SiliconPV 2023

13th International Conference on Crystalline Silicon Photovoltaics

npworkshop

Delft 2023

April 11 – 14, 2023

Delft, the Netherlands | Hybrid

PROGRAM

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Conference Info

Welcome to SiliconPV 2023!

The 13th edition of **SiliconPV** will take place from **April 11-13, 2023** and will be hosted by the Delft University of Technology and TNO, the Netherlands.

The conference will be held in a hybrid format, allowing for online and physical presentations and attendance.

Like in recent years, SiliconPV continues its fruitful cooperation with the nPV workshop.

SiliconPV Conference from April 11-13, 2023

The conference covers a variety of exciting topics around crystalline silicon for photovoltaic application, which is still the leading technology for solar electricity generation!

nPV Workshop from April 13-14, 2023

Taking place directly after the SiliconPV conference with one overlapping day, the workshop provides a complete overview of all trends, innovations and developments of n-type technology. The nPV Workshop is hosted by the Delft University of Technology, The Netherlands.

Committees

SiliconPV Conference Chairperson
Chair: Prof. Dr. Arthur Weeber (TNO Energy Transition)

SiliconPV Conference Executive Committee
Pierre Verlinden (Amrock Pty Ltd)
Sébastien Dubois (CEA)
Arthur Weeber (TNO Energy Transition)
Christophe Ballif (EPFL)
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Jef Poortmans (imec)
Robby Peibst (ISFH)
Giso Hahn (University of Konstanz)

nPV Workshop Chairperson
Olindo Isabella (TU Delft)

Chairperson's Message

Dear SiliconPV Friends,

Last year was special with both positive and negative aspects. In 2022 we were able to hold SiliconPV together with nPV and bifiPV on site and in a hybrid way. It was great to meet so many PV colleagues in person again and also being able to connect with the colleagues participating online. For the 2023 edition we will use the same format and the conference will be hybrid again.

Negative aspects are still the uncertain COVID19 situation, the climate change, and the geopolitical issues which have impact on the global society. Therefore it is becoming more and more important to enhance the energy transition and develop technologies that will be available for everyone and everywhere, have low cost, and can be manufactured locally. PV is the technology to hasten the energy transition and it can be done big, already now, and in the future with much better technologies. Compared to the current commercial PV technologies conversion efficiencies can be doubled by applying multijunction PV, prices can be reduced by another factor two to three, PV can be fully integrated in every surface, and its environmental impact can be minimized by using earth abundant and non-toxic materials only and by full recyclability. PV already met an important milestone in March 2022 to show its potential: the total globally installed PV capacity reached 1 TWp (DC)!

To speed up the energy transition and reduce dependency on other continents, the EU announced new targets for PV with 320 GWp cumulative installed capacity in 2025 and 600 GWp installed capacity in 2030; a huge increase! Furthermore, many initiatives to re-start manufacturing PV in Europe are ongoing and plans for multi-GW factories have been made or are already being implemented. The European Solar Manufacturing Council (ESMC) has proposed at least 35 GWp manufacturing of PV in the EU by 2025 and 100 GWp manufacturing by 2030. The latter will correspond to about 15% of the global market.

To reach these ambitious goals as well as meeting the climate goals of 2050, technology development will be crucial. An efficiency of 35.9% was obtained by Fraunhofer ISE in 2021 with a hybrid multijunction solar cell consisting of a III-V top and middle cell combined with a silicon bottom cell. Recently 31.25% has been announced by EPFL/CSEM for a perovskite-silicon tandem demonstrating that efficiencies beyond 30% can be reached with low-cost materials and processing; another important milestone and confirming the huge progress made so far!

I am looking forward to hearing the latest results on novel technologies and therefore you are invited to share your results by submitting abstracts and presenting them during the conference. Like previous years, your contribution can be published in a regular journal to ensure global visibility. The conference topics cover the value chain from materials up to and including modules and cover aspects such as reliability, sustainability and circularity. Of course the progress made with tandems and multijunction PV devices with silicon bottom cells will have a prominent position in the conference programme.

Like previous editions, the nPV workshop will be coupled to SiliconPV with an overlapping day in the middle. The whole inspiring event will take place at the campus of Delft University of Technology, which is walking distance from the historical city center.

Looking forward to meeting you in person in Delft or online for the SiliconPV 2023 conference!

Arthur Weeber, Chairman SiliconPV 2023

Conference Program

Tuesday, April 11, 2023

09:00 - 09:20 Opening Session
Auditorium

09:00 **Welcome to SiliconPV 2023**
A. Weeber, TNO, M. Zeman, TUD, H. Jeeniga, TNO

09:20 - 10:30 Highlight Session
Auditorium
Chair: Arthur Weeber / Olindo Isabella

09:20 **Development and Upscaling of Monolithic Silicon/Perovskite Tandem Solar Cells**
R. Schlatmann, Helmholtz-Zentrum Berlin

09:50 **Interactions of Hydrogen Atoms with Boron and Gallium in Cz-Grown Si Crystals Co-Doped with Phosphorus and Acceptors**
T.O. Abdul Fattah[1], V.P. Markevich[1], J.A.T. De Guzman[2], J. Coutinho[3], N.V. Abrosimov[4], M.P. Halsall[1], A.R. Peaker[1]

[1] University of Manchester; [2] Philippine Council for Industry, Energy, and Emerging Technology; [3] University of Aveiro; [4] Leibniz-Institut für Kristallzüchtung

10:10 **Process Influences on LeTID in Ga-Doped Silicon**
W. Kwapil[1], F. Maischner[1], Y. Jung[2], P. Saint-Cast[3], J. Greulich[3]

[1] University of Freiburg, Department for Sustainable Systems Engineering (INATECH); [2] Institute of Engineering Research, Korea University; [3] Fraunhofer Institute for Solar Energy Systems ISE

10:30 - 11:00 Break

11:00 - 12:30 Session 2: Dopant Free / Novel Passivation Layers
Auditorium
Chair: Meriç Fırat / Franz Josef Haug

11:00 **Enhancement of NiOx/poly-Si Contact Performance by Insertion of Ultrathin Metallic Ni Interlayer**
S. Lange[1], B. Fett[2], Ö.S. Kabakli[3], D. Adner[1], P. Schulze[3], B. Herbig[2], C. Hagendorf[1], G. Sextl[2], K. Mandel[2]
[1] Fraunhofer Center for Silicon-Photovoltaics CSP; [2] Fraunhofer Institute for Silicate Research ISC; [3] Fraunhofer Institute for Solar Energy Systems ISE

11:15 **Exploring Hafnium Oxide's Potential for Passivating Contacts**
A. Wratten[1], S. Pain[1], D. Walker[1], E. Khorani[1], T. Niewelt[1], N. Grant[1], J. Murphy[1]
[1] University of Warwick

11:30 **Highly Stable Strontium Fluoride as a Thickness-Tolerant Dopant-Free Electron-Selective Contact for Silicon Solar Cells**

W. Wang[1], L. Cai[2], L. Meng[3], N. Chen[1], H. Wei[1], Y. Hong[1], Y. Chen[1], L. Zeng[4]

[1] School of Physics, Sun Yat-sen University; [2] Energy Technology Research Institute Co., Ltd for Guangzhou High-tech Zone; [3] School of Materials Science and Engineering, Anyang Institute of Technology; [4] School of Physics and Optoelectronic Engineering, Guangdong University of Technology

11:45 **PERC Solar Cells with Fully Passivated Rear Contact Enabled by Local Hole-Selective MoOx/Ag**

H. Nasser[1], G. Altiner[1], F. Cambay Kuban[2], R. Turan[1]

[1] The Center for Solar Energy Research and Applications (ODTU-GUNAM), Middle East Technical University; [2] KalyonPV Research and Development Center, Kalyon Gunes Teknolojileri Uretim A.S

