

31st Workshop on Crystalline Silicon Solar Cells & Modules: Materials and Processes



July 28th – July 31st, 2024

Beaver Run at Breckenridge, Colorado

Sponsorship from:



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Sunday, July 28th

8:00 – 9:00 am Registration & Breakfast

9:00 – 9:30 am **Workshop Welcome and Introduction: Ron Sinton**, Sinton Instruments (USA)

Session 1: Characterization of Solar Cells, Modules, and Arrays

Session Chair: **David Hinken** (ISFH)

9:30 – 10:00 am **Karsten Bothe** (ISFH) – From multi-busbar to back-contact - challenges in certified measurements of large-area Si solar cells

10:00 – 10:30 am **Steven Spurgeon** (NREL) – Accelerating Interface Science Through NREL's New Electron Microscopy Suite

10:30 – 11:00 am Break

11:00 – 11:30 am **Adrienne Blum Karpen** (Sinton Instruments) – Characterization Solutions for the Next Generation Solar Cells

11:30 – 12:00 pm **Ziv Hameiri** (UNSW) – We are almost there: Recent progress in the contactless characterization of (tandem) solar cells

12:00 – 1:30 pm Lunch

Session 2: The Potential for Perovskite on Silicon Solar Cells

Session Chair: **Christophe Ballif** (CSEM/EPFL)

1:30 – 2:00 pm **Oliver Fischer** (F-ISE) – Electrical Loss Analysis on Perovskite-Silicon Tandem Solar Cells

2:00 – 2:30 pm **Laura Schelhas** (NREL) PACT – Perovskite module benchmarking with field tests

2:30 – 3:00 pm Break

3:00 – 3:30 pm **Philipp Wagner** (Helmholtz) – Three-Terminal Perovskite-Silicon Tandem Solar Cells

3:30 – 4:00 pm **Heping Shen** (ANU) – Efficient, Stable Perovskite/Silicon Tandem Solar Cell on Passivating Contact Silicon Solar Cells

4:00 – 4:30 pm Break

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Session 3: *Industrial Innovations and Challenges*

Session Chair: **Paul Stradins** (NREL)

- 4:30 – 4:50 pm **Matt Card** (Suniva) – A case study in reviving U.S. solar manufacturing
- 4:50 – 5:10 pm **Eric Hafter** (Origami Solar) – Durable, Domestic and Decarbonized: Necessary Evolutions in PV Module Frames
- 5:10 – 5:30 pm **Ben Wilkinson** (Syenta) – TW Scale Copper Metallisation with Localised Electrochemical Modelling (Virtual Presentation)
- 6:30 – 7:30 pm Welcome Reception with Dinner

Monday, July 29th

- 7:00 – 8:00 am Breakfast

Session 4: *Scaling Silicon Production Towards the TW/year scale*

Session Chair: **Rolf Brendel** (Institut für Solarenergieforschung GmbH)

- 8:00 – 8:30 am **Paul Basore** (DOE) – Federal PV Hot Topics
- 8:30 – 9:00 am **DaMing Chen** (Trina Solar) – Technology evolution and future prospect of TOPCon solar cells
- 9:00 – 9:20 am Break
- 9:20 – 9:50 am **Brett Hallam** (UNSW) – Silver-lean screen printing for sustainable terawatt-scale PV production
- 9:50 – 10:10 am **Mike Woodhouse** (NREL) – Reflections on 15 Years of PV Module and System Price Declines and Analysis of Where Things Go From Here
- 10:10 – 10:30 am Break

Session 5: *Discussion: Poly-Silicon production and Cz-Si crystal growth*

Session Chair: **Karsten Bothe** (Institut für Solarenergieforschung GmbH)

- 10:30 – 10:50 am **Erich Dornberger** (Wacker) – Sustainable Polysilicon for High Efficiency
- 10:50 – 11:10 am **Blake Barthelmess** (Hemlock Semiconductor) – Polysilicon and the Inflation Reduction Act: Strategic Insights for Reshoring PV Production in America
- 11:10 – 11:30 am **Wayne Osborne** (REC Silicon) – Reshoring North American PV with Energy-Efficient, Low Carbon Footprint, High-Purity Granular

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Silicon

11:30 – 12:00 pm **Talid Sinno** (U Pennsylvania) – Cz-Si crystal growth science and technology

12:00 – 1:30 pm Lunch

Free Afternoon to Enjoy Local Activities

6:30 – 8:30 pm Poster session and reception (Sponsored by Sinton Instruments)

Tuesday, July 30th

7:00 – 8:00 am Breakfast

Session 6: *High-Efficiency Cell Development*

Session Chair: **Ziv Hameiri** (UNSW)

