozac'h[1], Shota Nunomura[1], Hiroshi Umishio[1], Takuya Matsui[1], Koji Matsubara[1]

[1] *AIST - National Institute of Advanced Industrial Science and Technology*

S2-21 UV/O_3 as a Versatile Approach for Highly-Passivating Oxides: Application to ALD ZnO/Al_2O_3 Stacks

Bart Macco[1], Marc Dielen[1], Bas van de Loo[2], Jimmy Melskens[1], Erwin Kessels[1]

[1] *Eindhoven University of Technology;* [2] *Tempress Systems*

S2-22 Insights into Charge Carrier Transport Mechanisms of SiO_2/Poly-SiCx/TCO Contact Structures for Silicon Solar Cells

Luana Mazzarella[1], Paul Procel[1], Yifeng Zhao[1], Guangtao Yang[1], Gianluca Limodio[1], Arthur Weeber[2], Olindo Isabella[1], Miro Zeman[1]

[1] *TU Delft PVMD;* [2] *Delft University of Technology*

S2-23 SiO_xNy:B Layers for Ex-Situ Doping of Hole-Selective Poly-Silicon Contacts: A Passivation Study

Audrey Morisset[1], Raphaël Cabal[2], Valentin Giglia[2], Bernadette Grange[1], José Alvarez[3], Sébastien Dubois[2], Marie-Estelle Gueunier-Farret[4], Jean-Paul Kleider[3]

[1] *CEA-INES / IPVF;* [2] *CEA-INES;* [3] *GeePs / IPVF;* [4] *GeePs*

S2-24 Industrial Scale p-Type c-Si Solar Cells Featuring Hole-Selective Moox Rear Contact with Efficiencies Above 17.6%

Hisham Nasser[1], Firat Es[2], Mona Zolfaghari Borra[2], Emel Semiz[2], Efe Orhan[2], Gamze Kokbudak[2], Rasit Turan[2]

[1] *The Center for Solar Energy Research and Applications (GUNAM);* [2] *The Center for Solar Energy Research and Applications (GUNAM), Middle East Technical University*

S2-25 Electrical Characterization and Defect States Analysis of $Ag/ITO/MoO_x/n\text{-}Si/LiF_x/Al$ Carrier Selective Contact Solar Cells

Mrutyunjay Nayak[1], Krishna Singh[1], Sapna Mudgal[1], Sourav Mandal[1], Sonpal Singh[1]

[1] *Indian Institute of Technology Delhi*

S2-26 Inline Deposited PassDop Layers for Rear Side Passivation and Contacting of p-c-Si PERL Solar Cells with High Bifaciality

Mohammad Hassan Norouzi[1], Pierre Saint-Cast[1], Elmar Lohmüller[1], Sabrina Lohmüller[1], Bernd Steinhauser[1], Jan Benick[1], Andreas Wolf[1], Marc Hofmann[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S2-27 Enhanced Field-Effect Passivation Using Nano-Scaled Pyramids for Light Management in Diffused Junction Silicon Solar Cells

Arsalan Razzaq[1], Valerie Depauw[2], Joachim John[2], Ivan Gordon[2], Jozef Szlufcik[2], Jef Poortmans[3]

[1] *KU Leuven / imec;* [2] *imec;* [3] *KU Leuven / imec / U Hasselt / EnergyVille*

S2-28 Improved Temperature Coefficients in Very Thin Silicon Heterojunction Solar Cells

Hitoshi Sai[1], Yoshiki Sato[1], Toshiki Oku[1], Mayumi Tanabe[1], Takuya Matsui[1], Koji Matsubara[1]

[1] *AIST - National Institute of Advanced Industrial Science and Technology*

S2-29 Optical Properties of Poly-SiO_x Carrier-Selective Passivating Contacts

Manvika Singh

Delft University of Technology

S2-30 Different Flavors of Contact Passivation (Investigating SiO_x/n-poly-Si, SiO_x/p-poly-Si and AlO_x/p-poly-Si Tunnel Layer Passivated Contacts for Rear- & Front-Side Device Integration)

Rolf Stangl[1], Zheng Xin[1], Ranjani Sridharan[1], Cangming Ke[1], Puqun Wang[1], Zhi Peng Ling[1]

[1] *Solar Research Institute of Singapore (SERIS)*

S2-31 Compensation of the Sputter Damage During a-Si Deposition for poly-Si/SiO_x Passivating Contacts by Ex-Situ P-Doping

Jonathan Steffens[1], Johannes Rinder[1], Giso Hahn[1], Barbara Terheiden[1]

[1] *University of Konstanz*

S2-32 Review and Outlook of Doped and Undoped LPCVD PolySi Based Passivating Contacts for Industrial Si Solar Cells

Maciej K. Stodolny[1], Yu Wu[1], John Anker[1], Xiaoqian Lu[1], Ji Liu[1], Paula Bronsveld[1], Agnes Mewe[1], Gaby Janssen[1], Gianluca Coletti[1], Kees Tool[1], Bart Geerligs[1], Jochen Loffler[1], Arthur Weeber[1]

[1] *ECN part of TNO - Solar Energy*

S2-33 Ex Situ Phosphorus Doped Polysilicon Films by Plasma Immersion Ion Implantation (PIII): Controlling and Simplifying Passivated Contacts Integration

Antoine Veau[1], Thibaut Desrues[1], Anne Kaminski-Cachopo[2], Quentin Rafhay[2], Sébastien Dubois[1]

[1] *CEA-INES;* [2] *IMEP LAHC / PHELMA (Grenoble INP)*

S2-34 Tunnel Oxide Passivation and Polysilicon Contact on p-Type c-Si Wafers and High Efficiency Solar Cells

Baojie Yan[1], Xueqi Guo[1], Yuheng Zheng[1], Zhi Zhang[1], Yuqing Huang[1], Mingdun Liao[1], Qing Yang[1], Zhixue Wang[1], Chunhui Shou[2], Minyong Du[3], Jichun Ye[1]

[1] *Ningbo Institute of Materials Technologies and Engineering;* [2] *Zhejiang Energy Group R&D;* [3] *Dalian Institute of Chemical Physics, CAS*

S2-35 Opto-Electrical Optimization of nc-SiO_x:H Layers for Silicon Heterojunction Solar Cells

Yifeng Zhao[1], Luana Mazzarella[1], Paul Procel[1], Guangtao Yang[1], Gianluca Limodio[1], Olindo Isabella[1], Arthur Weeber[1], Miro Zeman[1]

[1] *Delft University of Technology*

17:00 - 18:30 Session 4: Progress in Process Step Development

Chairs: Joachim John (imec) & Fabian Fertig (Hanwha Q CELLS GmbH)

17:00 Improving Wall Slip Behavior on Screen Emulsions for Fine Line Screen Printing

Sebastian Tepner[1], Noah Wengenmeyr[1], Linda Ney[1], Michael Linse[1], Maximilian Pospischil[1], Florian Clement[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

17:15 Inkjet-Printing of Phosphorus- and Boron-Doped Liquid Silicon Ink for Interdigitated Back Contact Solar Cells

Nadine Wehmeier[1], Fabian Kiefer[1], Till Brendemühl[1], Larysa Mettner[1], Felix Haase[1], Robby Peibst[1], Sarah Kajari-Schröder[1], Michael Holthausen[2], Christoph Mader[2], Christian Daeschlein[2], Odo Wunnicke[2]

[1] *Institute for Solar Energy Research in Hamelin (ISFH);* [2] *Evonik Creavis GmbH*

17:30 Shallow Phosphorus Junctions by Plasma-Immersion Ion Implantation and Rapid Thermal Processing

Pierre Bellanger[1], Adeline Lanterne[1], Antoine Veau[1], Thibaut Desrues[1], Frank Torregrosa[2], Laurent Roux[2], Marianne Coig[3], Pierre Mur[3], Frederic Milesi[3], Sebastien Dubois[1]

[1] *CEA-INES;* [2] *IBS;* [3] *University Grenoble Alpes, CEA, LETI*

17:45 Establishment of the Native Oxide Barrier Layer for Selective Electroplated Metallization for Bifacial Silicon Heterojunction Solar Cells

