



Bildnachweis: Würth Solar

Thin-film Photovoltaics

Modules – Systems – Applications

Grundlagenseminar/Fundamentals Seminar

(Konferenzsprache deutsch,
simultaneous translation into English)

February 08th, 2010 – February 09th, 2010

International Conference Thin-Film

(conference language English)

February 09th, 2010 – February 10th, 2010

Congress Centrum Würzburg, Germany



Training
Seminare
Tagungen



Würzburg: Baroque City with southern flair and also known as the "gateway to the Romantic Road". Furthermore its "Residenz" is listed in the UNESCO World Heritage. It is the metropolis of sunny Franconia, a landscape whose vineyards flank the river Main and the wines are famous throughout the world.

Würzburg is very well accessed by train "ICE" and has a direct line from Frankfurt Airport.



Prof. Dr. Bernd Rech

Helmholtz Centre Berlin for Materials and Energy, Berlin, Germany

Director of the Institute Silicon-Photovoltaics, Helmholtz Centre Berlin for Materials and Energy, full professor at Technical University Berlin (Faculty Electrical Engineering and Computer Science, chair of photovoltaics), Spokesman of the programme renewable energy - Helmholtz Association

Organisation:

Conference Organiser/ Tagungsmanagement

Leonore Nanko, OTTI e.V.
Renewable Energies
Wernerwerkstraße 4,
93049 Regensburg, Germany
Phone +49 941 29688-24
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Conference Venue/Tagungsstätte

Congress Centrum Würzburg
Pleichtorstraße 12
97070 Würzburg, Germany

Fees cover the admission to all sessions, invitation to all coffee breaks, a lunch, a dinner, the conference proceedings and a CD-ROM.

Accommodation/ Zimmerreservierung

Congress & Tourismus
Zentrale Würzburg
Phone: +49 931 372335
Fax: +49 931 373652
www.wuerzburg.de

For list of hotels in Würzburg consult <http://www.hotelscombined.com/City/Wurzburg.htm>.

Fundamentals Seminar Fee if registered until November 23rd, 2009

Per Person: € 440,00
Member OTTI/Co-Organiser € 390,00

Fundamentals Seminar Fee if registered after November 23rd, 2009

Per Person: € 490,00
Member OTTI/Co-Organiser € 430,00

Conference Fee if registered until November 23rd, 2009

Per Person: € 440,00
Member OTTI/Co-Organiser € 390,00

Conference Fee if registered after November 23rd, 2009

Per Person: € 490,00
Member OTTI/Co-Organiser € 430,00

Fundamentals Seminar and International Conference Fee if registered until November 23rd, 2009

Per Person: € 860,00
Member OTTI/Co-Organiser € 740,00

Fundamentals Seminar and International Conference Fee if registered after November 23rd, 2009

Per Person: € 940,00
Member OTTI/Co-Organiser € 820,00

Scientific Committee:

Dipl.-Ing. Manfred Bächler

Phoenix Solar AG, Sulzemoos, Germany

Dr. Robert Bartl

Bayern Innovativ GmbH, Nürnberg, Germany

Dr. Dieter Bonnet

Friedrichsdorf, Germany

Dipl.-Phys. Ulrike Jahn

TÜV Rheinland, Köln, Germany

Dr.-Ing. Werner Knaupp

PV-plan, Stuttgart, Germany

Dr.-Ing. Michael Powalla

Zentrum für Sonnenenergie- und Wasserstoff-Forschung Baden-Württemberg (ZSW), Stuttgart, Germany

Dr. Heribert Schmidt

Fraunhofer-Institut für Solare Energiesysteme ISE, Freiburg, Germany

Sponsors:



Dear Ladies and Gentlemen,

Our conference and fundamentals seminar on Thin-film Technology in Photovoltaics will take place for the sixth time in February 2010.

When we started this event for the first time our community was very active but rather small. This has changed strongly during the past few years. The demand for thin-film modules skyrocketed and numerous new companies world-wide have entered the market or are currently setting-up large production facilities. The production capacity in Germany will exceed 1 GWp in 2009. Thin-film technology opens-up exciting possibilities for new products e.g. for building integration, and moreover, allows to produce flexible or semitransparent solar modules. Last but not least, thin-film solar modules are offering the lowest module prices today and still bare a huge potential for further cost reductions.