12:00 **Interdigitated-Back-Contacted Silicon Heterojunction Solar Cells Featuring Novel MoOx-Based Contact Stacks**

K. Kovačević[1], Y. Zhao[1], P. Procel[1], L. Cao[1], L. Mazzarella[1], O. Isabella[1]

[1] Photovoltaic Materials and Devices Group, Delft University of Technology

12:15 **Cu-Plated Bifacial Silicon Heterojunction Solar Cells With MoOx as Hole Collector**

L. Cao[1], Y. Zhao[1], C. Han[1], P. Procel Moya[1], L. Mazzarella[1], R. Santbergen[1], M. Zeman[1], O. Isabella[1]

[1] Delft University of Technology

12:30 - 13:15 Lunch

13:15 - 15:00 Poster Session Tuesday

TUE - A - 01 **Hydrogen Thermal Activation in Poly-Si/SiOx Based Passivating Contacts**

B. Uygun[1], H. Nasser[1], G. Altiner[1], E.H. Ciftpinar[1], H. Osman[1], S. Aslan[1], H.H. Canar[1], A.E. Kececi[1], R. Turan[1]

[1] The Center for Solar Energy Research and Applications (ODTU-GUNAM), Middle East Technical University

TUE - A - 04 **LAB to FAB Nanocrystalline Silicon Layers for Single and Double Junction Solar Cells: From Materials Conception to Device Integration**

P. Vasquez[1], G. Masmitja[1], D. Munoz[1], A. Ozanne[1]

[1] CEA – INES

TUE - A - 07

Reduction of Scarce Materials in SHJ Solar Cells and Implications on the Low Light Performance in the Field

S. Pingel[1], A. Steinmetz[1], M. Bivour[1], J. Huyeng[1], I. Voicu Vulcanean[1], W. Wolke[1], V. Georgiou-Sarlikiotis[1], H. Nagel[1], P. Schmid[1], K. Zimmermann[1], A. Krieg[1], D. Erath[1], T. Wenzel[1], F. Clement[1], J. Rentsch[1], J. Seif[1]
Presented by A. Steinmetz[1]
[1] Fraunhofer ISE

TUE - A - 10

Tailoring of interface quality of MoOX/Si for Si solar cells

A. Kumar[1], M. Dutta[2]
[1] CSIR-National Physical Laboratory; [2] National Institute of Solar Energy

TUE - A - 13

Blister Free PECVD Polysilicon Layers for Tunnel Oxide Passivated Contact (TOPCon) Solar Cells

H. Osman[1], H. Osman[2], H. Nasser[2], M. Ghasemi[2], B. Uygun[2], E. Donercark[2], R. Turan[2]
[1] ODTU-GUNAM; [2] Middle East Technical University

TUE - A - 16

Surface Recombination Velocity of the Si/SiOx Interface in Tunnel-Oxide Passivating Contacts

F. Haug[1], S. Libraro[1], A. Morisset[1], C. Ballif[1]
[1] EPFL

TUE - B - 01

A Novel Method for Accurately Characterizing Selective Contact Resistivity

D. Steyn[1], W. Nemeth[2], D. Young[2], P. Stradins[2], S. Agarwal[1]
[1] Colorado School of Mines; [2] National Renewable Energy Lab

TUE - B - 04

On the General Current Dependence of the Distributed Series Resistance of Solar Cells: the Influence of the Base Resistivity

J. Wagner[1], J. Carstensen[1], R. Adelung[1]
[1] University of Kiel

TUE - B - 07

Electrical Contact Solution for Measuring Back Contact Solar Cells

N. Chen[1], R. Roescu[1], F. Buchholz[1], V.D. Mihailetchi[1]
[1] ISC Konstanz

TUE - B - 10

Analysis of Cell Degradation Using Public IV-Curve Data

A. Schütt
CELLOscan

TUE - D - 01

Analysis of the performance of mc-Si and CdTe modules under soiling conditions

P. Ferrada[1], M. Escalona-Llaguno[2], A. Marzo[3], G. López[4]
[1] Centro de Desarrollo Energético Antofagasta (CDEA), Universidad de Antofagasta; [2] Universidad Autónoma de Zacatecas; [3] Departamento de Óptica, Universidad de Granada; [4] Departamento de Ingeniería Eléctrica y Térmica, Universidad de Huelva

TUE - D - 04

Influence of Material Models on the Numerical Predictions of Thermomechanical Behavior of Silicon Photovoltaic Modules

S.A. Al-Manaseer[1], J.P. Correia[1], S. Touchal[1]
[1] *University of Strasbourg - ICube Laboratory*

TUE - D - 06

Investigation of Degradation in 20-Year-Field-Exposed PV Modules From India by Cross-Characterization Using Electroluminescence Imaging and Thermography

A. Pareek[1], R. Meena[2], R. Gupta[2]
[1] *Indian Institute of Technology Bombay;* [2] *Indian Institute of Technology Bombay, India*

TUE - D - 07

Performance Assessment of Cell-Separation Processes for Rear-Contact Solar Cells: Comparison of Indoor and Outdoor Measurements

M. Turek[1], A.A. Abdallah[2], M. Meusel[1], C. Hagendorf[1]
[1] *Fraunhofer CSP;* [2] *Qatar Environment and Energy Research Institute (QEERI)*

TUE - D - 08

Impact of Spectral Absorption and Heat Dissipation Mechanism of Each Optical Layer on Module Temperature

Y. Yu[1], C. Feng[1], Y. Li[1], M. Li[1]
[1] *Longi Green Energy Technology Co., Ltd.*

TUE - D - 09

Structural Analysis for Maximum Solar Power of Soundproof Photovoltaics

H. Jang
KU-KIST Green School Graduate School of Energy and Environment

TUE - E - 01

Design of an Optical Filter for Thermal Managment of Photovoltaic Modules

J.C. Ortiz Lizcano[1], I. Kaaya[2], H. Ziar[1], Y. Zhou[1], M. Zeman[1], O. Isabella[1]
[1] *Delft University of Technology;* [2] *Interuniversity Microelectronics Centre (IMEC)*

TUE - G - 01

Optical Design Strategies for High-Efficiency Monofacial and Bifacial Four-Terminal Perovskite-Silicon Tandem Modules

Y. Zhao[1], R. Santbergen[1], D. Zhang[2], S. Veenstra[2], G. Coletti[2], A. Weeber[1], M. Zeman[1], L. Mazzarella[1], O. Isabella[1]
[1] *Delft University of Technology;* [2] *TNO*

TUE - G - 04

Optical Design of Perovskite/Silicon Tandem Solar Cells Applying Different Texture Combinations

K. Bittkau[1], W. Duan[1], K. Ding[1]
[1] *IEK5-Photovoltaik, Forschungszentrum Jülich GmbH*

TUE - H - 01

Revisiting Silicon Solar Cells for Space - Electron Irradiation of TOPCon Si Solar Cells

G. Li[1], X. Wang[1], P. Toth[2], G. Conibeer[1], B. Hoex[1]
[1] *University of New South Wales;* [2] *Extraterrestrial Power Ltd.*

TUE - H - 04

Effect of Doping and Regeneration Process on LID and LeTID Mechanisms in B and Ga Doped p-type c-Si PERC Solar Cells in Industrial Production

K. Celen[1], A. Kumtepe[1]
[1] *Kalyon PV*

TUE - H - 07

Tracking Photovoltaic Systems at Mountain Heights

M. Ilolov[1], F. Inagaki[2], A. Ilolov[3], S. Kabirov[4], J. Rahmatov[1]
[1] *Center of Innovative Development of Science and New Technologies/ NAS of Tajikistan;* [2] *Graduate School of International Resource Sciences/ Akita University, Japan;* [3] *M.S.Osimi Tajik Technical University;* [4] *Ministry of Industry and New Technologies of Tajikistan*