Thibaud Hatt[1], Sven Kluska[1], Jonas Bartsch[1], Markus Glatthaar[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

18:00 Impact of the Thermal Budget of the Emitter Formation on the pFF of PERC+ Solar Cells

Philip Jäger[1], Verena Mertens[1], Ulrike Baumann[1], Thorsten Dullweber[1], Rolf Brendel[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH)*

18:15 Potential Induced Degradation of Bifacial PERC Solar Cells - Root Cause Analysis at the Rear Side Passivation Layer

Kai Sporleder[1], Marko Turek[1], Jan Bauer[1], Susanne Richter[1], Christian Hagendorf[1], Volker Naumann[1]

[1] *Fraunhofer Center for Silicon Photovoltaics CSP*

Tuesday, April 09, 2019

08:00 Registration

08:30 - 10:00 Session 5: Carrier Selective Contacts I: Detailed Analysis of Poly-Si Passivated Contacts

Chairs: Erwin Kessels (Eindhoven University of Technology) & Martin Hermle (Fraunhofer ISE)

08:30 Study on the Interfacial Oxide in Passivating Contacts

Jana-Isabelle Polzin[1], Frank Feldmann[1], Bernd Steinhauser[1], Armin Richter[1], Martin Hermle[1], Stefan Glunz[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

08:45 Poly Si/SiO_x Contacts for Silicon Solar Cells on Textured Surfaces: The Role of Surface Morphology and Orientation

Abhijit Kale[1], William Nemeth[2], Harvey Guthrey[2], Vincenzo LaSalvia[2], San Theingi[2], Dawn Findley[2], Matthew Page[2], Mowafak Al-Jassim[2], David Young[2], Sumit Agarwal[1], Paul Stradins[2]

Presented by Paul Stradins[2]

[1] *Colorado School of Mines;* [2] *National Renewable Energy Laboratory (NREL)*

09:00 Quantum Transport Across Amorphous-Crystalline Interfaces in Tunnel-Oxide Passivated Contact Solar Cells: Direct vs. Defect-Assisted Tunneling

Kaining Ding[1], Feng Li[1], Urs Aeberhard[1], Manuel Pomaska[1], Weiyuan Duan[1], Uwe Rau[1]

[1] *Forschungszentrum Jülich GmbH*

09:15 Passivation Maximization of Poly-Si by Applying ALD-Al_2O_3 Capping Layers

Guangtao Yang[1], Bas van de Loo[2], Maciej Stodolny[3], Gianluca Limodio[1], Jimmy Melskens[2], Bart Macco[2], Paula P.C.P. Bronsveld[3], Olindo Isabella[1], Arthur Weeber[1], Miro Zeman[1], Erwin W.M.M. Kessels[1]

[1] *Delft University of Technology;* [2] *Eindhoven University of Technology;* [3] *ECN part of TNO*

09:30 Exploring Co-Deposition of ZnO:Al and SiO_2 for Efficient Electron-Selective Contacts on Silicon Solar Cells

Sihua Zhong[1], Monica Morales-Masis[2], Mathias Mews[3], Lars Korte[3], Quentin Jeangros[1], Weiliang Wu[1], Mathieu Boccard[1], Christophe Ballif[4]

[1] *EPFL PV-Lab;* [2] *University of Twente, MESA+ Institute for Nanotechnology;* [3] *Helmholtz-Zentrum Berlin, Institute of Silicon Photovoltaics;* [4] *EPFL*

09:45 Development of n-Type Nanocrystalline Silicon Oxide for Tunnel Oxide Passivated Contacts

Manuel Pomaska[1], Jan Hoß[2], Joachim Kirchhoff[1], Felix Komoll[1], Jan Lossen[2], Friedhelm Finger[1], Uwe Rau[1], Kaining Ding[1]

[1] *Forschungszentrum Jülich GmbH;* [2] *International Solar Energy Research Center (ISC) Konstanz*

10:00 - 10:30 Coffee Break

10:30 - 10:45 Poster Session 3: Cell Interconnection and Module Aspects *(red session)*

Chair: Henning Schulte-Huxel (ISFH)

S3-01 Dynamics in c-Si PV Systems: Shading and Inverter Performance

Antonius R. Burgers[1], Bas B. van Aken[1], Gaby J.M. Janssen[1], Anna J. Carr[1], Josco C.P. Kester[1], Bonna K. Newman[1]

[1] *ECN part of TNO*

S3-02 A New High Efficiency PERC Bifacial Solar Cell and Module: Fabrication, Characterization and Application

Hu Dangping[1], Zhang Shude[1], Lian Weifei[1]

[1] *Suzhou Talesun Solar Technologies Co., Ltd*

S3-03 An Advanced LED-Based Setup Enabling the Characterization of Full-Size Modules at Different Temperatures and Spectra

Jonathan Govaerts[1], Monica Aleman[2], Jef Poortmans[1]

[1] *imec-Energyville;* [2] *imec*

S3-04 Effect of Outdoor Rear-Side Irradiance Non-Uniformity on the Performance of Bifacial Silicon PV Modules

Robert Kenny[1], Ebrar Ozkalay[1], Juan Lopez Garcia[1], Laura Pinero Prieto[1]

[1] *Joint Research Centre*

S3-05 Evaluation of the Non-Uniformity of Rear-Side Irradiance in Outdoor Mounted Bifacial Silicon PV Modules

Robert Kenny[1], Ebrar Ozkalay[1], Juan Lopez Garcia[1], Laura Pinero Prieto[1]

[1] *Joint Research Centre*

S3-06 Influence of Cell Packaging and Design Parameters on Thermo-Mechanical Reliability of Fingers in Crystalline Silicon Photovoltaic Modules

Sagarika Kumar[1], Rajesh Gupta[1]

[1] *Indian Institute of Technology Bombay*

S3-07 Instrumented Hardness Changes with a Spatial Resolution of Encapsulant Layer in PV Modules Caused by Different Accelerated Aging Tests

Djamel Eddine Mansour[1], Luciana Pitta Bauermann[1], Daniel Philipp[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S3-08 Estimation of Most Frequent Operating Conditions of Different Technology Silicon Photovoltaic Module in India Using IEC 61853-1 Approach

Humaid Mohammed[1], Rajesh Gupta[1], Oruganti Sastry[2], Brinchi Bora[2], Dhiraj Magare[1], Yogesh Kumar[2], Sagarika Kumar[1]

Presented by Sagarika Kumar[1]

[1] *Indian Institute of Technology Bombay;* [2] *National Institute of Solar Energy*

S3-09 Influence of Soiling and Moisture Ingress on Long Term PID Susceptibility of Photovoltaic Modules

Volker Naumann[1], Klemens Ilse[1], Matthias Pander[1], Christian Hagendorf[1]

[1] *Fraunhofer Center for Silicon Photovoltaics CSP*

S3-10 Simulated Energy Yield of Bifacial Back-Contact Modules

Bas Van Aken[1], Lars Okel[1], Maurice Goris[1], Jan Kroon[1]

[1] *ECN part of TNO*

S3-11 Reaching 39% Higher Specific Yields with Bifacial Passivating Contact Modules in High-Albedo Conditions

Bas van de Loo[1], Willem Vermeulen[1], Bonna Newman[2], Anna Carr[2], Peter Venema[1], Jan-Marc Luchies [1]

[1] *Tempress Systems; 2 ECN part of TNO*

10:45 - 11:45 Session 6: Detailed Studies on Hydrogen-In-Si

Chairs: Jan Schmidt (ISFH) & Arthur Weeber (ECN part of TNO)

10:45 Analysis of Hydrogen Distribution and Migration in Fired Passivating Contacts (FPC)

Mario Lehmann[1], Andrea Ingenito[1], Franz-Josef Haug[1], Christophe Ballif[1], Xavier Niquille[1], Philippe Wyss[1], Quentin Jeangros[1], Aïcha Hessler-Wyser[1], Gizem Nogay[2], Jörg Horzel[2], Christophe Allebé[2], Matthieu Despeisse[2], Nathalie Valle[3], Santhana Eswara[3], Alisa Pshenova[3], Tom Wirtz[3], Josua Stückelberger[4]