It is the philosophy of this event to bring together experts and newcomers having their background in academics, technology development, solar module production, application in systems or even in the financial sector. Thus you will find expertly presented information about modules, system components, and practical experience at the convention centre in Würzburg. The success relies on the intense dialogue between developers and producers with system designers and users.

The event will start on Monday with a fundamentals seminar given by well-known experts in German language. Note that all talks will be simultaneously translated into English. On Tuesday, the international conference will take place. Certainly, the conference language will be English to attract guests from abroad which will bring in their experience about international developments and markets.

The speakers will bring light into the variety of thin-film technologies and materials. You will learn about the basics and future trends of thin-film silicon and compound semiconductor technologies (a-Si, a-Si/ $\mu\text{-Si}$, thin c-Si, CdTe and CIS) and products. Reports of real-life experiences with specific systems will be from great practical relevance. Besides technical approaches, economic aspects will also be discussed. The innovation forum and exhibition will provide latest information from thin-film PV industry.

With best regards,

Prof. Dr. Bernd Rech

Helmholtz Centre Berlin for Materials and Energy, Germany

- The worldwide shortage of crystalline silicon modules brings up the question of convenient alternatives.
- How can PV thin-film modules contribute to the market in view of customer value and cost cutting potential?
- Do thin-film techniques provide practicable and low-cost solutions for open field application and building integrated systems?
- Is there sufficient application experience available to forecast safe and stable yields?

Materials scientists, production engineers and developers from well-known institutes and companies will answer these questions competently.

Your benefit:

- Figures, facts about the state of the art and potentials of the three relevant thin-film technologies: cadmium-telluride (CdTe), copper-indium-diselenide (CIS), amorphous and/or microcrystalline silicon (a/ $\mu\text{-Si}$).
- The essential thin-film PV-modules manufacturers will present their product and application highlights within the innovation forum and the associated exhibition.
- Participant orientated discussion forums and a communication friendly number of participants guarantee opportunities to find answers to your questions.
- During breaks and the meals you can compare notes with speakers, experts and other participants.

You will meet:

Engineers, planning offices, project companies for the construction of large PV installations, manufacturers and operators of PV installations, developers of components, production planners and suppliers, utilities, energy advisers, building developers, credit institutions, municipal decision makers, technical colleges and universities.

In Cooperation with:



Media Partner:



English programme on page 8

Grundlagenseminar

08. bis 09. Februar 2010

Montag, 08. Februar 2010

ab 08.00 Uhr Ausgabe der Teilnehmerunterlagen,
Begrüßungskaffee und Snack

09:00 Begrüßung der Teilnehmer – Konzept des Grundlagen-
seminars
Dipl.-Kfm. Eckardt Günther, OTTI, Regensburg

09:15 Herausforderungen für die photovoltaische
Energieversorgung
PV-Technologien, Grundlagen Dünnschicht-Photovoltaik
Prof. Dr. Bernd Rech, Helmholtz-Zentrum Berlin für
Materialien und Energie

09:55 Fragerunde

Dünnschicht-Technologien: Materialwissenschaft und Produktion

Sitzungsleiter: Prof. Dr. Bernd Rech, Helmholtz-Zentrum Berlin
für Materialien und Energie

10:00 Kadmium-Tellurid (CdTe)-Dünnschichtsolarzellen
Dr. Dieter Bonnet, Solarpact e.V., Friedrichsdorf

10:25 Fragerunde

10:30 Kupfer-Indium-Diselenid Technologie
Dr.-Ing. Michael Powalla, Zentrum für Sonnenenergie- und
Wasserstoff-Forschung (ZSW), Stuttgart

10:55 Fragerunde

11:00 Kaffeepause und Snack, Besichtigung der Fachausstellung

11:30 Dünnschichtsilizium: Amorphes Silizium, Mikrokristallines
Silizium, Tandemzellen, Kristalline Dünnschichtzellen
Florian Ruske, Helmholtz-Zentrum Berlin für Materialien und
Energie GmbH