TUE - H - 10

Ito-Passivated Contacts on Low Temperature Phosphoric Acid-Based Crystalline Silicon Solar Cells: Structural, Optical, and Electrical Characterizations

S. Sepeai
Solar Energy Research Institute

TUE - J - 01

Excellent Passivation by POx/Al2O3 Stacks: Drawing Parallels Between Si and Ge Surfaces

R. Theeuwes[1], W. Berghuis[1], B. Macco[1], E. Kessels[1]
[1] *Eindhoven University of Technology*

TUE - J - 04

Stable Chemical Enhancement of Passivating HfO2/Al2O3 Stacks Grown by Atomic Layer Deposition

S. Pain[1], E. Khorani[1], A. Wratten[1], T. Niewelt[1], N. Grant[1], J. Murphy[1]
[1] *University of Warwick*

TUE - J - 07

Implementation of Nanoimprinted Light Trapping Structure Into Si Heterojunction Solar Cells

Y. Kurokawa[1], Y. Kimata[1], Y. Iseki[1], K. Gotoh[1], S. Miyamoto[1], R. Ozaki[2], K. Nakamura[2], Y. Ohshita[2], N. Usami[1]
[1] *Nagoya university;* [2] *Toyota Technological Institute*

TUE - J - 10

Optimization of Doped Layers for Totally Screen-Printed Interdigitated Back Contact Solar Cells

E.H. Ciftpinar[1], A. Aliefendioglu[1], H.H. Canar[1], A.E. Kececi[1], R. Turan[1]
[1] *ODTU-GUNAM*

TUE - J - 13

Influence of Inserting Intrinsic Poly-Si Layer Between Siox and Doped Poly-Si Layer on Passivating Contact Solar Cell

H. Lee
Department of Materials Science and Engineering, Korea University

TUE - J - 16

The Etching Methods to Control the Surface Morphology of Silicon Wafer for Spin Coating the Perovskite Thin Films on Silicon Sub-Cells

J. Jeong
Department of Department of Energy System Engineering, KU-KIST Green School, Korea University

15:00 - 16:00 Session 3: Module Characterization, Simulation and Annual Yield

Auditorium

Chair: Nils-Peter Harder /

15:00 **Characterization of Mechanical Strength of Shingle Joints Using Die Shear Test**

N. Abdel Latif[1], R. Lamsairhri[1], T. Roessler[1]

[1] *Fraunhofer ISE*

15:15 **A Simple Approach for Module Temperature and Power Prediction**

A. Schneider[1], J. Chochollek[1], T. Nierhoff[1]

[1] *University of Applied Sciences Gelsenkirchen*

15:30 **Recent Advances in Crystalline Silicon Solar Cells with Integrated Power Electronics**

D. van Nijen[1], P. Manganiello[1], Y. Mercimek[1], M. Muttillo[1], R. van Swaaij[1], M. Zeman[1], O. Isabella[1]

[1] *Delft University of Technology*

15:45 **Lightly Doped Silicon Heterojunction Solar Cells in Relevant Field Conditions of Illumination and Temperature**

A. Augusto

Dalarna University

16:00 - 16:30 Break

16:30 - 18:15 Session 4: Silicon Materials

Auditorium

Chair: Jan Schmidt / Giso Hahn

16:30 **Understanding the Firing Cooling Ramp's Influence on Light and Elevated-Temperature-Induced Degradation in Silicon**

B. Hammann[1], N. Assmann[2], J. Schön[3], W. Kwapil[3], F. Schindler[1], E.V. Monakhov[2], M.C. Schubert[1]

[1] *Fraunhofer Institute for Solar Energy ISE;* [2] *University of Oslo;* [3] *University of Freiburg, Department of Sustainable Systems Engineering INATECH*

16:45 **Atomistic Level Study of the Defect Responsible for Light and Elevated-Temperature-Induced Degradation in Ga-Doped Czochralski Si Using Electron Paramagnetic Resonance**

C. Mule[1], P.C. Taylor[1], A. Meyer[1], W. Nemeth[2], V. LaSalvia[2], M. Page[2], S. Agarwal[1], P. Stradins[2]

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

17:00 **Reducing Time and Costs of FT-IR Studies of Hydrogen Species in Si Wafers and Solar Cell Structures**
N. Aßmann[1], R. Søndernå[2], B. Hammann[3], E. Monakhov[1]

[1] Centre for Materials Science and Nanotechnology, University of Oslo; [2] Institute for Energy Technology; [3] Fraunhofer Institute for Solar Energy ISE

17:15 **Investigation on the Long-Term Stability of AlOx/SiNy:H and SiNy Passivation Layers During Illuminated Annealing at Elevated Temperatures**
F. Geml[1], S. Sanz[1], A. Herguth[1], G. Hahn[1], M. Mehler[1]

Presented by M. Mehler[1]

[1] University of Konstanz

17:30 **Impact of Fast-Firing on LeTID in Ga-Doped Cz-Si**
M. Winter[1], D.C. Walter[1], J. Schmidt[1]

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

17:45 **Correlation Study Between Letid Defect Density, Hydrogen and Firing Profile**
J. Simon[1], R. Fischer-Süßlin[1], P. Dufke[1], L. Kutschera[1], S. Roder[2], G. Hahn[1], A. Herguth[1]

[1] University of Konstanz; [2] Fraunhofer Institute of Solar Energy Systems ISE

18:00 **Surface Examination of Structure Loss in N-type Czochralski Silicon Ingots**
R. Hendawi[1], E. Johannes Øvrelid[2], G. Stokkan[2], M. Di Sabatino[1]

[1] NTNU; [2] SINTEF industry

Wednesday, April 12, 2023

08:30 - 10:15 Session 5: Cell Characterization

Auditorium

Chair: Sébastien Dubois / Bram Hoex

08:30

Simultaneous Measurement of Charge Carrier Density, Mobility and Lifetime

D. Krisztián[1], F. Korsós[1]

[1] *Semilab Co. Ltd.*

08:45

LeTID Stability Tests on Gallium-Doped Industrial PERC Cells and Wafers

T. Niewelt[1], F. Maischner[2], E. Khorani[1], Y. Jung[3], S. Pain[1], M. Frosch[4], N.E. Grant[1], W. Kwapil[4], P.P. Altermatt[5], J.D. Murphy[1]

[1] *University of Warwick / School of Engineering;* [2] *Fraunhofer ISE;* [3] *Institute of Engineering Research, Korea University;* [4] *University of Freiburg;* [5] *Trina Solar*

09:00

Properties of Engineered Pinholes in Passivating Contacts Formed by Local Dielectric Etching

H. Guthrey[1], C. Lima Salles[2], W. Nemeth[1], S. Agarwal[3], D. Young[1], P. Stradins[1]

[1] *National Renewable Energy Laboratory;* [2] *National Renewable Energy Laboratory / Colorado School of Mines;* [3] *Colorado School of Mines*

09:15

Improved Determination and Simulation of the Surface Recombination Parameter J0s

B. Hammann[1], B. Steinhauser[1], A. Fell[1], R. Post[1], T. Niewelt[1], W. Kwapil[2], A. Wolf[1], A. Richter[1], H. Höffler[1], M.C. Schubert[1]

[1] *Fraunhofer Institute for Solar Energy ISE;* [2] *University of Freiburg, Department of Sustainable Systems Engineering INATECH*

09:30

Implied Open-Circuit Voltage Imaging of Solar Cells and Cell Precursors: Single Bandpass Filter Method

A. Mahboubi Soufiani[1], R. Lee-Chin[1], P. Fassl[2], M.A. Mahmud[3], M.E. Pollard[1], J. Zheng[3], J.W. Weber[1], A. Ho-Baillie[3], T. Trupke[1], Z. Hameiri[1]

[1] *University of New South Wales;* [2] *Karlsruhe Institute of Technology;* [3] *The University of Sydney*

09:45

Automated Classification of Electroluminescence Images Using Artificial Neural Networks in Correlation to Solar Cell Performance Parameters