[1] *EPFL;* [2] *CSEM;* [3] *LIST;* [4] *ANU*

11:00 Easy-to-Apply Methodology to Measure the Hydrogen Concentration in Boron-Doped Crystalline Silicon

Dominic Walter[1], Dennis Bredemeier[1], Robert Falster[2], Vladimir Voronkov[3], Jan Schmidt[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH);* [2] *formerly Sun Edison Semiconductors;* [3] *Sun Edison Semiconductor*

11:15 Impact of Pre-Oxidation on Hydrogen Depth Profiles Around A-Si:H/c-Si Heterointerface

Kauzhiro Gotoh[1], Shohei Ogura[2], Markus Wilde[2], Yasuyoshi Kurokawa[1], Katsuyuki Fukutani[2], Noritaka Usami[1]

[1] *Nagoya University;* [2] *University of Tokyo*

11:30 Degradation and Regeneration of Radiation Induced Defects in Silicon: A Study of Vacancy-Hydrogen Interactions

Muhammad Umair Khan[1], Malcolm Abbott[1], Daniel Chen[1], Takeshi Ohshima[2]

[1] *University of New South Wales (UNSW);* [2] *National Institutes for Quantum and Radiological Science and Technology (QST)*

11:45 - 13:00 Bus Transfer to EnergyVille in Genk

EnergyVille

All participants will have the special opportunity to visit EnergyVille in Genk, Belgium. This is the brand-new lab in which PV-module technology is being developed as well as new types of solid-state batteries. Moreover, the labs in EnergyVille allow to develop and test a local multi-energy network consisting of electrical and thermal parts.

Schedule: Shuttle buses will be leaving at 11:45 after the oral session in front of the conference venue. At EnergyVille a technical session and tour will be part of the program. After the tour, buses will directly go to the Faculty Club in Leuven, where the Conference Dinner takes place.

© EnergyVille

13:00 - 13:30 Lunch Break

13:30 - 14:30 Session 7: Novel Cell Interconnection Technologies and Module Degradation

Chairs: Ian Bennett (DSM Advanced Surfaces) & Jonathan Govaerts (imec)

13:30 Interconnect-Shingling: Maximizing the Active Module Area with Conventional Module Processes

Henning Schulte-Huxel[1], Susanne Blankemeyer[1], Rolf Brendel[1], Marc Köntges[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH)*

13:45 Physics of Potential-Induced Degradation in Bifacial p-PERC Solar Cells

Jorne Carolus[1], John Tsanakas[2], Arvid Van Der Heide[2], Eszter Voroshazi[2], Ward De Ceuninck[2], Michaël Daenen[1]

[1] *Hasselt University;* [2] *imec*

14:00 Woven Multi-Ribbon Interconnection for Back-Contact Cells: Extending the Functionality of the Encapsulant

Rik Van Dyck[1], Tom Borgers[2], Jonathan Govaerts[2], Aart Willem Van Vuure[1], Jef Poortmans[2]

[1] *KULeuven;* [2] *imec*

14:15 Overlapped Module: A Unique Cell Layup Capability Thanks to Smart Wire Connection Technology

Pierre Papet[1], Ludovic Andreetta[1], Simon Hänni[2], Benedicte Bonnet-Eymard[2], Benjamin Strahm[1]

Presented by Damien Lachenal[1]

[1] *Meyer Burger Research;* [2] *Meyer Burger Switzerland*

14:30 - 14:45 Coffee Break

14:45 - 17:45 Visit EnergyVille - THE PAST AND THE FUTURE

18:00 Bus Transfer to Leuven

19:00 Conference Dinner *(see page 44)*

Wednesday, April 10, 2019

08:00 Registration

08:30 - 08:45 Opening Session nPV

Welcome to nPV Workshop

Joachim John, imec

08:45 - 09:15 Keynote

Studying Dopant Diffusion from Poly-Si Passivating Contacts

Frank Feldmann[1], Jonas Schön[1], Jana-Isabelle Polzin[1], Jürgen Nieß[2], Wilfried Lerch[3], Martin Hermle[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE;*
[2] *HQ-Dielectrics GmbH;* [3] *SkyLark.Solutions*

Dr. Frank Feldmann

Frank Feldmann studied Electrical Engineering and Information Technology at the Technical University of Aachen (RWTH) in Germany from 2005 to 2010. During his studies he was awarded the Henry Ford II Prize. In 2011 he joined the Fraunhofer Institute for Solar Energy Systems (ISE) and developed the TOPCon technology. In 2015 he received the PhD degree from the Albert-Ludwigs-University of Freiburg for the dissertation „Carrier-selective contacts for high-efficiency Si solar cells". In 2016 he was awarded the Junior Einstein Award sponsored by Solar-World AG. Frank Feldmann is currently employed as a project manager and is responsible for research activities on the TOPCon technology at Fraunhofer ISE.

09:15 - 10:00 Session 8: Carrier Selective Contacts II: Detailed Understanding and Cell Integration

Chairs: Rolf Brendel (ISFH) & Nils Harder (TOTAL New Energies)

09:15 Numerical Analysis of Dopant-Free Asymmetric Silicon Heterostructure Solar Cell with SiO_2 as Passivation Layer

Haris Mehmood[1], Hisham Nasser[2], Tauseef Tauqeer[1], Rasit Turan[2]

[1] *Information Technology University of the Punjab (ITU);*
[2] *Middle East Technical University (METU)*

09:30 Demonstration of 22.8% Screen-Printed Industrial n-Type Silicon Solar Cells with a n+:Poly-Si Passivated Rear Contact

Naomi Nandakumar[1], John Rodriguez[1], Thomas Kluge[2], Thomas Grosse[2], Lauretta Fondop[2], Marcel Koenig[2], Shubham Duttagupta[1]

[1] *Solar Research Institute of Singapore (SERIS);* [2] *Meyer Burger Germany*

09:45 Fully-Passivated, Black, High-Efficiency c-Si Solar Cells Featuring Passivating Contacts

Olindo Isabella[1], Guangtao Yang[1], Gianluca Limodio[1], Luana Mazzarella[1], Paul Procel[1], Manvika Singh[1], Yifeng Zhao[1], Arthur Weeber[1], Miro Zeman[1]

[1] *Delft University of Technology*

10:00 - 10:30 Coffee Break

10:30 - 11:00 Review Paper

Surface Passivation of Crystalline Silicon Solar Cells: Past, Present and Future

Jan Schmidt[1], Robby Peibst[1], Rolf Brendel[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH)*

11:00 - 12:00 Session 9: Surface Passivation: Understanding and Implementation

Chairs: Oliver Schultz-Wittmann (OSW-Photovoltaics GmbH) & Matthieu Despeisse (CSEM)

11:00 Critical Interface: Poly-Silicon to Tunneling SiO_2 for Passivated Contact Performance

Bill Nemeth[1], Abhijit Kale[2], Matthew Page[1], Dawn Findley[1], Vincenzo LaSalvia[1], San Theingi[1], David Young[1], Paul Stradins[1]

[1] *National Renewable Energy Laboratory (NREL);* [2] *Colorado School of Mines*

11:15 Efficiency Gain in Plated Bifacial n-Type PERT Cells by Means of a Selective Emitter Approach Using Selective Epitaxy

María Recamán Payo[1], Yuandong Li[1], Richard Russell[1], Izabela Kuzma Filipek[1], Sukhvinder Singh[1], Filip Duerinckx[1], Jozef Szlufcik[1], Jef Poortmans[1]

[1] *imec*

11:30 Positive Aging of Heterojunction Solar Cells Under Illumination: Kinetics, Amplitude and Stability

Jordi Veirman[1], Adrien Danel[1], Camille Oliveau[1]

[1] *CEA-INES*

11:45 Smart Manufacturing of SHJ Solar Cells: PECVD Bifacial Deposition

Loris Barraud[1], Fabrice Jeanneret[1], Emmanuel Sagnes[1], Christelle Emery[1], Omid Shojaei[1]

[1] *Indeotec SA*

12:00 - 13:00 Lunch Break

13:00 - 13:45 Poster Session 4: Silicon Material Investigation *(yellow session)*

Chairs: Halvard Haug (Institute for Energy Technology) & Yichun (YC) Wang (LONGi Green Energy Technology)