12:10 Fragerunde

Grundlagen der Systemtechnik

Sitzungsleitung: Dipl.-Phys. Ulrike Jahn, TÜV Rheinland, Köln

12:15 Systemtechnische Eigenschaften von PV-Dünnschicht Anlagen
Dr.-Ing. Werner Knaupp, PV-plan, Stuttgart

12:50 Fragerunde

12:55 Benötigen Dünnschichtmodule spezielle Wechselrichter?
Dr.-Ing. Heribert Schmidt, Fraunhofer-Institut für Solare
Energiesysteme ISE, Freiburg

13:25 Fragerunde

13:35 Buffet und get together im Bereich der Fachausstellung

Solarmodulmesstechnik und Qualifizierung

Sitzungsleiter: Dr.-Ing. Werner Knaupp, PV-plan, Stuttgart

15:00 Bestimmung der Nennleistung von Dünnschicht-Modulen
Dipl.-Phys. Ulrike Jahn, TÜV Rheinland, Köln

15:25 Fragerunde

15:30 Schwachlicht- und Rückspannungsverhalten von
Dünnschicht-Modulen
Alexander Preiss, Photovoltaik-Institut Berlin AG, Berlin

15:50 Fragerunde

15:55 Felddaten-Auswertung von Dünnschicht-Anlagen
Dipl.-Phys. Hans-Dieter Mohring, Zentrum für Sonnenenergie-
und Wasserstoff-Forschung (ZSW), Stuttgart

16:15 Fragerunde

16:20 Kaffeepause mit Besichtigung der Fachausstellung

Anwendungserfahrungen

Sitzungsleiter: Dr.-Ing. Michael Powalla, Zentrum für Sonnen-
energie- und Wasserstoff-Forschung (ZSW), Stuttgart

17:00 Felderfahrungen mit Silizium-Dünnschicht-Modulen
Dipl.-Ing. Manfred Bächler, Phoenix Solar AG, Sulzemoos

17:20 Fragerunde

17:25 Felderfahrungen mit CdTe-Anlagen
Jörgen Klammer, First Solar GmbH, Mainz

17:45 Fragerunde

17:50 Erfahrungen mit CIS-Technik an ausgewählten Projekt-
beispielen
Timo Bauer, Würth Solar GmbH & Co. KG, Schwäbisch Hall

18:10 Fragerunde

18:15 Vorstellung der Besichtigungsziele Buchheim und Moos
Lars Rulf, Phoenix Solar AG, Ulm

18:25 Zusammenfassung der Ergebnisse
Ausblick und Teilnehmerfeedback
Prof. Dr. Bernd Rech, Helmholtz-Zentrum Berlin für
Materialien und Energie

18:30 Ende des Grundlagenseminars
Buffet und get together im Bereich der Fachausstellung
mit Bier vom Fass

19:30 Networking im Bürgerspital, Theaterstraße 19
(für Selbstzahler)

Dienstag, 9. Februar 2010

09:00 bis 13.30 Uhr Besichtigungsfahrt zu den Anlagen Buchheim
und Moos mit dem Bus
Details zur Besichtigungsfahrt siehe Programm International
Conference Thin-film Photovoltaics auf Seite 13 (gleiche Tour
wie am Mittwoch)

Fundamentals Seminar

8th/9th February 2010

Monday, 08th February 2010

08.00 Registration and check in, welcome coffee and snacks

09:00 Opening address – concept of the fundamentals seminar
Dipl.-Kfm. Eckardt Günther, OTTI, Regensburg, Germany

09:15 Challenges to photovoltaic energy supply
PV technologies, basics of thin-film photovoltaics
Prof. Dr. Bernd Rech, Helmholtz-Centre Berlin for Materials and Energy, Berlin, Germany

09:55 Discussion

Thin-film Technology: Material Science and Production

Chair: Prof. Dr. Bernd Rech, Helmholtz-Centre Berlin for Materials and Energy, Berlin, Germany

10:00 Cadmium-telluride (CdTe) thin-film solar cells
Dr. Dieter Bonnet, Solarpact e.V., Friedrichsdorf, Germany