8:00 – 8:30 am **Rabin Basnet** (ANU) – Current status and challenges for hole-selective poly-Si based passivating contacts

8:30 – 9:00 am **Jana Polzin** (Fh-ISE) – Preparation of poly-Si Based Passivating Contacts for TOPCon Solar Cells

9:00 – 9:20 am Break

9:20 – 9:50 am **Hitoshi Sai** (AIST) – In-free silicon heterojunction solar cells with tin-oxide based TCO layers

9:50 – 10:20 am **Christophe Ballif** (CSEM/EPFL) – Status and future prospects for SHJ solar cells: advantages and drawbacks for single junction and tandem devices

10:20 – 10:40 am Break

Session 7: *Research needs up/down the Silicon value chain*

Session Chair: **Susan Huang** (U.S. Department of Energy), and **Larkin Sayre** (U.S. Department of Energy, SETO)

10:40 – 11:00 am Where does Si PV research go from here?

11:00 – 12:00 pm Panel discussion

- **Rolf Brendel** (ISFH)
- **Christophe Ballif** (CSEM/EPFL)
- **Mike Woodhouse** (NREL)
- **Eric Dornberger** (Wacker)

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12:00 – 1:30 pm Lunch

Session 8: *Present and Future Challenges in Silicon Technology* Session Chair: **Toshio Yoshita** (Toyota Technological Institute, Japan)

1:30 – 2:00 pm **Martin Springer** (NREL) – Big Floppy modules

2:00 – 2:15 pm **Zhaolong Zhang** (Solar4 America) – Greening PV Module manufacturing process: Reducing Carbon Footprint with Alternatives Raw Material Solutions

2:15 – 2:30 pm **Hari Achuthan** (Convalt Energy)

2:30 – 3:00 pm **Heather Mirletz** (NREL) – Using Circular Economy framework to inform PV technology improvements

3:00 – 3:30 pm **Chris Stearns** (Solar Cycle) – Maximizing Commodity Value in Solar Recycling

3:30 – 4:00 pm Break

Session 9: *Workforce development (needs, internships, engagement with NREL and academia)*

Session Chair: **Richard Wallace** (Boston Government Services)

4:00 – 5:00 pm **Panelist:** Hari Achuthan: Convalt (hiring veterans)
Matt Card: Suniva (restart factory, GiT connections)
Feri Farzad: Q-cells (retraining textile workers)
Wayne Osborne: REC (restart of factory, remote location)
Blake Barthelme: Hemlock Semiconductor (training programs)

5:00 – 5:25 pm **Y.C. Wang** (Longi) – Online talk, A new type of mass-production silicon wafer for High Efficiency Solar Cells - TaiRay Wafer.

5:25 – 5:30 pm Sponsor Message (Bühler Leybold Optics)

5:30 – 6:30 pm Break

6:30 – 8:30 pm Poster session and reception (Sponsored by Buhler)

Wednesday, July 31st

7:00 – 8:00 am Breakfast

Session 10: *Silicon for Space applications* Session Chair: **Abby Meyer** (Aerospace Corp. USA)

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- 8:00 – 8:20 am **Lejo Joseph Koduvelikylathu** (ISC-Konstanz) – p-type c-Si technologies: Back to Space
- 8:20 – 8:40 am **Kaveh Rouhani** (MPower) – Silicon solar cells for space applications
- 8:40 – 9:00 am **Michelle Eyink** (Solestial) – Ultrathin Silicon Solar Cells and Flexible Modules for Space
- 9:00 – 9:20 am **Peter Toth** (Extraterrestrial Power) – Extraterrestrial Silicon Solar Cells
- 9:20 – 9:40 am Break

Session 11: Metallization

Session Chair: **Rabin Basnet** (ANU)

- 9:40 – 10:10 am **Mariana Bertoni** (ASU) – Reactive Silver Ink Metallization: More Than Just a Path to 90% Less Silver
- 10:10 – 10:30 am **Cody Van Cleve** (Sunflex) – Laser-Welded Interconnection of Back-Contact Cells with Aluminum Foil Electrodes
- 10:30 – 10:45 am **Paul Stradins** (NREL/Bert Thin Films) – Cu fire-through paste metallization
- 10:45 – 11:15 am **Eve Krassowski** (Cell Engineering) – Technological evolution of the Laser Enhanced Contact Optimization

Session 13: DISCUSSION & WRAPUP: Conclusions and Open Questions from the Workshop

- 11:15 – 11:20 am **Debbie Brodt-Giles** (NREL) – Solar Prize
- 11:20 – 12:00 pm **Radovan Kopecek** (International Solar Energy Research Center Konstanz e.V.) – Moderator
- 12:00 pm Adjourn