M. Turek[1], M. Meusel[1]

[1] *Fraunhofer CSP*

10:00

Tracking H During Poly-Si/SiOx Contact Fabrication: an IR Spectroscopy Analysis of Si-H Bond Configurations

V. Bocquet[1], R. Cabal[1], M. Albaric[1], N. Rochat[2], R. Ramos[1], J. Barnes[2], S. Dubois[1]

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

10:15 - 10:45 Break

10:45 - 12:00 Session 6: Tandem Technologies

Auditorium

Chair: Rutger Schlatmann / Gianluca Coletti

10:45

Impact of Top Cell Degradation and Current Mismatch in Two and Three-Terminal Perovskite–Silicon Tandem Solar Cells

P. Wagner[1], P. Tockhorn[1], S. Hall[1], S. Albrecht[1], L. Korte[1]

[1] *Helmholtz-Zentrum Berlin für Materialien und Energie*

11:00

Atomic Layer Deposition of NiO for Monolithic Tandem Perovskite/Silicon with an Industrial Standard PERC Cell

N. Phung[1], D. Zhang[2], C. van Helvoirt[1], M. Verhage[1], M. Verheijen[1], V. Zardetto[2], F. Bens[2], L.J.(. Geerligs[3], W.M.M.(. Kessels[1], B. Macco[1]

[1] *Eindhoven University of Technology;* [2] *TNO Partner in Solliance;* [3] *TNO*

11:15

Both Side TOPCon Solar Cells: Towards a Lean Process Flow for Si Bottom Solar Cell

J. Seif[1], J. Polzin[1], M. Bories[1], M. Hermle[1], M. Bivour[1]

[1] *Fraunhofer ISE*

11:30

Optical Simulation-Assisted Design and Optimization of SHJ Bottom Subcells for High-Efficiency Monolithic Perovskite-Silicon Tandem Solar Cells

Y. Zhao[1], M. Fardousi[1], R. Santbergen[1], K. Datta[2], A. Bracesco[2], D. Zhang[2], A. Weeber[1], M. Zeman[1], L. Mazzarella[1], M. Creatore[2], R. Janssen[2], O. Isabella[1]

[1] *Delft University of Technology;* [2] *Eindhoven University of Technology*

11:45

Niox Films by Industrial Inline Sputtering for Perovskite-Silicon Tandem Solar Cells: Optical and Electrical Properties

G. Masmitjà[1], E. Bruhat[2], P. Carroy[2], R. Köhler[3]

Presented by P. Carroy[2]

[1] *Universitat Politècnica de Catalunya (UPC);* [2] *National Institute for Solar Energy (CEA-INES);* [3] *Von Ardenne GmbH*

12:00 - 12:45 Lunch

12:45 - 14:30 Poster Session Wednesday

WED - A - 02

Localization of Front Side Passivating Contacts for Direct Metallization of High-Efficiency C-Si Solar Cells

J. Hurni[1], A. Morisset[1], S. Libraro[1], E. Genç[1], F. Haug[1], C. Ballif[1]

[1] *EPFL - PV lab*

WED - A - 05

Key Aspects of p-Type TOPCon on Textured Surface for Silicon Bottom Cells in Tandem Devices

J. Polzin[1], K. Krieg[1], A. Richter[1], S. Kluska[1], J. Benick[1], M. Hermle[1]

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

WED - A - 08

Metal-Complex Inks for Lower Cost and Improved Passivation for Silicon Photovoltaic Metallization

D. Young[1], M. Page[1], W. Nemeth[1], M. Kaupa[1], S. Theingi[1], P. Stradins[1], M. LeMieux[2]

[1] *NREL;* [2] *Electroninks Incorporated*

WED - A - 11

Thermal Annealing Effects on Passivation Properties in Tunnel Oxide Passivated Hole-Selective Contacts

Y. Kim[1], I.S. Kweon[2], K.H. Min[1], S.H. Lee[1], S. Choi[1], K.T. Jeong[1], S. Park[1], H. Song[1], H. Song[1], M.G. Kang[1]

[1] *Korea Institute of Energy Research;* [2] *Chungbuk National University*

WED - A - 14

Ex-situ Phosphorus Doped Polysilicon/SiOx Passivating Contacts for Application in Single-Junction and Tandems Solar Cells

A. Chaudhary[1], E.P. Wete[1], T. Schmid[1], A. Causevic[1], R.Z. Gottwick[1], M. Saliba[1], S. Essig[1]

[1] *Institut für Photovoltaik (ipv), University of Stuttgart*

WED - A - 17

Dopant-Free Carrier-Selective Contacts for Si Heterojunction Solar Cells

M. Della Noce[1], E. Bobeico[1], L. Lancellotti[1], L.V. Mercaldo[1], I. Usatii[1], P. Delli Veneri[1]

[1] *ENEA Portici Research Center*

WED - A - 19

Annealing-Free, Electron-Selective Ohmic Contacts Using Zirconium Oxide and Aluminum for n-type Crystalline Si Solar Cells

L.A.M.K. Madbouly

Middle East Technical University

WED - B - 02

Numerical Analysis of Three Terminal Perovskite/Silicon Tandem Using Sentaurus TCAD

P. Procel Moya[1], M. Al-Zoubi[1], M. Vogt[1], Y. Blom[1], R. Santbergen[1], O. Isabella[1]

[1] *TuDelft*

WED - B - 05

Injection-Dependent Carrier Lifetime Analysis Method of Silicon Solar Cells for Industrial Applications

S.H. Lee[1], K.H. Min[1], S. Choi[1], H. Song[1], M.G. Kang[1], K.T. Jeong[1], T. Kim[2]

[1] *Korea Institute of Energy Research;* [2] *Hyundai Energy Solution*

WED - B - 08

Current-Detecting Atomic Force Microscopy for Applications in Si-Based Photovoltaics

M. Hývl

Institute of Physics, Czech Academy of Sciences

WED - C - 01

Demonstration and Validation of Silicon LIPV Products

F. Colberts[1], A. Bondt, de[2], J. Boumans[1], L. Boumans[1], A. Kingma[3], K. Plug[4], C. Mass-Protzen[1], D. Roosen[3], J. Simons[1], Z. Vroon[5]

[1] Zuyd University; [2] SolaRoad B.V.; [3] TNO Solliance; [4] Strukton; [5] Zuyd University and TNO

WED - D - 02

Unveiling the Potential of Electroluminescence Characteristics in Investigating Different Types of Defects and Degradations in C-Si PV Module

R. Kumar[1], R. Kumar[1], R. Gupta[1]

[1] Indian Institute of Technology Bombay

WED - D - 05

Analytical Extraction of PV Modules' Electric Parameters in the Lima's "Donkey's Belly" Sky in Peru

M.Á. Sevillano Bendezú[1], J.A. Palomino Töfflinger[1], J.d.l. Casa Higueras[2]

[1] Pontificia Universidad Católica del Perú; [2] Universidad de Jaén

WED - E - 04

Influence of Industrial Activity and Coastal Climate on Module Soiling in Northern Chile

D. Olivares[1], A. Taquichiri[1], R. Espinoza[1], P. Ferrada[1], E. Fuentealba[1], A. Marzo[2]

[1] University of Antofagasta; [2] University of Granada

WED - F - 01

Fabrication of Silicon Heterojunction Solar Cells Using an In-House Built Hot-Wire (HW) CVD Cluster Tool

K. Singh[1], A. Kumbhar[1], N. Wadibhasme[1], A. Mandal[1]

[1] Indian Institute of Technology Bombay

WED - G - 02

Passivating Silicon Tunnel Junctions for Pk/Si Tandems: New Insights Into the Subcells Interface Properties

B. Marteau[1], T. Desrues[1], J. Ditsougou[1], D. Mariolle[2], F. Saint Antonin[3], A. Kaminski[4], Q. Rafhay[4], S. Dubois[1]