S4-01 Thin Wafers and Superior Surface Passivation: A Path to Increase the Practical Limit of Silicon Solar Cells

Andre Augusto[1], Joseph Karas[1], Pradeep Balaji[1], Stuart Bowden[1]

[1] *Arizona State University*

S4-04 Understanding Hydrogen-Induced Degradation: An Assessment of Light- and Elevated Temperature-Induced Degradation Behaviors in n- and p-Type Silicon

Daniel Chen[1], Phillip Hamer[1], Catherine Chan[1], Alison Ciesla[1], Ran Chen[1], Fiacre Rougieux[1], Brendan Wright[1], Moonyong Kim[1], Aref Samadi[1], Shaoyang Liu[1], Utkarshaa Varshney[1], Carlos Vargas[1], Xinyu Zhang[2], Hao Jin[2], Ziv Hameiri[1], Brett Hallam[1], Malcolm Abbott[1]

[1] *University of New South Wales (UNSW);* [2] *Zhejiang Jinko Solar Co Ltd.*

S4-05 Tin Assisted Growth of Silicon Nanowires by Plasma-Enhanced Chemical Vapour Deposition

Siham Djoumi[1], Fatiha Kail[1], Larbi Chahed[1], Pere Roca i Cabarrocas[2]

[1] *University of Oran1 Ahmed Ben Bella;* [2] *LPICM, CNRS, Ecole Polytechnique*

S4-06 Gettering Efficacy of an APCVD Glasses Based Stacked Co-Diffusion for Bifacial mc-Si PERT Solar Cells

Johannes Fichtner[1], Annika Zuschlag[1], Giso Hahn[1]

[1] *University of Konstanz*

S4-07 Determination of BO-LID and LeTID Related Activation Energies in Cz-Si and FZ-Si Using Constant Injection Conditions

Alexander Graf[1], Axel Herguth[1], Giso Hahn[1]

[1] *University of Konstanz*

S4-08 Annealing Behavior of Oxygen– and Carbon–Related Defects in Oxygen–Lean Silicon

Aleksei Grigorev[1], Hussein Ayedh[1], Augustinas Galeckas[1], Eduard Monakhov[1]

[1] *University of Oslo*

S4-09 The Impact of Surface Finish Conditions of Silicon Bricks on the Mechanical Strength of Diamond-Wire-Sawn Thin Wafers (120 µm)

Sekhar Halubai[1], Tetsuo Fukuda[1], Katsuto Tanahashi[1], Hidetaka Takato[1]

[1] *AIST - National Institute of Advanced Industrial Science and Technology*

S4-10 Direct Examination of the Boron-Oxygen Deactivation Via Electroluminescence Characterization of Cz-Si Solar Cells Under Regeneration Conditions

Lailah Helmich[1], Dominic C. Walter[1], Jan Schmidt[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH)*

S4-11 Simulation Study on the Impact of Boron-Oxygen Related Light-Induced Degradation in Different Cell Architectures

Axel Herguth

University of Konstanz

S4-12 Reduced Hydrogen Out-Effusion by Using Dense Silicon Nitride as Capping Layer

Sahar Jafari[1], Chaitanya Chaitanya[2], Jens Hirsch[1], Volker Naumann[2], Norbert Bernhard[3], Dominik Lausch[1]

[1] *Anhalt University of Applied Sciences/Fraunhofer CSP;* [2] *Fraunhofer Center for Silicon Photovoltaics CSP;* [3] *Anhalt University of Applied Sciences*

S4-13 Optimization of Boron, Phosphorus, Carbon Extraction from Metallurgical-Grade Silicon

Sergey Karabanov[1], Andrey Trubitsyn[1], Dmitry Suvorov[1], Dmitriy Tarabrin[1], Andrey Serebryakov[1], Evgeny Slivkin[1], Andrey Karabanov[2], Oleg Belyakov[2]

[1] *Ryazan State Radio Engineering University;* [2] *Helios Resource Ltd.*

S4-14 Destabilization Effects in Cz-PERC Modules During Transport: The Impact of the Boron-Oxygen Defect

Friederike Kersten[1], Felix Frühauf[1], Ronny Lantzsch[1], Matthias Schütze[1], Christian Taubitz[1], Fabian Fertig[1], Martin Schaper[1], Jörg W. Müller[1]

[1] *Hanwha Q CELLS GmbH*

S4-15 Hydrogen Diffusion in Silicon: Unravelling the Mechanism Behind the Recovery of Light- and Elevated Temperature-Induced Degradation

Moonyong Kim[1], Daniel Chen[1], Shaoyang Liu[1], Malcolm Abbott[1], Brett Hallam[1]

[1] *University of New South Wales (UNSW)*

S4-16 Study of Changes in PL Spectrum from Defects in PERC Solar Cells with Respect to LeTID

Torbjørn Mehl[1], Tabea Luka[2], Dominik Lausch[2], Ingunn Burud[1], Espen Olsen[1]

[1] *Norwegian University of Life Sciences;* [2] *Fraunhofer Center for Silicon Photovoltaics CSP*

S4-17 Analysis of Shingled Interconnected Solar Cells by Scanning Acoustic Microscopy and X-Ray Imaging

Laila Mesquita[1], Nils Klasen[1], Andrew Mondon[1], Daniel Philipp[1], Luciana Pitta Bauermann[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S4-18 Investigating LeTID Where We Can Control It - Application of FZ Silicon for Defect Studies

Tim Niewelt[1], Regina Post[1], Florian Schindler[2], Wolfram Kwapil[1], Martin C. Schubert[2]

[1] *Albert Ludwig University of Freiburg;* [2] *Fraunhofer Institute for Solar Energy Systems ISE*

S4-19 Recombination-Center-Defects Generated by Indium-Tin Oxide Reactive Plasma Deposition

Yoshio Ohshita[1], Takefumi Kamioka[2], Yuki Isogai[1], Tomohiko Hara[1], Hyunju Lee[1], Kyotaro Nakamura[1], Atushi Ogura[2]

[1] *Toyota Technological Institute;* [2] *Meiji University*

S4-20 Quantitative Iron Imaging in Gallium-Doped Silicon Wafers

Regina Post[1], Tim Niewelt[1], Wolfram Kwapil[1], Jonas Schön[1], Florian Schindler[2], Martin C. Schubert[2]

[1] *Albert Ludwig University of Freiburg;* [2] *Fraunhofer Institute for Solar Energy Systems ISE*

S4-21 Hydrogenation of Dislocations in p-Type Cast-Mono Silicon

Aref Samadi[1], Daniel Chen[1], Moonyong Kim[1], Chandany Sen[1], Shaoyang Liu[1], Tsun Hang Fung[1], Alison Ciesla[1], Catherine Emily Chan[1], CheeMun Chong[1], Malcolm David Abbott[1]

[1] *University of New South Wales (UNSW)*

S4-22 Zone Melting Recrystallization of Microcrystalline Silicon Ribbons Obtained by Chemical Vapor Deposition

Filipe Serra[1], Elmahdi Amar[2], José Silva[1], João Serra[1]

[1] *University of Lisbon;* [2] *University Mohammed V*

S4-23 Low-T Anneal as Cure for LeTID in mc-Si PERC Cells

Michael Serué[1], Marko Yli-Koski[1], Hele Savin[1], Toni Pasanen[1]

Presented by Toni Pasanen[1]

[1] *Aalto University*

S4-24 Hydrogen Diffusion from PECVD Silicon Nitride Into Multicrystalline Silicon Wafers: Elastic Recoil Detection Analysis (ERDA) Measurements and Impact on Light and Elevated Temperature Induced Degradation (LeTID)

Romika Sharma[1], Saumitra Vajandar[2], Thomas Osipowicz[2], Joel B. Li[1], Armin G. Aberle[1], Ying Huang[1]

[1] *Solar Energy Research Institute of Singapore (SERIS) / National University of Singapore;* [2] *Center for Ion Beam Applications*

S4-25 Evolution of Defect Densities with Height in a HPMC-Si Ingot

Rune Søndenå[1], Halvard Haug[1], Junjie Zhu[1], Marie Syre Wiig[1]

