

Photon Management in c-Si Solar Cells via Plasmonic Nanogratings

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Photon management is key to advanced photovoltaics as efficient solar cells increasingly consist of thin-film active layers, where both recombination probability and photon absorption are notably decreased. One of the most promising techniques relies on plasmonic nanogratings for back light trapping to enhance the absorption in the active layer by increasing the photon lifetime. Our thin-film solar cell includes a 400nm crystalline silicon absorbing layer with an additional 55nm Si₃N₄ thin-film on top as anti-reflection coating. The Ag nanostructure consists of a binary nanograting (on top of a 40nm Ag bottom layer) having a periodicity of 400nm, a tooth height of 180nm with a duty cycle of 0.4. The numerical study of the overall solar cell was carried out using the finite-elements-method (FEM) based simulation platform COMSOL Multiphysics™ analyzing broadband absorption of the nanostructured thin-film cell in comparison to the reference thin-film cell with an unstructured Ag layer.

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Plasmonic back-gratings

- Reflect light back to the layer
- Excite plasmonic resonance modes
- Strong resonant field localization due to interference of different diffraction orders

Electric Field At 605nm, absorption at the same wavelength

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Outlines

- Photon management
- Plasmonic back-gratings
- Optimization procedure
- Absorption in the active layer

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Optimization procedure

- Our thin-film solar cell includes a 400nm crystalline silicon absorbing layer with an additional 55nm Si₃N₄ thin-film on top as anti-reflection coating
- The Ag nanostructure consists of a binary nanograting (on top of a 40nm Ag bottom layer)
- Grating parameters were optimized using a breeder genetic algorithm
- The optimized parameters have a periodicity of 400nm, a tooth height of 180nm with a duty cycle of 0.4

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Photon management

Thin-film solar cells:

- Low cost
- Low weight
- Shorter carriers path length
- Mechanical flexibility
- However, lower photon absorption probability

- Plasmonic nano particles
- Surface roughness
- Plasmonic back grating

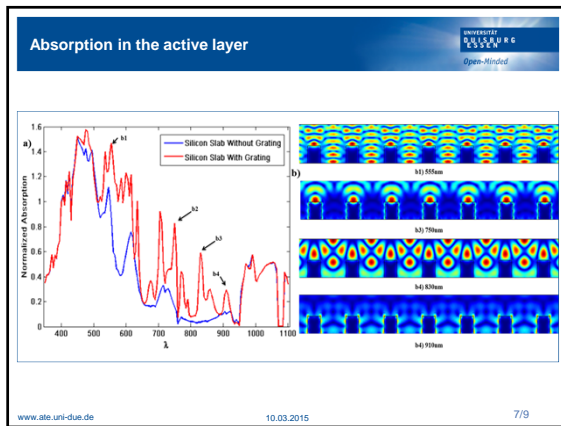
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Absorption in the active layer

- The presence of back-grating enhanced absorption in a broad spectral range

	Enhancement percentage
Total absorption	24.8%
Carrier generation rate	29.5%

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To conclude

Plasmonic back-gratings enhance optical absorption through trapping light inside the active layer

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Thanks for your attention

Questions?
Handouts are available

CENIDE NanoBio Workshop 2015

Program

Thursday, March 12, 2015

Venue: Bibliotheksaal R11, Library for humanities and social sciences Campus Essen,
Universitätsstraße 9-11, 45141 Essen

- 09:00 *Welcome*
Prof. Dr. Shirley Knauer,
Faculty of Biology, CENIDE, UDE
- 09:10 *An interdisciplinary academic career at the nano-bio-interface*
Dr. Dominic Docter, Molecular and cellular Oncology, University Medical Center Mainz
- 10:00 Coffee Break
- 10:30 Rapid Fire Session 1:
Medical applications - from bacteria & viruses to neurodegenerative disease & cancer
(9 Talks - 9 (7+2) min each)
- 12:00 Lunch Break
- 13:00 Rapid Fire Session 2
Technical applications - from zoology & molecule manipulation to solar cells
(8 Talks - 9 (7+2) min each)
- 14:20 Closing Remarks

Rapid Fire Session 1:

Medical applications - from bacteria & viruses to neurodegenerative disease & cancer

- 10:30 - Impact of bacterial Endotoxins on the structural change of DMPC Membranes using AFM, solid state NMR and PFG-NMR, *Michael Nagel, Physical Chemistry*
- 10:39 - Potential of nanoparticles for the immunization against viral infections, *Viktoriya Sokolova, Inorganic Chemistry*
- 10:48 - Functionalized gold nanoparticles counteract misfolding of the Alzheimer peptide A β , *Carmen Streich, Organic Chemistry*
- 10:57 - Nanostructuring of Neural Electrodes by Electrophoretic Deposition for the Treatment of Parkinson's Disease, *Sven Koenen, Technical Chemistry I*
- 11:06 - Aqueous synthesis of hydrogels with embedded laser generated nanoparticles for burn wound treatment, *Nina Million, Technical Chemistry I*
- 11:15 - Analysis of interaction between hypoxia-inducible transcription factor (HIF) proteins using Fluorescence Resonance Energy Transfer (FRET) microscopy, *Irina Pisarenko, Institute of Physiology*
- 11:24 - The potential of biodegradable calcium phosphate nanoparticles as molecular carriers in nanomedicine, *Olga Rotan, Inorganic Chemistry*
- 11:35 - Alloy nanoparticles for applications in point of care diagnostics, *Christoph Rehbock, Technical Chemistry I*
- 11:46 - Perfect microswimmer: Investigation of single nanoparticles, *Florian Römer, Experimental Physics*