[1] CEA INES; [2] CEA LETI; [3] CEA LITEN; [4] IMEP LAHC

WED - G - 05

CIGSu/Si Tandem Solar Cells With PERT Si Bottom Cell Including a c-Si Tunnel Junction

T. Charif[1], E. Fourmond[2], A. Fave[2]

[1] Institut des Nanotechnologies de Lyon (INL- UMR 5270)); [2] Univ. Lyon, INSA Lyon, CNRS, Ecole Centrale de Lyon,

WED - H - 02

Influence of AlOx Interlayers on LeTID Kinetics in Ga-Doped Cz-Si

J. Kamphues[1], A. Schmid[1], R. Fischer-Süßlin[1], G. Hahn[1], F. Geml[1]

[1] University of Konstanz

WED - H - 05

Influence of Different Post Porosification Cleaning Steps on the Parameters of Porous Silicon Layer Stack

S. Sanz[1], Y.P. Botchak Mouafi[1], G. Micard[1], G. Hahn[1], B. Terheiden[1]

[1] *University of Konstanz*

WED - H - 08

Silicon Quantum Dots Preparation and Its Preliminary Application on Silicon Solar Cells

R. Chen

SZTU

WED - H - 11

The Selection of the Inductor Optimal Design for Electromagnetic Stirring of Silicon Melt

S. Karabanov[1], D. Suvorov[1], D. Tarabrin[1], E. Slivkin[1], G. Gololobov[1], M. Reginevich[1]

[1] *Ryazan State Radio Engineering University*

WED - H - 13

Effect of Phosphorus Gettering Process on Light Induced Degradation of p-Type Mono Silicon Wafers with Various Base Resistivity and Dopant Types

S. Aslan[1], V. ÖZYAHNİ[1], A.E. KEÇECİ[1], H.H. CANAR[1], S.K. BÜTÜNER[1], H. ASAV[1], S. SEYREK[1], G. BEKTAŞ[1], N. YILDIRIM[2], B. ARIKAN[1], R. TURAN[1]

[1] *ODTÜ-GÜNAM;* [2] *KalyonPV R&D Center*

WED - J - 02

Impact of Al2O3/IZO Double-Layer Antireflective Coating on the Front Side of Rear Emitter Silicon Heterojunction Solar Cell.

M.A. Zahid[1], S. Park[1], Y. Kim[1]

[1] *Sungkyunkwan University*

WED - J - 05

Mechanism of Hydrogen Passivation in Passivated Contact Si Solar Cells

S. Mitra[1], M.B. Hartenstein[2], H. Guthrey[1], W. Nemeth[1], S. Agarwal[1], D. Young[1]

[1] *NREL;* [2] *Colorado School of Mines*

WED - J - 08

Practical Jsc Limits for Silicon Heterojunction Devices: Insights from Modelling

E. Spaans[1], S. Venkataraj[2], A. Aberle[2], N. Nampalli[2]

[1] *National University of Singapore;* [2] *Solar Energy Research Institute of Singapore*

WED - J - 11

Exceptional Surface Passivation of C-Si Utilizing Organic Superacids

M. Ghasemi[1], K. Tsoi[1], G. Bektas[1], S. Yerci[1], E.G. Gunbas[1]

[1] *ODTU-GUNAM*

WED - J - 14

Tuning the Optical and Material Properties of Hot-wire CVD Deposited Multi-layer [a-Si:H/a-SiN:H] for Application as the Front Side in IBC SHJ Solar Cells

K. Singh[1], A. Kumbhar[1]

[1] *Indian Institute of Technology Bombay*

WED - J - 17

Impact of Thickness, Refractive Index and Diffusion Length of Minority Carriers on Antireflection Materials: Study on the Spectral Response of a Monocrystalline Silicon Solar Cell.

M. Nacire

University; Science Faculty

14:30 - 16:00 Session 7: Module Reliability and Processing

Auditorium

Chair: Robby Peibst / tbc

14:30

Dynamics of BS-Driven Insulation Issues

C. Buerhop Lutz[1], O. Stroyuk[2], L. Lüer[3], M. Peters[2]

[1] *Forschungszentrum Jülich GmbH, HI ERN;* [2] *HI ERN;* [3] *Friedrich - Alexander - Universität Erlangen - Nürnberg (FAU)*

14:45

Design Aspects Considering Hotspot Phenomena in Modern High-Performance Silicon Photovoltaic Modules

C. Reichel

Fraunhofer Institute for Solar Energy Systems (ISE)

15:00

Screen-Printed Front Side Al Metallization: Requirements on Solder Pad Design

H. Schulte-Huxel[1], T. Daschinger[1], B. Min[1], T. Brendemuehl[1], M. Brinkmann[1], R. Peibst[1], R. Brendel[1]

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

15:15

Comparing the Role of Na+ in Damp Heat-Induced Failure in Bifacial Silicon HJT, PERS and TOPCon Cells

C. Sen[1], X. Wu[1], H. Wang[1], M.U.K. Khan[1], L. Mao[2], J. Jaubert[2], F. Jiang[2], G. Zhang[2], C. Chan[1], B. Hoex[1]

Presented by B. Hoex[1]

[1] *UNSW Sydney;* [2] *CSI Solar Co. Ltd.*

15:30

Increasing the Speed of Potential-Induced Degradation (PID) Testing at the Cell-Level by Two Orders of Magnitude Using a Salt-Enriched Hybrid Polymer

M.U. Khan[1], C. Sen[1], C. Chan[1], Y. Wu[2], R. Lv[2], J. Jaubert[2], G. Zhang[2], B. Hoex[1]

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

15:45

PID Evaluation of Transparent Backsheet Modules

J. Dupuis[1], R. Bodeux[2], C. Abdel Nour[1], P. Lefillastre[3], A. Becker[3]

[1] *EDF R&D;* [2] *EDF R&D – IPVF;* [3] *EDF Renouvelables*

16:00 - 16:30 Break

16:30 - 18:15 Session 8: Process Technologies / Back-Contacted Solar Cells

Auditorium

Chair: Barbara Terheiden / tbc

16:30 **Thermal Laser Separation and Edge Passivation for TOPCon Shingle Solar Cells**

E. Lohmüller[1], P. Baliozian[2], M. Hofmann[1], L. Gutmann[1], L. Kniffki[1], A. Richter[1], J. Geng[3], L. Wang[4], R. Dunbar[4], A. Lepert[4]

[1] Fraunhofer ISE; [2] VDMA Photovoltaic Equipment; [3] Plasma Electronic GmbH; [4] Solaria Corporation

16:45 **Self-Aligned Laser Opening and Stencil Metallisation for Silver-Free Contacts in Silicon Solar Cells**

Y. Xiong

University of Oxford

17:00 **Edge Passivation of Shingled Poly-Si/SiOx Passivated Contacts Solar Cells**

F. Dhainaut[1], M. Albaric[1], T. Desrues[1], B. Martel[1], R. Dabadie[1], B. Marie[1], G. Lefevre[2], S. Dubois[1], O. Palais[3]

[1] CEA-INES; [2] CEA-LITEN / DTNM / STDC / LCAE; [3] Aix Marseille Univ, Université de Toulon, CNRS, IM2NP

17:15 **Contact Resistivity Breakdown in Fired Passivating Contacts**

S. Libraro[1], A. Morisset[1], J. Hurni[1], L. Antognini[1], C. Ballif[1], A. Hessler-Wyser[1], F. Haug[1]

[1] Photovoltaics and Thin Films Laboratory - PV-Lab, École Polytechnique Fédérale de Lausanne

17:30 **In-Stable Efficiency Improvement Affected by Iron Contamination in P-Type Back Contact Solar Cell**