10:25 Discussion

10:30 Copper-indium-diselenide technology
Dr.-Ing. Michael Powalla, Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW), Stuttgart, Germany

10:55 Discussion

11:00 Coffee break and snack, trade exhibition

11:30 Thin-film silicon: amorphous silicon, microcrystalline silicon, tandem cells, crystalline thin-film cells
Dr. Florian Ruske, Helmholtz-Centre Berlin for Materials and Energy, Berlin, Germany

12:10 Discussion

Basics of System Technology Fundamentals

Chair: Dipl.-Phys. Ulrike Jahn, TÜV Rheinland, Köln, Germany

12:15 System characteristics of thin-film photovoltaic plants
Dr.-Ing. Werner Knaupp, PV-plan, Stuttgart, Germany

12:50 Discussion

12:55 Do thin-film modules need special inverters?
Dr.-Ing. Heribert Schmidt, Fraunhofer-Institut für Solare Energiesysteme ISE, Freiburg, Germany

13:25 Discussion

13:35 Buffet and get together in the trade exhibition

Measurement of Thin-film Modules and Qualification

Chair: Dr.-Ing. Werner Knaupp, PV-plan, Stuttgart, Germany

15:00 Characterisation of thin-film PV modules – performance measurements
Dipl.-Phys. Ulrike Jahn, TÜV Rheinland, Köln, Germany

15:25 Discussion

15:30 Low irradiance and reverse voltage characteristics of thin-film modules
Alexander Preiss, Photovoltaik-Institut Berlin AG, Berlin

15:50 Discussion

15:55 Field data evaluation of thin-film applications
Dipl.-Phys. Hans-Dieter Mohring, Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW), Stuttgart, Germany

16:15 Discussion

16:20 Coffee break and snack, trade exhibition

Application Experience

Chair: Dr.-Ing. Michael Powalla, Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW), Stuttgart, Germany

17:00 Field experience with silicon-thin-film-modules
Dipl.-Ing. Manfred Bächler, Phoenix Solar AG, Sulzemoos, Germany

17:20 Discussion

17:25 Field experience with CdTe applications
Jörgen Klammer, First Solar GmbH, Mainz, Germany

17:45 Discussion

17:50 Experiences with CIS applications - presentation of selected examples
Timo Bauer, Würth Solar GmbH & Co. KG, Schwäbisch Hall, Germany

18:10 Discussion

18:15 Introduction to technical tour Buchheim und Moos
Lars Rulf, Phoenix Solar AG, Ulm, Germany

18:25 Closing remarks

Future prospects and seminar feedback
Prof. Dr. Bernd Rech, Helmholtz-Centre Berlin for Materials and Energy, Berlin, Germany

18:30 Buffet and get together in the trade exhibition with draft beer

19:30 Networking in the Bürgerspital, Theaterstraße 19 (self payment)

Tuesday, 09th February 2010

09:00 until 13:30 Technical tour to the applications Buchheim und Moos by coach
For details of the technical tour pls. regard the programme International Conference Thin-film Photovoltaics page 13 (same tour as Wednesday)

International Conference Thin-Film

09th/10th February 2010

Tuesday, 09th February 2010

- 08:00 Registration and check in, welcome coffee and snacks
- 08:30 Opening address, concept of the international conference
Eckardt Günther, OTTI, Regensburg, Germany
Prof. Dr. Bernd Rech, Helmholtz Centre Berlin for Materials and Energy, Berlin, Germany

Technology and production

Chair: Prof. Dr. Bernd Rech, Helmholtz Centre Berlin for Materials and Energy, Berlin, Germany