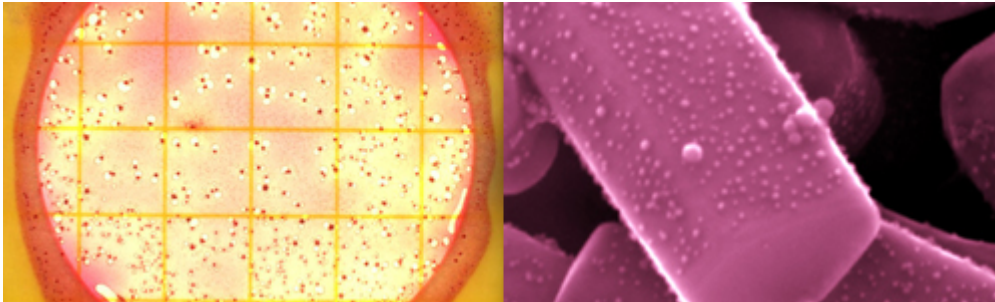
Rapid Fire Session 2:

Technical applications - from zoology & molecule manipulation to solar cells

- 13:00 - Design of bivalent gold nanoparticle-oligonucleotide-peptide conjugates for efficient sperm sorting, *Lisa Gamrad, Technical Chemistry I*
- 13:09 - (Eco-)toxicological aspects of nanoparticles: Uptake and effects in aquatic organisms, *Sonja Zimmermann, Aquatic Ecology*
- 13:18 - Impact of proteins on the switching process of thermoresponsive polymer brushes, *Marc Thomas, Technical Chemistry II*
- 13:27 - Biomimetic encapsulation systems, *Andreas Sprengel, Bionanotechnology*
- 13:36 - Modification of PACA-nanocapsules using click chemistry, *Christian Erdmann, Physical Chemistry*
- 13:45 - Enhancement of Iodine-123-Radioactivity by Laser-Generated Pt Nanoparticles for Thyroid Scintigraphy, *Sandra Jendrzzej, Technical Chemistry I*
- 13:54 - Nonlinear Laser Techniques for Local Immobilization of Biomolecules with Sub-Wavelength Resolution, *Nils Hartmann, Physical Chemistry*
- 14:03 - Photon Management in c-Si Solar Cells via Plasmonic Nanogratings, *Mandana Jalali, General and Theoretical Electrical Engineering*

UNIVERSITÄT DUISBURG-ESSEN

CENIDE NanoBio Workshop 2015



March 12, 2015

CENIDE NanoBio Workshop 2015

When? Where?

Thursday, March 12, 2015, 09:00–15:00

Bibliotheksaal R11, Library for humanities and social sciences Campus Essen, Universitätsstraße 9-11, 45141 Essen

([directions \(https://www.uni-due.de/imperia/md/content/dokumente/lageplaene/lp_campus_essen.jpg\)](https://www.uni-due.de/imperia/md/content/dokumente/lageplaene/lp_campus_essen.jpg))

What is the idea of the workshop?

This UDE internal workshop is intended to bring together researchers from different disciplines including chemistry, physics, engineering, biology, and medicine working on aspects of nano and bio. This workshop provides an interdisciplinary environment to interconnect projects and ideas with regards to future cooperation, networking, and career development.

How can you actively participate in the workshop?

The participation is free of charge and open to all researchers and especially young academics (Master and PhD students, postdocs) from the University of Duisburg-Essen (Campus and University Hospital). Participation in the workshop is connected to an oral presentation (no posters!), which will be held as rapid fire presentations of approx. 5-7 min. Please find the preliminary program below, session details will follow as soon as possible. Please register below and submit an English abstract on current research project or a planned project idea as a Word document including title, authors, and short description (Arial 11 pt, 500–1.000 characters) by February 6, 2015. The number of participants is limited to 50.

Registration

Name: *

E-Mail: *

Position: *

Institute/Department: *

Campus/Hospital: *

 Keine Datei ausgewählt.

All PhD students will get an official certificate of attendance at the end of the workshop, which serves as a confirmation for the doctoral thesis qualification phase (own contribution equals 2 cps).

Will the workshop abstracts be published?

No. To promote sharing of research ideas within the UDE environment, the research abstracts will not be published online. Instead, all participants will get a version of all abstracts to facilitate the establishment of interdisciplinary follow-up collaborations.

Preliminary Program

09:00	<i>Welcome</i> Prof. Dr. Shirley Knauer, Faculty of Biology, CENIDE, UDE
09:10	<i>An interdisciplinary academic career at the nano-bio-interface</i> Dr. Dominic Docter, Molecular and cellular Oncology, University Medical Center Mainz
10:00	Coffee Break
10:20	Rapid Fire Session 1 (10-25 Talks)
12:00	Lunch Break

13:00	Rapid Fire Session 2 (10-25 Talks)
14:20	Closing Remarks

(subject to change)

Photos:

left: (c) Sebastian Karkus, Pixelio

right: (c) Marcus Lau, AG Barcikowski, CENIDE, UDE



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Registration:

[Form](#)

Deadline: February 6, 2015

Organizing Committee:

Prof. Dr. Shirley Knauer

Faculty of Biology, ZMB/CENIDE, University of Duisburg-Essen

Prof. Dr. Stephan Barcikowski

Faculty of Chemistry, Deputy Scientific Director CENIDE, University of Duisburg-Essen

Dr. Tobias Teckentrup

Managing Director CENIDE, University of Duisburg-Essen

Local Organizer and Contact:

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Managing Director CENIDE

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11.03.15

[CENIDE Nanobiophotonics Symposium \(https://www.uni-due.de/cenide/nbp_symposium_2015\)](https://www.uni-due.de/cenide/nbp_symposium_2015)

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