[1] *Institute for Energy Technology (IFE)*

S4-26 Statistical Analysis of Structure Loss and Modelling of Thermal Fluctuations in Czochralski Silicon Growth

Øyvind Sunde Sortland[1], Eivind J. Øvrelid[2], Mohammed M'Hamdi[2], Hendrik Schön[3], Marisa Di Sabatino[1]

[1] *Norwegian University of Science and Technology;* [2] *SINTEF Industry, Norwegian University of Science and Technology;* [3] *NorSun AS*

S4-27 High Rate Deposition of Epitaxial Silicon by E-Beam

Marit Stange[1], Tor Olav Sunde[1], Runar Dahl-Hansen[1], Amin Shahrestani Azar[1], Joachim Seland Graff[1], Alexander Ulyashin[1]

[1] *SINTEF*

S4-28 Evaluation of Dissolved Oxygen Concentration in Silicon Wafers by Measuring Infrared Attenuated Total Reflection

Kenshiro Usuki[1], Toshimitsu Mochizuki[2], Katsuto Tanahashi[2], Hidetaka Takato[2], Katsuhiko Yamaguchi[1]

[1] *Fukushima University;* [2] *AIST - National Institute of Advanced Industrial Science and Technology*

S4-29 Study of Oxygen Content Impacting Cell Efficiency and Degradation on p-Type PERC Cell

Yichun (YC) Wang[1], Hao Deng[1], Nannan Fu[1], Bowen (Harry) Guo[1], Rui Zhou[1]

[1] *LONGi Green Energy Technology Co., Ltd.*

13:45 - 15:00 Session 10: Carrier Selective Contacts III: Advanced and Novel Processes

Chairs: Jef Poortmans (imec) & Thorsten Dullweber (ISFH)

13:45 Tunnel Oxide Prepared by PECVD-Assisted N_2O Oxidation and the Application for High-Efficiency Passivated-Contact Solar Cells

Yuqing Huang[1], Baojie Yan[1]

[1] *Ningbo Institute of Materials Technologies and Engineering*

14:00 SiC_x- and SiO_x-Based Passivating Contacts for High-Efficiency Silicon Solar Cells

Franz-Josef Haug[1], Mario Lehmann[1], Josua Stückelberger[2], Philippe Wyss[1], Andrea Ingenito[1], Christophe Ballif[1], Horzel Jörg[3], Gizem Nogay[3], Christophe Allebé[3], Juan Diaz[3], Antoine Descoeudres[3], Matthieu Despeisse[3]

[1] *EPFL PV-Lab;* [2] *now at ANU;* [3] *CSEM*

14:15 TCO Contacts on Poly-Si Layers: High and Low Temperature Approaches to Maintain Passivation and Contact Properties

Elise Bruhat[1], Thibaut Desrues[1], Cabal Raphaël[1], Grange Bernadette[1], Sébastien Dubois[1], Danièle Blanc-Pélissier[2]

[1] *CEA-INES;* [2] *INL*

14:30 TCOs for Poly-Si Based Passivating Contacts

Leonard Tutsch[1], Frank Feldmann[1], Bart Macco[2], Jana Polzin[1], Martin Bivour[1], Erwin Kessel[2], Martin Hermle[1]

[1] Fraunhofer Institute for Solar Energy Systems ISE; [2] Eindhoven University of Technology

14:45 Wet Chemical Etch-Back of n+ Polysilicon Layers and its Impact on monoPoly Solar Cells

Ranjani Sridharan[1], Zhi Peng Ling[1], Shubham Duttagupta[1], Rolf Stangl[1]

[1] *Solar Research Institute of Singapore (SERIS)*

15:00 - 15:35 Session 11: Progress in Kerfless Wafering

Chairs: Jef Poortmans (imec) & Thorsten Dullweber (ISFH)

15:00 Extended Talk: Lift-Off Techniques for Kerfless Thin Crystalline Si Production

Hariharsudan Radhakrishnan Sivaramakrishnan[1], Valerie Depauw[1], Ivan Gordon[1], Jozef Szlufcik[1], Jef Poortmans[1]

[1] *imec*

15:20 Statistics of the Detachment Yield for Crystalline Silicon Layer Transfer Using the Porous Silicon Process

Catherin Gemmel[1], Sarah Kajari-Schröder[1], Rolf Brendel[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH*

15:35 - 16:00 Coffee Break

16:00 - 17:00 Poster Session 5: Advanced Solar Cell Processing *(green session)*

Chairs: Sébastien Dubois (CEA-INES) & Ivan Gordon (imec)

S5-01 Impact of Undoped Substrates on Highly Passivated Solar Cells for Different Injection Regimes

Andre Augusto[1], Apoorva Srinivasa[1], Richard King[1], Stuart Bowden[1]

[1] Arizona State University

S5-02 Influence of Illumination on Silicon Heterojunction Series Resistance: A Lumped Analysis

Léo Basset[1], Wilfried Favre[1], Jean-Pierre Vilcot[2]

[1] *CEA-INES;* [2] *CNRS-IEMN*

S5-03 Role of Thermal SiO_2 on Passivation of Highly Doped Layers

Amir Dastgheib-Shirazi[1], Barbara Terheiden[1], Giso Hahn[1]

[1] *University of Konstanz*

S5-04 Understanding the Origin of V_{oc} and FF Loss After Co-Plating of Bifacial Cells: An In-Depth Microstructure Study

Valérie Depauw[1], Richard Russell[1], Sukhvinder Singh[1], Maria Recamán Payo[1], Monica Aleman[1], Shruti Jambaldinni[1], Ivan Gordon[1], Filip Duerinckx[1], Jozef Szlufcik[1], Jef Poortmans[1]

[1] imec

S5-05 Analysis of Temperature Dependent Surface and Emitter Recombination Properties

Rebekka Eberle[1], Andreas Fell[1], Tim Niewelt[1], Florian Schindler[1], Martin C. Schubert[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S5-06 Laser Doping from As-Deposited CVD Layers for High-Efficiency Crystalline Silicon Solar Cells

Josh Engelhardt[1], Hermann Kromer[1], Giso Hahn[1], Barbara Terheiden[1]

Presented by Barbara Terheiden[1]

[1] *University of Konstanz*

S5-07 Dispensed Al Fire Through Contacts for p-Type Bifacial PERC Devices

Tobias Fellmeth

Fraunhofer Institute for Solar Energy Systems ISE

S5-08 Improvement of PERC Solar Cell Efficiency Based on Laser-Doped Selective Emitter

Miao Fengxiu[1], Lian Weifei[1], Zhang Shude[1]

[1] *Suzhou Talesun Solar Technologies Co., Ltd.*

S5-09 Impact of Grippers Utilized for Automated Wafer Handling Prior a-Si Passivation for Silicon Hetero Junction Solar Cells

Andreas Fischer[1], Anamaria Moldovan[1], Jochen Rentsch[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S5-10 Thermal and Contamination Effects on the Bulk Excess Carrier Lifetime During ~22% Industrial PERC Cell Fabrication

Nicholas Grant[1], Pietro P. Altermatt[1], Yang Yang[1], Daming Chen[2], ZhiQiang Feng[1], John Murphy[1]

[1] *University of Warwick;* [2] *Trina Solar*

S5-11 Tailoring Indium Tin Oxide for High-Efficiency Silicon Heterojunction Solar Cells

Jan Haschke[1], Raphaël Monnard[1], Raphaël F. Lemerle[1], Mathieu Boccard[1], Christophe Ballif[1]

[1] *PV-Lab, EPFL*

S5-12 Study of Multiple Metallization Processes on PECVD Boron Doped Polysilicon Layers for Contact Passivation

Maxim Hayes[1], Benoit Martel[1], Sébastien Dubois[1], Olivier Palais[2]

[1] *CEA-INES;* [2] *IM2NP*

S5-13 Stability of the Surface Passivation Properties of Atomic Layer Deposited Aluminium Oxide in Damp Heat Conditions

Ismo T. S. Heikkinen[1], George Koutsourakis[2], Sebastian Wood[2], Joonas Isometsä[1], Hele Savin[1]