- 08:45 Introduction to thin-film photovoltaics
Prof. Dr. Bernd Rech, Helmholtz Centre Berlin for Materials and Energy, Berlin, Germany
- 09:00 Discussion
- 09:05 PV thin-film industry
Daniela Schreiber, EuPD Research, Bonn, Germany
- 09:20 Discussion
- 09:25 Ramp-up of the first European micromorph thin-film Fab by Inventux Technologies AG
Dr. Niklas Papatthaniou, Inventux Technologies AG, Berlin, Germany
- 09:40 Discussion
- 09:45 Laser concepts and processes for the industrial thin-film solar cell production
Dr.-Ing. Roland Mayerhofer, Rofin / Baasel Lasertechnik, Starnberg, Germany
- 10:00 Discussion
- 10:05 Simplified integrated series connection and shunt reduction of silicon thin-film solar modules
Dr. Eerke Bunte; Forschungszentrum Jülich, Germany
- 10:20 Discussion
- 10:25 Packaging of thin-film solar cells
Dr. Florian Schwager, Evonik Degussa GmbH, Hanau, Germany
- 10:40 Discussion
- 10:45 Coffee break and visit to the poster and trade exhibition

New Concepts

Chair: Dipl.-Ing. Manfred Bächler, Phoenix Solar AG, Sulzemoos, Germany

- 11:15 Commercial and industrial rooftops: a vast, underutilized resource which can be addressed by the Solyndra Module
Clemens Jargon, Solyndra, Holzkirchen, Germany
- 11:30 Discussion
- 11:35 Nanosolar CIGS – roll-to-roll manufactured solar cells and modules
Dr. Erik Oldekop, Nanosolar International GmbH, Zug, Switzerland
- 11:50 Discussion
- 11:55 Analysis of the performance ratio of a-Si thin film modules and plants in terms of a positive “effective temperature coefficient” of power
Dr. Diego Fischer, Flexcell (VHF-Technologies SA), Yverdon, Switzerland
- 12:10 Discussion

Innovation Forum

Chair: Dr. Robert Bartl, Bayern Innovativ GmbH, Nürnberg, Germany

- 12:15 Exhibitors present their highlights in a short talk
- 13:15 Buffet and get-together in the poster and trade exhibition

Modules and performance

Chair: Dr. Robert Bartl, Bayern Innovativ GmbH, Nürnberg, Germany

- 14:30 Accelerated ageing of different thin-film module types by exposure to damp heat with additional applied voltage
Dipl.-Ing. Dieter Geyer, Zentrum für Sonnenenergie- und Wasserstoff-Forschung (ZSW), Stuttgart, Germany
- 14:45 Discussion
- 14:50 Annealing effect in amorphous silicon
MSc Ruud Wijtvliet, CentroSolar Group, Paderborn, Germany
- 15:05 Discussion
- 15:10 Development of performance and module temperature of thin-film modules
Dipl.-Phys.oec. Jochen Wirth, Fraunhofer ISE, Freiburg, Germany
- 15:25 Discussion
- 15:30 Amorphous and micromorphous Silicon thin-film photovoltaics – product development process und field experience
Dr. Christian Koitzsch, Bosch Solar Thin Film GmbH, Erfurt, Germany
- 15:45 Discussion

- 15:50 Introduction to technical tour Buchheim and Moos
Lars Rulf, Phoenix Solar AG, Ulm, Germany
- 16:00 Coffee break and visit to the poster and trade exhibition

Applications

Chair: Dr.-Ing. Heribert Schmidt, Fraunhofer-Institut für Solare Energiesysteme ISE, Freiburg, Germany

- 16:30 Design of fixation- and rack solutions for frameless thin-film modules based on numerical calculations
Dr.-Ing. Cedrik Zapfe, Schletter GmbH, Kirchdorf/Haag i. OB., Germany
- 16:45 Discussion
- 16:50 Bonding of the substructure - a way to reduce costs and increase durability of thin film PV modules
Dipl.-Ing. Leo Scheiwiller, Sika Services AG, Zürich, Switzerland
- 17:05 Discussion
- 17:10 Performance and characteristics of thin-film PV technologies – Fraunhofer ISE experience from field and laboratory measurements
Daniela Dirnberger, Fraunhofer ISE, Freiburg, Germany
- 17:25 Discussion
- 17:30 Capacitive discharge currents – challenges of using TL-inverters with flexible laminates
Dr. Meinhard Stalder, SMA Solar Technology AG, Niestetal, Germany
- 17:45 Discussion
- 17:50 Closing remarks
perspective and participants' feedback
Prof. Dr. Bernd Rech, Helmholtz Centre Berlin for Materials and Energy, Berlin, Germany
- 18:00 End of the international conference - visit to the poster and trade exhibition
- 18:15 Buffet
- 19:30 Networking in the Bürgerspital, Theaterstraße 19 (self payment)