X. Meng[1], B. Yu[1], J. Fan[1], M. Deng[1], G. Xing[1]

[1] Tongwei Solar(Chengdu)Co. Ltd

17:45 **Integration of Photonic Crystals in Highly Efficient POLO²-IBC Cells – Interplay between Structural, Optical and Electrical Properties**

M. Rienäcker[1], J. Maksimovic[2], Y. Larionova[1], S.H. Ng[2], T. Katkus[2], T. Pinedo Rivera[3], M. Stuiber[3], J. Krügener[4], F. Haase[1], R. Brendel[1], S. John[5], S. Juodkazis[2], R. Peibst[1]

[1] Institute for Solar Energy Research Hamelin (ISFH); [2] Swinburne University of Technology; [3] Melbourne Centre for Nanofabrication; [4] Institute for Electronic Materials and Devices, Leibniz Universität Hannover; [5] Department of Physics, University of Toronto

18:00 **Fabricating High Aspect Ratio Front Contacts for Solar Cells by String-Printing**

R. Saive[1], M. Van de Voorde[1], J. Andersons[1]

[1] *University of Twente*

19:00 - 19:15 Conference Dinner

Thursday, April 13, 2023

08:30 - 08:45 Opening Session nPV 2023

Auditorium

08:30 **Welcome to nPV Workshop 2023**
O. Isabella, Delft University of Technology

08:45 - 10:15 Session 9: Silicon Hetero Junction Solar Cells

Auditorium

Chair: Perrine Carroy / Gizem Nogay

08:45 **Strategies for Realizing High-Efficiency Silicon Heterojunction Solar Cells Featuring Reduced Consumption of Indium and Silver**
Y. Zhao[1], P. Procel[1], C. Han[1], L. Mazzarella[1], L. Cao[1], R. Santbergen[1], K. Kovačević[1], A. Weeber[1], M. Zeman[1], O. Isabella[1]

[1] Delft University of Technology

09:00 **Organically Modified Silica Aerogel as Rear Reflector in Silicon Heterojunction Solar Cells**
D. Koçak[1], K. Tsoi[2], D. Türkay[3], M. Koç[2], E. Dönerçark[2], H. Budunoğlu[4], R. Turan[2]

[1] Middle East Technical University; [2] ODTÜ-GÜNAM; [3] Ecole Polytechnique Fédérale de Lausanne; [4] ASELSAN

09:15 **Feasibility Test of Drastic Indium Cut Down in SHJ Solar Cells and Modules Using Ultra-Thin ITO Layers**
T. Gageot[1], J. Veirman[1], F. Jay[1], D. Munoz-Rojas[2]

[1] CEA-INES; [2] INP-LMGP

09:30 **Method of Contact Resistivity Extraction at Typical Operating Conditions for Heterojunction Solar Cell**
S. Zogbo[1], W. FAVRE[1], M. GUEUNIER-FARRET[2], O. BONINO[1]

[1] CEA-INES Liten, Université Genobles Alpes; [2] Université de Bordeaux

09:45 **Nanocrystalline Silicon Layers for Industrial Application in Silicon Heterojunction Solar Cells**
J. Seif[1], I. Koc[1], D. Kurt[1], I. Voicu Vulcanean[1], S. Pingel[1], A. Steinmetz[1], M. Hermle[1], M. Bivour[1]

Presented by A. Steinmetz[1]

[1] Fraunhofer ISE

10:00 **Identifying and Overcoming the Passivation-Carrier Extraction Trade-Off in Transparent Passivating Contacts**
A. Eberst[1], B. Xu[1], W. Duan[1], A. Lambertz[1], U. Rau[1], K. Ding[1]

[1] IEK-5 Photovoltaics, Forschungszentrum Jülich GmbH

10:15 - 10:45 Break

10:45 - 12:15 Poster Session Thursday

THU - A - 03

Investigation of Contact Resistivities on APCVD (p) Poly-Si for Fired Passivating Contacts

T. Okker[1], R. Glatthaar[1], F. Huster[1], G. Hahn[1], B. Cela Greven[2], S. Seren[3], B. Terheiden[1]

[1] Universität Konstanz; [2] Fenzi Advanced Glass Technologies Netherlands BV; [3] Schmid Group | Gebr. Schmid GmbH

THU - A - 06

Sputtered Poly-Si Layers for the Formation of Front and Rear Passivating Contacts of PVK/Si Tandem's Bottom Cells

A. Descoeudres[1], C. Allebé[1], P. Wyss[1], N. Pernès[1], A. Walter[1], Q. Jeangros[1], C. Ballif[1], B. Paviet-Salomon[1]

Presented by G. Nogay[2]

[1] CSEM; [2] PV-Center, Centre Suisse d'Électronique et de Microtechnique (CSEM)

THU - A - 09

Plasma-Assisted N2O Oxidation (PANO) in an Industrial Direct Plasma Reactor for Tunnel-Oxide Passivating Contacts

M. Bories[1], J. Polzin[1], B. Steinhauser[1], M. Bivour[1], J. Benick[1], M. Hermle[1], S. Glunz[1]

[1] Fraunhofer Institute for Solar Energy Systems ISE

THU - A - 12

Incorporating ALD Oxide Interlayers for Carrier-Selective Passivating Contacts

E. Khorani[1], C. Messmer[2], S. Pain[1], T. Niewelt[1], B. Healy[1], A. Wratten[1], M. Walker[1], N. Grant[1], J. Murphy[1]

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

THU - A - 15

SiC by PECVD for High-Temperature Passivating Contacts

E. Genç[1], A. Morisset[1], J. Hurni[1], S. Libraro[1], C. Ballif[1], F. Haug[1]

[1] EPFL-PVLAB

THU - A - 18

Silver-Lean Screen-Printed Contacts With a Hybrid Metallization Design for Sustainable PV at the TW Scale

Y.A. Chang[1], L. Wang[1], H. Wang[1], C. Huang[1], Y. Zhang[1], S. Wang[1], R. Chen[1], C. Chan[1], B. Hallam[1]

[1] University of New South Wales

THU - A - 20

Influence of Firing Profile on Passivating Contacts for High Efficient Silicon Solar Cells

Y. Cho[1], J.S. Park[1], S. Park[1], Y.J. Kim[1], D. Kim[1], K.H. Im[1], S.H. Lee[1], K.T. JEONG[1], M.G. Gang[1]

[1] Korea Institute of Energy Research

THU - B - 03

Fast Photoluminescence Imaging of Interdigitated Back-Contacts Prepared on Rough Silicon Substrates

M. Ledinsky[1], R. Dvorak[1], R. Hlavac[1], S. Banerjee[1], A. Fejfar[1]

[1] *Institute of Physics, AS CR*

THU - B - 06

Minimizing the Cycle Time for a Rapid Quantum Efficiency Measurement by Modulating Multiple Channels of Led Solar Simulators

M. Turek[1], M. Meusel[1]

[1] *Fraunhofer CSP*

THU - B - 09

Impacts of Cut Cells and Full Cells on the Performance of Photovoltaic Solar Cells and Modules

M. Çalışkan Arslan[1], B. Aydoğan[1], H. Duman[1]

[1] *Kalyon PV Güneş Teknolojileri Üretim AŞ.*

THU - D - 03

Calculation Tool to Determine the Shading Tolerability of PV Modules

A. Alcañiz[1], N. Rukhshi[1], M. Dallapiccola[2], M. Zeman[1], O. Isabella[1], H. Ziar[1]

[1] *Delft University of Technology;* [2] *Eurac Research*

THU - E - 03

Advanced Determination of Temperature Coefficients of Photovoltaic Modules by Field Measurements

A. Schneider[1], J. Chochollek[1], T. Nierhoff[1]

[1] *University of Applied Sciences Gelsenkirchen*

THU - E - 05

Heterojunction Bifacial Technology for High Irradiance Regions

E. Urrejola[1], D. Munoz[2]

[1] *ATAMOSTEC;* [2] *CEA – INES*

THU - E - 06

Tracking Algorithms for Improving Bifacial Modules Energy Yield with Albedo Enhance Materials and Agrivoltaics