[1] *Aalto University;* [2] *National Physical Laboratory*

S5-14 Comparison of Laser-Doped Layers from As-Deposited and Thermally Diffused APCVD Doping Glasses on Silicon Substrates

Matthias Heilig[1], Josh Engelhardt[1], Giso Hahn[1], Barbara Terheiden[1]

[1] *University of Konstanz*

S5-15 Towards All Screen Printed Back-Contact Back-Junction Silicon Solar Cells

Jonas D. Huyeng[1], Raphael Efinger[1], David Bruge[2], Alma Spribille[1], Oliver Doll[2], Roman Keding[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE;* [2] *Merck KGaA*

S5-16 iV_{oc} 706mV Passivation with Understanding Hydrogen Behavior in SiN_x Film

Jiyeon Hyun

Korea University

S5-17 Phosphorus Gettering of Impurities at Low-Temperature Annealing for Enhancing the Performance of p-Type PERC

Supawan Joonwichien[1], Yasuhiro Kida[1], Masaaki Moriya[1], Satoshi Utsunomiya[1], Katsuhiko Shirasawa[1], Hidetaka Takato[1]

[1] *AIST - National Institute of Advanced Industrial Science and Technology*

S5-18 Fabrication of 25.0% Efficiency IBC Solar Cell with ONO Surface Passivation

Teng Choon Kho[1], Kean Chern Fong[1], Keith McIntosh[2], Evan Franklin[3], Matthew Stocks[1], Wensheng Liang[1], Sieu Pheng Phang[1], Andrew Blaker[1]

[1] *The Australian National University;* [2] *PV Lighthouse;* [3] *University of Tasmania*

S5-19 Screen-Printable Metallization Pastes for HJT Solar Cells

Stefan Körner[1], Manja Marcinkowski[1], Uwe Partsch[1]

[1] *Fraunhofer IKTS*

S5-20 Industrial Demonstration of 18.5% Maximum Efficiency Inline-Diffused Additive-Free Acid-Textured DWS Multicrystalline Silicon Solar Cells

Sreejith KP[1], Ashok Sharma[1], Anzar Gani[2], DN Singh[2], Anil Kottantharayil[1], Prabir Basu[3]

[1] *IIT Bombay;* [2] *Indosolar Limited;* [3] *National University of Singapore*

S5-21 Investigation of n-Al:ZnO/p-Cu_2O Heterojunction for c-Si Tandem Heterojunction Solar Cell Applications

Raj Kumar[1], Ørnulf Nordseth[2], Sean Erik Foss[2], Eduard Monakhov[1], Geraldo Cristian Vasquez[1], Bengt Gunnar Svensson[1]

[1] *University of Oslo;* [2] *Institute for Energy Technology (IFE)*

S5-22 On Plasma Treatments of Functional Layers and Interfaces in Silicon Heterojunction and Silicon Thin-Film Solar Cells

Hosni Meddeb[1], Oleg Sergeev[1], Alex Neumüller[2], Hyo-Jei Cho[1], Martin Vehse[1]

[1] *DLR-Institut für Vernetzte Energiesysteme e. V.;* [2] *Next Energy*

S5-23 Investigation of Contact Resistivity on a Laser Doped Boron Emitter from CVD Doping Layers

Matthias Bernd Mörtter[1], Josh Engelhardt[1], Giso Hahn[1], Barbara Terheiden[1]

[1] *University of Konstanz*

S5-24 Effect of Burnout Temperature on Contact Formation of Industrial Screen Printed PERC Cells

Daniel Ourinson[1], Gernot Emanuel[1], Florian Clement[1], Stefan Glunz[1]

[1] *Fraunhofer Institute for Solar Energy Systems ISE*

S5-25 Antireflection-Coating-Free MACE Black Silicon

Toni P. Pasanen[1], Kexun Chen[1], Ville Vähänissi[1], Hele Savin[1]

[1] *Aalto University*

S5-26 Adaptation of the Industrial PERC Solar Cell Process Chain to Plated Ni/Cu/Ag Front Contact Metallization

Damian Pysch[1], John Burschik[1], Michael Passig[1], Markus Sieber[1], Holger Kühnlein[1], Sabrina Lohmüller[2], Andreas Wolf[2]

[1] *RENA Technologies GmbH;* [2] *Fraunhofer Institute for Solar Energy Systems ISE*

S5-27 PERC+ Solar Cells with Screen-Printed Dashed Ag Front Contacts

Martin Rudolph[1], Christian Kruse[1], Helge Hannebauer[1], Ulrike Baumann[1], Sonja Bräunig[1], Melanie Ripke[1], Tom Falcon[2], Rolf Brendel[1], Thorsten Dullweber[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH);* [2] *ASM Alternative Energy*

S5-28 Lead Free Ohmic Connections on Large Surface Area Silicon Solar Cells

Eleftherios Skuras[1], Dimitrios Anagnostopoulos[2], Konstantinos Tselios[1], Theodoros Makris[1], Colin R. Stanley[3]

[1] *University of Patras;* [2] *Department of Materials Engineering, School of Engineering;* [3] *James Watt Nanofabrication Centre, School of Engineering*

S5-29 Does LeTID Occur in c-Si Even Without a Firing Step?

David Sperber[1], Axel Herguth[1], Florian Furtwängler[1], Giso Hahn[1]

[1] *University of Konstanz*

S5-30 Impact of Electrical Shading Loss Suppression on Interdigitated-Back-Contact Si Solar Cells with Screen Printing Metallization Concepts

Tomihisa Tachibana[1], Toshimitsu Mochizuki[1], Katsuhiko Shirasawa[1], Hidetaka Takato[1]

[1] *AIST - National Institute of Advanced Industrial Science and Technology*

S5-31 Fine Line Al Printing on Narrow Point Contact Opening for Front Side Metallization

Kosuke Tsuji[1], Masahiro Nakahara[1], Shota Suzuki[1], Naoya Morishita[1], Marwan Dhamrin[1], Zih-Wei Peng[2], Thomas Buck[2]

[1] *TOYO ALUMINUM K.K.;* [2] *International Solar Energy Research Center (ISC) Konstanz*

S5-32 Optimization of PEDOT:PSS Hole Transport Layers Deposited on Silicon Surfaces by Spray Coating

Deniz Turkay[1], Elif Cuce[1], Kerem Artuk[1], Milad Ghasemikhastiban[1], Konstantin Tsoi[1], Hava Zekiye Kaya[1], Selcuk Yerci[1]

[1] *GÜNAM*

S5-33 A Pathway to 720 mV p-Type mc-Si Heterojunction Solar Cells

Bruno Vicari Stefani[1], Daniel Chen[1], Moonyong Kim[1], Anastasia Soeriyadi[1], Matthew Wright[1], Brett Hallam[1]

[1] *University of New South Wales (UNSW)*

S5-34 Multifunctional Process to Improve Surface Passivation and Carrier Transport in Industrial n-Type Silicon Heterojunction Solar Cells by 0.7% Absolute

Matthew Wright[1], Moonyong Kim[1], Anastasia Soeriyadi[1], Daniel Chen[1], Xu Xin[2], Brett Hallam[1]

[1] *University of New South Wales (UNSW);* [2] *China Intellectual Electric Power Technology (Taixing) Co.*

S5-35 A Facile Way to Improve the Efficiency of Perovskite/Silicon Four-Terminal Tandem Solar Cell Based on the Optimization of Long-Wavelength Spectral Response

Shude Zhang[1], Xiang Fang[2]

[1] *Suzhou Talesun Solar Technologies Co., Ltd.;* [2] *Changzhou University*

S5-36 Interface Engineering for Si Surface Passivation with Screen Printed Al_2O_3

Junjie Zhu[1], Lei Gong[2], Libin Mo[2], Rune Søndenå[1], Chunlan Zhou[2], Wenjing Wang[2]

[1] *Institute for Energy Technology (IFE);* [2] *Chinese Academy of Science*

17:00 - 18:30 Session 12: High Efficiency PERX and IBC Solar Cell Processing

Chairs: Jozef Szlufcik (imec) & Christophe Ballif (EPFL)

17:00 Efficiency Roadmaps for Industrial pPERC+ and nPERT+ Cells

Loic Tous[1], Filip Duerinckx[1], Meriç Fırat[1], Jozef Szlufcik[1]