Poster Presentations

Thin-film modules

- BIPV – designing thin-film solar cells by laser**
Uwe Wagner, JENOPTIK Automatisierungstechnik GmbH, Jena, Germany
- Two in-situ methods to find the optimum conditions for the deposition of solar cells based on microcrystalline silicon**
Dr. Aad Gordijn, Forschungszentrum Jülich, Germany

Thin-film PV module performance under varying weather conditions

Dr. Marcus Rennhofer, AIT - Austrian Institute of Technology, Wien, Austria

Next generation of thin-film PV scribing equipment

Dr.-Ing. Marc Hüske, LPKF SolarEquipment GmbH, Garbsen, Germany

Performance evaluation of thin-film technologies based on operating data

Dr. Henrik te Heesen, meteocontrol GmbH, Augsburg, Germany

Systems

Polyaniline/TiO2 thin film heterostructure by plasma enhanced polymerization of aniline monomers for device fabrication
Ph.D. Sadia Ameen, Chonbuk National University, Jeonju, South Korea

Wednesday, 10th February 2010

9:00 until 13:30 technical tour to the applications Buchheim and Moos by coach

09:00 Departure in front of the main entrance Maritim Hotel

09:50 Arrival at the application Buchheim, Burgbernheim

Duration of visit one hour

Technical data:

Performance of application: 3.800 kWp

Module producer: First Solar

Inverters: SMA SC 500

Yield data:

Location Buchheim

rated system power: 3,9 MWp (for about 1000 households)

Power supply line:

Electricity supplier: N-ERGIE

Power supply: since December 2006

11:00 Departure from Buchheim

12:00 Arrival at the application Moos

Technical data:

Performance of application: ca. 1.100 kWp

Module producer First Solar

Inverters: 2 x Xantrex GT500

Yield data:

Location Moos near Würzburg

Yield: 1.044 kWh/kWp*a (average over 20 years)

Power supply line:

Electricity supplier: Stadtwerke Würzburg

Power supply: since December 2007

13:00 Departure from Moos

13:30 Arrival at Würzburg Central Station and CCW, Pleichertorstr. 12, 97070 Würzburg

Thin-film Photovoltaics

February 08th – 10th, 2010 (DSM-3394)

OTTI e.V.

Headword: Thin-film Photovoltaics

**Wernerwerkstraße 4
93049 Regensburg
Germany**

Please print your member or customer number:

OTTI (Member number only)

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Registration Conditions

You will receive the relevant papers and confirmation as soon as we have your registration. The fees are exempt from value-added tax (VAT) and are payable in full upon receipt of the invoice. Payment must be received no later than 14 days before the conference begins (it has to be settled in EURO). All bank charges have to be covered by the transmitter! OTTI reserves the right to refuse admission if the amount has not arrived, unless said amount is paid by cheque on the day. In case transferring occurs later than 14 days before the conference, please keep a copy of the transfer order ready and show it in the organisation office at the conference. OTTI reserves the right to change the programme at short notice for urgent reasons. There is no charge for cancellations made at least 35 days before the event starts. If the booking is cancelled 34 days before the start of the conference a service charge of € 120,00 will be made. For later cancellations (14 days before the conference starts) the complete conference fee will be charged. All cancellations must be in writing. It is possible to send a substitute delegate at any time without additional cost, but we need a written message about the change 4 days before the conference starts. Legal domicile and place of fulfilment is Regensburg, Germany.

I will participate

Fundamentals (DSG-3393)

I need simultaneous translation into English

International Conference (DSM-3394)

Both events

We are interested in the trade exhibition or the sponsorship. Please send us information and the registration form.

I cannot participate but wish to order the conference proceedings at the price of € 100,00 (incl. VAT) plus postage and packing – delivery after the conference.

Family name

First name

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Date

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Registration only valid with signature and company stamp!

Timetable:

Thin-Film Photovoltaics: February 08th-10th 2010