J. Guerrero-Perez[1], A. Ros Gómez[1]

[1] *Soltec Innovations*

THU - G - 03

Detailed Comparison of Loss Distribution in Monofacial and Bifacial Perovskite/Silicon Tandem PV Systems

Y. Blom[1], M.R. Vogt[1], C.M.R. Tobon[1], R. Santbergen[1], O. Isabella[1], M. Zeman[1]

[1] *Delft University of Technology*

THU - H - 03

Gallium-doped Silicon Heterojunction Solar Cells

B. Vicari Stefani[1], B. Hallam[2], A. Soeriyadi[2], M. Wright[3], D. Andronikov[4], I. Nyapshaev[4], A. Sergey[4]

[1] *CSIRO;* [2] *UNSW;* [3] *University of Oxford;* [4] *Hevel Solar*

THU - H - 06

SMART Cast-Mono Silicon for High Efficiency TOPCon Cells

P. Krenckel[1], S. Mack[1], J. Stegmaier[1], A. Steinmetz[1], T. Trötschler[1], S. Riepe[1]

Presented by S. Riepe[1]

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

THU - H - 09

Optical Analysis of Perovskite/Silicon Tandem Solar Cells: Effect of Rear Side Grating and TOPCon Tunnel Junction

M. Hanser[1], A. Richter[1], B. Bläsi[1], O. Höhn[1], J. Benick[1]

[1] *Fraunhofer ISE*

THU - H - 12

Si Substrate Dependent-Surface Defects on p-Poly Layers in the p-TOPCon Solar Cells

D. Kim[1], Y. Kim[1], M. Lee[1], J.S. Yun[1], K. Im[1], S.H. Lee[1], Y. Cho[1], K.T. Jeong[1], S. Park[1], M.G. Kang[1], H. Song[1]

[1] *Korea Institute of Energy Research*

THU - H - 14

Application of Ag-Coated Polymer-Particle Composites as Transparent Conductive Adhesives for Tandem Solar Cells

H. Yousuf[1], M.Q. Khokhar[1], M.A. Zahid[1], S. Park[1], S. Sanyal[1], Y. Kim[1]

[1] *Sungkyunkwan University*

THU - J - 03

Toward TCO-Free Silicon Heterojunction Solar Cells - Revisiting the Role of TCO Layers in Electrical Transport and Stability

H. Sai[1], T. Matsui[2]

[1] *Multijunction PV Team, Global Zero Emission Research Center (GZR);* [2] *National Institute of Advanced Industrial Science and Technology*

THU - J - 06

Effective Contact Formation of Crystalline Silicon Solar Cells by Current Injection Methods

S. Bae[1], D. Choi[2], D. Kim[2]

[1] *Korea Institute of Energy Research;* [2] *Korea University*

THU - J - 09

Impact of Texture Height and Ozone-Based Rounding on Silicon Heterojunction Solar Cells Performance

P. Sansoldo

Fraunhofer Institute for Solar Energy Systems (ISE)

THU - J - 12

Investigation of the Microstructure of Underdense Hydrogenated Amorphous Silicon Layers by Raman Spectroscopy and Hydrogen Effusion

B. Fischer[1], W. Beyer[1], A. Lambertz[1], M. Nuys[1], W. Duan[1], K. Ding[1]

[1] *Forschungszentrum Jülich GmbH*

THU - J - 15

Optimization of Laser Parameters for Ablation of PECVD SiNx:H and Removal of Laser Induced Surface Damages on Silicon by Alkaline Solution

A.E. Keçeci[1], V. Özyahni[1], Y.M. Kaplan[1], M. Korkmaz Arslan[1], S. Aslan[1], H. Asav[1], H.H. Canar[1], G. Çelik[1], G. Bektaş[1], R. Turan[1]

[1] *ODTÜ-GÜNAM*

THU - J - 18

Optimisation of Photolithographic Fabrication of Photonic Crystals on Rough Wafers for High Efficiency Solar Cells

L. Salomon[1], R. Peibst[2], M. Rienäcker[2], J. Krügener[1]

[1] *Institute of Electronic Materials and Devices, Leibniz University Hannover;* [2] *Institute for Solar Energy Research in Hamelin*

THU - K - 03

Renewable Energy Application and Carbon Reduction Study on the Campus Teaching Building

J. He[1], Y. Luo[1], H. Chen[1]

[1] *ShenZhen Technology University*

12:15 - 13:00 Lunch

13:00 - 14:30 Session 10: Poly-Si Passivating Contacts

Auditorium

Chair: Stefan Glunz / Luana Mazzarella

13:00

Locally Enhanced Doping Under Poly-Si Passivating Contacts

M. Fırat[1], L. Wouters[2], P. Lagrain[2], F. Haase[3], J. Polzin[4], A. Chaudhary[5], G. Nogay[6], T. Desrues[7], J. Krügener[8], R. Peibst[9], L. Tous[10], H. Sivaramakrishnan Radhakrishnan[2], J. Poortmans[11]

[1] *KU Leuven/imec (Work done at KU Leuven/imec, the author currently affiliated with Oxford PV);* [2] *Imec;* [3] *ISFH;* [4] *Fraunhofer ISE;* [5] *ISC-Konstanz (Work done at ISC Konstanz, author currently affiliated with University of Stuttgart);* [6] *CSEM;* [7] *Université Grenoble Alpes, CEA, LITEN, DTS, LPA;* [8] *Leibniz University Hannover, Institute of Electronic Materials and Devices;* [9] *ISFH/Leibniz University Hannover;* [10] *imec (Work done at imec, the author currently affiliated with AGC Glass Europe);* [11] *Imec/KU Leuven/Hasselt University*

13:15

Influence of the Annealing Temperature of (n) poly-Si/SiOx Passivating Contacts on their Firing Stability

J. Linke[1], J. Hoß[1], F. Buchholz[1], J. Lossen[1]

[1] *ISC Konstanz e.V.*

13:30

Improvement of Passivation Performance of Silicon Nanocrystal/Silicon Oxide Compound Layer by Two-Step Hydrogen Plasma Treatment

M. Matsumi[1], K. Gotoh[1], M. Wilde[2], Y. Kurokawa[1], K. Fukutani[2]

Presented by N. Usami[1]

[1] *Graduate School of Engineering, Nagoya University;* [2] *Institute of Industrial Science, The University of Tokyo*

13:45 **Low Resistivity Hole Selective SiNx/p+ poly-Si Passivating Contacts for High Efficiency Solar Cells**
S. McNab[1], A. Morisset[2], E. genc[2], F. Haug[2], M. Wright[1], P. Altermatt[3], P. Wilshaw[1], S. Bonilla[1]

[1] University of Oxford; [2] EPFL STI IEM PV-LAB; [3] Trina Solar

14:00 **Impact of Doping Type and Thermal Budget on Long-Term Stability of Poly-Si Passivating Contacts**
A. Morisset[1], A. Ingenito[1], F. Haug[1], C. Ballif[1]

[1] EPFL PV-Lab

14:15 **Towards >25% Efficiency of Passivated-Contact Solar Cells in Mass Production**
B. Lee[1], F. Fertig[1], M. Fischer[1], I. Höger[1], S. Hörnlein[1], E. Jarzembowski[1], M. Junghänel[1], M. Kauert[1], K. Kim[1], A. Mette[2], J.W. Müller[1], S. Peters[2], K. Petter[1], M. Schaper[1], S. Schulz[1], M. Schütze[1], A. Weihrauch[1]

[1] Hanwha Q CELLS GmbH; [2] Hanwha Q Cells

14:30 - 15:00 Closing SiliconPV 2023

Auditorium

Chair: Arthur Weeber / Sébastien Dubois

14:30 **Closing SiliconPV 2023**
A. Weeber, TNO

14:40 **SiliconPV Award Ceremony for the Best 10 Abstracts and the Best Posters**
A. Weeber, TNO