[1] *imec*

17:15 693 mV V_{OC} Large Area Screen-Printed n-PERT-RJ Solar Cells with Efficiency Beyond 22%

Zih-Wei Peng[1], Thomas Buck[1], Joris Libal[1], Radovan Kopecek[1]

[1] *International Solar Energy Research Center (ISC) Konstanz*

17:30 Selective Deposition of Thin Silicon Layers for High Efficiency BC-SHJ Solar Cells

Bertrand Paviet-Salomon[1], Curdin Wüthrich[1], Laurie-Lou Senaud[1], Gabriel Christmann[1], Antoine Descoeudres[1], Sylvain Nicolay[1], Matthieu Despeisse[1], Christophe Ballif[1]

[1] *CSEM PV-Center*

17:45 26%-Efficient and 2 cm Narrow Interdigitated Back Contact Silicon Solar Cells with Passivated Slits on Two Edges

Sören Schäfer[1], Felix Haase[1], Christina Hollemann[1], Jan Hensen[1], Jan Krügener[2], Rolf Brendel[1], Robby Peibst[1]

[1] *Institute for Solar Energy Research in Hamelin (ISFH);*
[2] *Institute for Electronic Material and Devices*

18:00 A Low Cost Ten-Process Steps IBC HJT: A New Technology Breakthrough for High Efficiency Solar Cells

Damien Lachenal[1], Bertrand Paviet-Salomon[2], Pierre Papet[1], Boris Legradic[1], Till Kössler[1], Cedric Aeby[1], Robert Kramer[1], Sarah Pitteloud[1], Niels Holm[1], Ludovic Andreetta[1], Derk Baetzner[1], Patrick Jeanneret[1], Jean-Patrick Cardoso[1], Walter Frammelsberger[1], Martin Ledinsky[3], Benjamin Strahm[1]

[1] *Meyer Burger Research;* [2] *CSEM;* [3] *Institute of Physics AS CR*

18:15 Decoupling Bulk and Interface Properties in the Shells of Silicon Heterojunction Solar Cells

Laurie-Lou Senaud[1], Bertrand Paviet-Salomon[1], Gabriel Christmann[1], Matthieu Despeisse[1], Antoine Descoeudres[1], Jonas Geissbühler[1], Nicolas Badel[1], Sylvain Nicolay[1], Christophe Allebé[1], Luca Antognini[2], Mathieu Boccard[2], Gizem Nogay[1], Patrick Wyss[1], Christophe Ballif[1]

[1] *CSEM;* [2] *EPFL*

18:30 - 19:00 Closing Session SiliconPV

18:30 Closing SiliconPV

Jef Poortmans, imec

18:40 SiliconPV Award Ceremony for the Best 10 Abstracts and the Best Posters

Jef Poortmans, imec

The award ceremony is sponsored by Sinton Instruments.
Thank you!

18:50 Announcement of SiliconPV 2020

Thursday, April 11, 2019

08:00 Registration

08:30 - 08:40 Opening Session nPV

Welcome to nPV Workshop
Joachim John, imec

08:40 - 09:00 Overview

LeTID Test on n-Type PV Modules: Standardization and Technology Comparison
Elias Garcia Goma, Eternal Sun

09:00 - 09:50 Session 1: Silicon Material

Chairs: Jan Schmidt (Institute for Solar Energy Research in Hamelin (ISFH)) & Arthur Weeber (ECN part of TNO - Solar Energy)

09:00 Overview Silicon Material Growth / n-Type Quality
Paula Bronsveld, ECN part of TNO - Solar Energy

09:20 Achieving Stable Supply of Dozen-GW High-Quality Silicon Wafers for High-Efficiency n-Type Products
Yichun (YC) Wang, LONGi Green Energy Technology Co., Ltd.

09:35 High Performance n-Type Cz-Si
Yu Hu, Norsun AS

09:50 - 10:20 Coffee Break

10:20 - 11:25 Session 2: Cell Production

Chairs: Delfina Muñoz (CEA-INES) & Joachim John (imec)

10:20 Current Status and Outlook for Industrial nPERT Cells
Loic Tous, imec

10:40 The Development of n-Type TOPCon Cell and Module in Jolywood
Jia Chen, Jolywood (Taizhou) Solar Technology Co., Ltd

10:55 Jinko High Efficiency Cell
Xinyu Zhang, Zhejiang Jinko Solar Co Ltd.

11:10 Progress of High Efficiency Solar Cell and Module Technology with Amorphous Silicon/Crystalline Silicon Heterostructure
Keiichiro Masuko, Panasonic

11:25 - 12:15 **Panel Discussion**

Moderator: Christophe Ballif (CSEM)

12:15 - 13:15 Lunch Break

13:15 - 14:05 **Session 3: Passivation & Contacts**

Chair: Stefan Glunz (Fraunhofer ISE)

13:15 Passivating Contacts for High Efficiency Silicon Solar Cells
Martin Hermle, Fraunhofer ISE

13:35 PVD Process Developments for High Volume Manufacturing of Silicon Solar Cells
Eric Schneiderlöchner, VON ARDENNE GmbH

13:50 Poly-Silicon Passivated Contacts
Martijn Lenes, Tempress

14:05 Development of Metallization Solutions for Industrial n-Type TOPCon Solar Cells
Vinodh Chandrasekaran, Heraeus Precious Metals North America LLC

14:20 - 14:50 Coffee Break

14:50 - 16:10 **Session 4: Modules & Systems**

Chairs: Radovan Kopecek (ISC Konstanz e.V.) & Matthieu Despeisse (CSEM)

14:50 Overview of p-Type vs n-Type in PV Modules
Vincent Barth, CEA-INES

15:10 Shingling Process
Diego Tonini, *Applied Materials Italia*

15:25 SmartWire Modules and HJT SW Systems Monitoring
Rainer Grischke, *Meyer Burger (Switzerland) AG*

15:40 ENEL Bifacial Systems
Claudio Colletti, *ENEL*

15:55 Solitek Bifacial Commercial Projects and R&D Activities
Julius Denafas, *Solitek*

16:10 - 16:20 **Closing Session nPV**

Closing nPV Workshop
Joachim John, *imec*

Conference Dinner

The SiliconPV and nPV Conference Dinner will take place at the Faculty Club, a beautiful location rich with history and within walking distance of Leuven city center. Faculty Club receives its guests in a centuries-old historic setting – in the Infirmary of the Grand Beguinage, which dates from the 13th century and was renovated in the 16th and 17th century, or in the Convent of Chièvres, which was built in 1561. Since 2000 the Grand Beguinage has been recognised as UNESCO World Heritage.

This unique venue promises to be a great location for a pleasant evening in a convivial and relaxed atmosphere with colleagues and friends!

Date: Tuesday, April 09
Time: 19:00
Fee: The dinner is included in all full tickets, pre-registration required.

A bus transfer from EnergyVille in Genk directly to the dinner location will be provided.

Address:
Faculty Club
Groot Begijnhof 14
3000 Leuven

© Faculty Club

Technical Tour: Zonnepark Rilland

On Friday a technical tour will be offered to the „Zonnepark Rilland“ project in The Netherlands. In Rilland a 11.8 MW n-type bifacial solar power plant will be visited.

Date: Friday, April 12

Schedule: 10:30 Bus will depart from Campus Gasthuisberg, Leuven
12:00 Lunch
13:00 Visit of the 11.8 MW n-Type Bifacial Solar Power Plant
15:00 Bus will return back to Leuven
16:30 Approx. arrival at Leuven train station (depending on traffic)

Fee: Free of charge; pre-registration is required.

The technical tour is organized and sponsored by Jolywood (Taizhou)

© Jolywood

© Unisun

© Unisun

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 07, from 17:00 – 19:00 at the Welcome Reception and during conference hours, starting on Monday, April 08 at 7:45 and the following days at 8:00.

Posters

See the poster plan on page 47 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 before you leave. Remaining posters will be discarded.

Speaker Information

All presentations must be handed in at the Media Upload Desk one hour before your session starts. 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 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.

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.

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.

Contact Participants

SiliconPV offers a contact opportunity for conference participants in its internal Download Area on the conference website, www.siliconpv.com. Log in with your password and contact other participants by e-mail.

All participants who want to use the contact feature can confirm their admission to receive e-mails from other conference participants. The first contact will occur indirectly via the conference system in the Download Area. No personal data will be handed out.

Conference Proceedings

The proceedings will be published with AIP, the American Institute of Physics (www.aip.org), after the conference, covering papers with sufficient scientific quality. This collaboration will provide optimum visibility of the proceedings and ensure that the authors' publications remain traceable and citable. Final online papers will be accessible on the AIP website and contain an ISBN number for the conference volume as well as individual DOI numbers for each paper.

Full papers of the twenty best abstracts will be published in Elsevier's peer reviewed journal Solar Energy Materials & Solar Cells (SOLMAT).

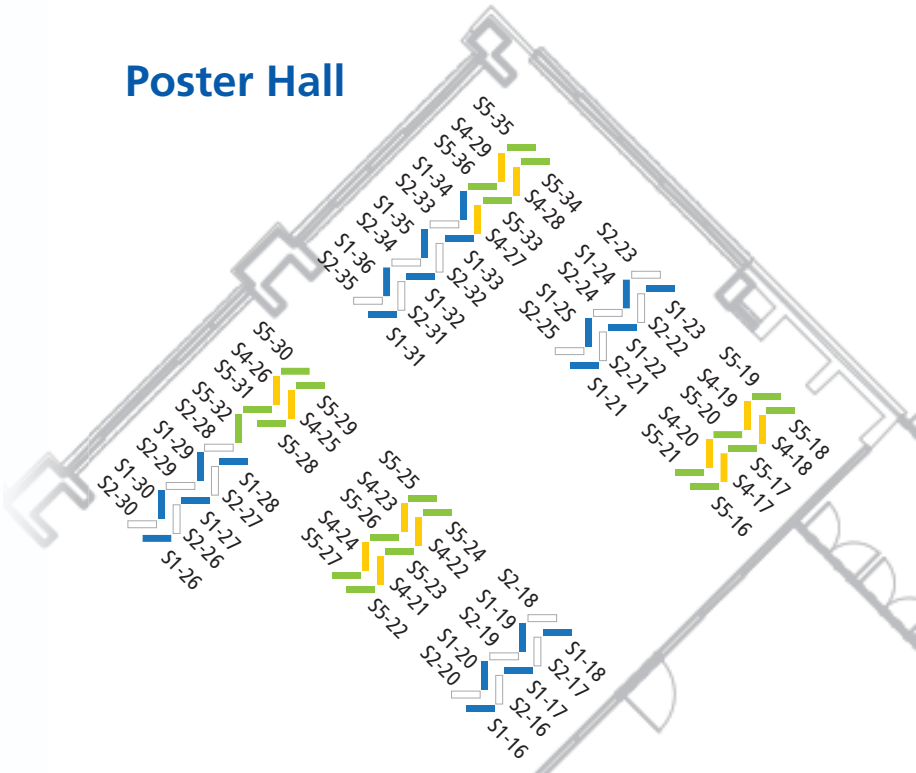
WiFi Access

WiFi will be available free of charge in the whole conference area with individual access codes.

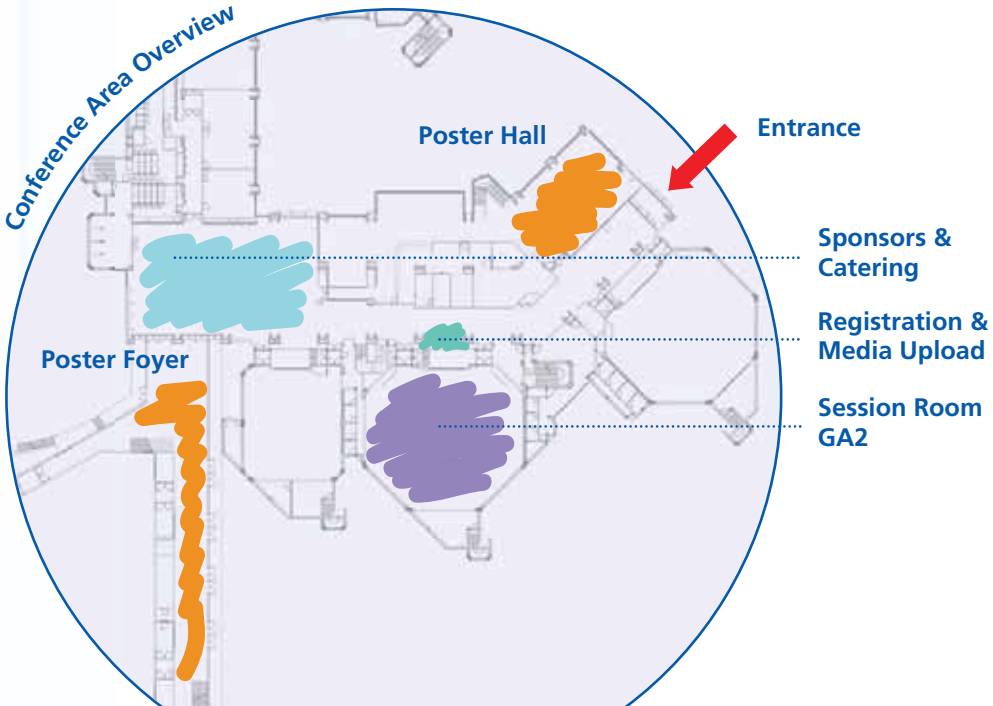
Poster Plan

Poster Foyer

Poster Hall



Poster Session 1:
Poster Session 2:
Poster Session 3:
Poster Session 4:
Poster Session 5:



Program Overview

	Sunday April 07	Monday April 08	Tuesday April 09	Wednesday April 10	Thursday April 11
		SiliconPV Conference 2019		nPV Workshop 2019	
08:00		Registration	Registration	Registration	Registration
08:15					
08:30		Opening Session	Carrier Selective Contacts I: Detailed Analysis of Poly-Si Passivated Contacts	Opening Session nPV	Opening Session nPV
08:45		Keynote		Keynote	Overview
09:00					Silicon Material
09:15		Different Flavors of Tandem Cell Architectures		Carrier Selective Contacts II: Detailed Understanding and Cell Integration	
09:30					
09:45					
10:00		Coffee Break	Coffee Break	Coffee Break	Coffee Break
10:15					
10:30		Advanced Analysis for Material Defects and Metal Impurities in Si	Poster 3: Cell Interconnection...	Review Paper	Cell Production
10:45			Detailed Studies on Hydrogen-In-Si		
11:00				Surface Passivation: Understanding and Implementation	
11:15					
11:30					Panel Discussion
11:45			*Bus Transfer to EnergyVille in Genk*		
12:00		Lunch Break		Lunch Break	
12:15					Lunch Break
12:30					
12:45					
13:00	13:00 - 16:50 Tutorials for Young Scientists	Poster Session 1: Novel Characterization and Modelling	SiliconPV at EnergyVille: Lunch Break	Poster Session 4: Silicon Material Investigation	
13:15					Passivation & Contacts
13:30			Novel Cell Interconnection Technologies and Module Degradation		
13:45				Carrier Selective Contacts III: Advanced and Novel Processes	
14:00		Keynote			
14:15					
14:30		Growing Insights in Light- and Temperature Induced Degradation Mechanisms	Coffee Break		Coffee Break
14:45					
15:00			Technical Tour: Visit EnergyVille	Progress in Kerfless Wafering	Modules & Systems
15:15					
15:30		Coffee Break		Coffee Break	
15:45					
16:00		Poster Session 2: Improvements on Carrier Selective Contacts		Poster Session 5: Advanced Solar Cell Processing	Closing Session nPV
16:15					
16:30					
16:45					
17:00	Welcome Reception & Registration at "De Hoorn"	Progress in Process Step Development		High Efficiency PERX and IBC Solar Cell Processing	
17:15					
17:30					
17:45					
18:00			*Bus Transfer to Leuven*		
18:15					
18:30				Closing Session SiliconPV	
18:45					
19:00			Conference Dinner at "Faculty Club"		
19:15					