14:50 **Announcement of SiliconPV 2024**
A. Weeber, TNO

15:00 - 15:30 Break

15:30 - 19:00 Technical Tour

19:00 - 20:30 TGV- Get-Together

The Green Village - Co Creation Center

Friday, April 14 2023

08:45 - 08:50 **Opening Session Friday**
Auditorium
Chair: Olindo Isabella

08:45 **Summary of nPV R&D Day / Outlook of nPV Industry Day**
O. Isabella, Delft University of Technology

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08:50 - 10:10 **Session 11: Silicon-related Material and Market Trends**
Auditorium
Chair: Barbara Terheiden / Jan Schmidt

08:50 **Wafer Formats and Trends in the Market**
J. Zhao, CSEM SA

09:10 **Ingots Production at Norwegian Crystals**
M. Peschke, Norwegian Crystals

09:30 **Market Trends in n-type c-Si PV Technology**
S. Chunduri, TaiyangNews

09:50 **Sputtered poly-Si for c-Si Solar Cells Applications**
E. Schneiderlöchner, VON ARDENNE GmbH

10:10 - 10:40 Break

10:40 - 12:00 **Session 12: Advanced Production Technologies**
Auditorium
Chair: Robby Peibst / Olindo Isabella

10:40 **Latest Industrial Results from RENA**
D. Brunner, Rena Technologies GmbH

10:55 **Thermal AP Gas Etching Process for Selective Poly-Si Removal**
L. Clochard, Nines Photovoltaics

11:15 **Reactive Plasma Deposition of TCOs**
Q. Chen, ChinaSC

11:35 **Conductive Copper Pastes and ECAs for Lower Costs and Improved Sustainability of PV Metallization**
O. Shochet, Copprint

12:00 - 13:00 Lunch

13:00 - 14:20 **Session 13: Solar Cells Production**
Auditorium
Chair: Gizem Nogay / Stefan Glunz

13:00 **Record Silicon Heterojunction Solar Cells**
C.X. Xu, LONGi

13:20 **Record TOPCon Solar Cells**
X. Zhang, Zhejiang Jinko Solar Co. Ltd

13:40 **Tunnel-IBC Solar Cells**
D. Lachenal, Meyer Burger Research

14:00 **Silicon Heterojunction Technology at TrinaSolar**
G. Yang, Trina Solar Co., Ltd.

14:20 - 15:40 Session 14: Modules and Systems

Auditorium
Chair: Radovan Kopecek / Arthur Weeber

14:20 **24% Efficient Maxeon IBC Modules - Cell and Module Characteristics**
J. Tan, Maxeon

14:40 **3Sun Silicon Heterojunction PV Modules**
C. Gerardi, ENEL GREEN POWER / 3SUN

15:00 **Installations by Jolywood in MENA Area**
J.X. Ni, Jolywood (Taizhou) Solar Technology Co.,Ltd.

15:20 **to be announced**

15:20 - 15:40 Break

16:00 - 17:00 Session 15: Sustainability, Recycling and Circularity Aspects

Auditorium
Chair: Perrine Carroy, Malte Vogt

16:00 **Terawatt Scale Sustainability with Silicon PV**
T. Barnes, NREL

16:20 **Fully Recyclable Solar Panels**
M. Späth, TNO

16:40 **Circular PV Modules**
G. de Leede, Solarge

17:00 - 17:20 Closure of nPV Workshop

Auditorium

17:00 **Closure of nPV Workshop & Announcement Future Events**
O. Isabella, Delft University of Technology

Side Events

Welcome Reception

All participants are invited to take part in the Welcome Reception, which will take place on Monday, April 10, 2023.

It will take place at 't Postkantoor located in the historical centre of Delft. Cosy atmosphere will ensure good vibes and meeting other attendees in an informal settings will surely mark a wonderful start into the SIliconPV Week in Delft!

Day: Monday, April 10, 2023
Time: 17:00 - 19:00 (CEST)
Place: 't Postkantoor, Hippolytusbuurt 14, 2611 HN Delft
Registration is required

Conference Dinner

The SiliconPV Conference Dinner will take place at the Loetje restaurant, beautifully situated at a canal in Delft, just a 20-minute walk from the conference venue.

Day: Wednesday, April 12, 2023
Time: 19:00 - 24:00 (CEST)

The dinner is included in all SiliconPV tickets, pre-registration is required.

Address:
Loetje Delft
Korte Geer 1A
2611 CA Delft

© Loetje

Technical Tour

Take a Tour!

We are happy to invite you to three locations on the grounds of TU Delft as part of the Technical Tour Program:

- The Clean Room at TU Delft PV Technology Center (limited tickets)
- The Electrical Sustainable Power Laboratory
- The Green Village

Day: Thursday, April 13, 2023
Time: 15:15 - 19:15 (CEST)
Registration fee: 15,- EUR
Registration deadline: March 21, 2023

Participants registered for the tour will meet in the foyer (break area) of the Aula to be assigned to small groups.

TU Delft PV Technology Center

One location will be the 300 m2 wide thematic clean room within the buildings of the Else Kooi Laboratory. Supported by TNO and imec, this center is equipped with all the necessary instrumentation to process thin-film silicon, crystalline silicon, perovskite and multi-junction solar cells to industrial sizes.

Electrical Sustainable Power Laboratory

Another part of the tour will be the massive laboratory designed for studying energy transition in the power sector and system integration. In the ESP Lab, which is supported by TenneT and the Dutch Ministry of Economic Affairs and Climate, researchers from photovoltaic, wind energy, power electronics, smart grids, and high voltage technologies work together under one roof to accelerate the transition to sustainable energy.

The Green Village

A sustainable future requires innovative ideas and new usable methods and techniques. At The Green Village, our third location, knowledge and educational institutions, companies, governments and citizens research, experiment, validate and demonstrate their sustainable innovations. The Green Village is a low-regulation “open-air laboratory” on TU Delft Campus with a focus on the built environment where tests can be carried out at district, street and building level.

Drinks at TGV

At the end of the tour please join us for an informal get-together at the Co-Creation Center of The Green Village.

OVERVIEW

Program Overview

*as of 3 April, subject to change

CEST	Monday April 10, 2023	Tuesday April 11, 2023	Wednesday April 12, 2023	Thursday April 13, 2023	Friday April 14, 2023
		SiliconPV Conference		nPV Workshop	
8:30			Cell Characterization	Opening Session nPV 2023	
8:45					Opening
9:00		Opening SiliconPV 2023		Silicon Hetero Junction Solar Cells	Silicon-related Material and Market Trends
9:20		Highlight Session			
9:45					
10:00					
10:15			Coffee Break	Coffee Break	Break
10:30		Coffee Break			
10:45			Tandem Technologies	Poster	Advanced Production Technologies
11:00		Dopant Free Contacts / Novel Surface Passivating Layers			
11:15					
11:30					
11:45					
12:00			Lunch Break	Lunch Break	Lunch Break
12:15					
12:30		Lunch			
12:45			Poster		
13:00				Poly-Si Passivating Contacts	Solar Cells Production
13:15		Poster			
13:30					
13:45					
14:00					
14:15					
14:30			Module Reliability and Processing	Closing SiliconPV 2023	Modules and Systems
14:45					
15:00		Module Characterization, Simulations, Annual Yield		Break	
15:15					
15:30				Technical Tour	Break
15:45					
16:00		Break	Break		Sustainability, Recycling and Circularity Aspects
16:15					
16:30		Silicon Material	Process Technologies / Back-Contacted Solar Cells		
16:45					
17:00					Closure of nPV Workshop
17:15	Welcome Reception				
17:30					
17:45					
18:00					
18:15					
18:30					
18:45					
19:00			Conference Dinner	Drinks at TGV	
19:15					