



JOANNEUM RESEARCH

Technologies for PV

JOANNEUM
RESEARCH
MATERIALS



Paul Hartmann
2020-06-26

EPIC Online Technology Meeting
Photonics for Solar Energy Systems

Introduction: MATERIALS

Institute for Surface Technologies and Photonics

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- Director:
 - Paul Hartmann
- 5 Research Groups
~ 100 Employees
- 3 Locations in Austria
 - Weiz
 - Niklasdorf
 - Pinkafeld



**Hybrid Electronics
and Patterning**
Barbara Stadlober

**Light and Optical
Technologies**
Christian Sommer

**Laser and Plasma
Processing**
Wolfgang Waldhauser

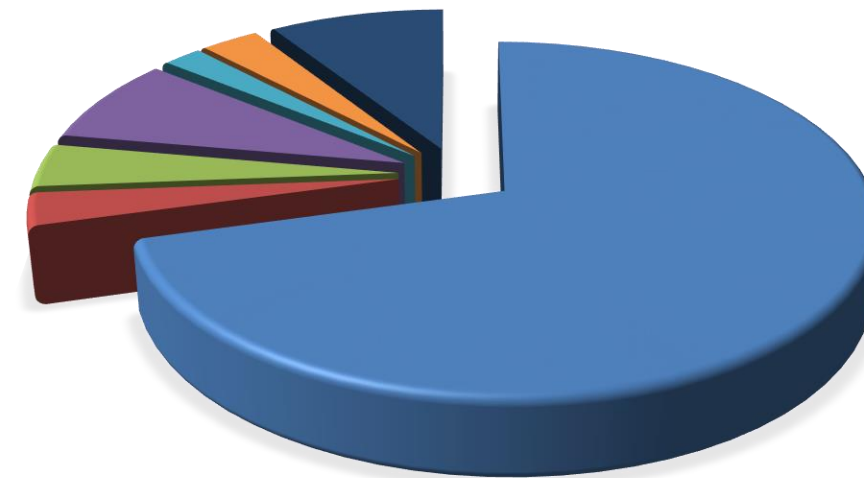
**Sensors and
Functional Printing**
Jan Hesse

Smart Connected Lighting
Franz-Peter Wenzl

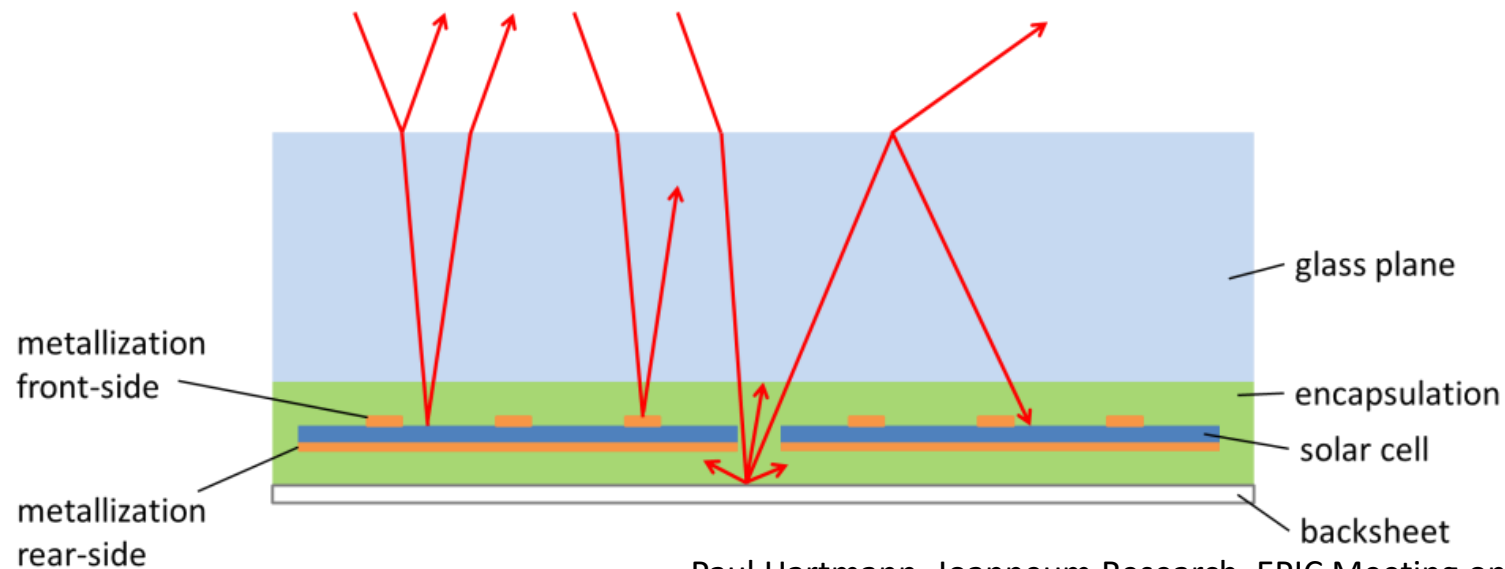
The problem: optical loss in standard PV modules



Aim:
Reduction of optical loss

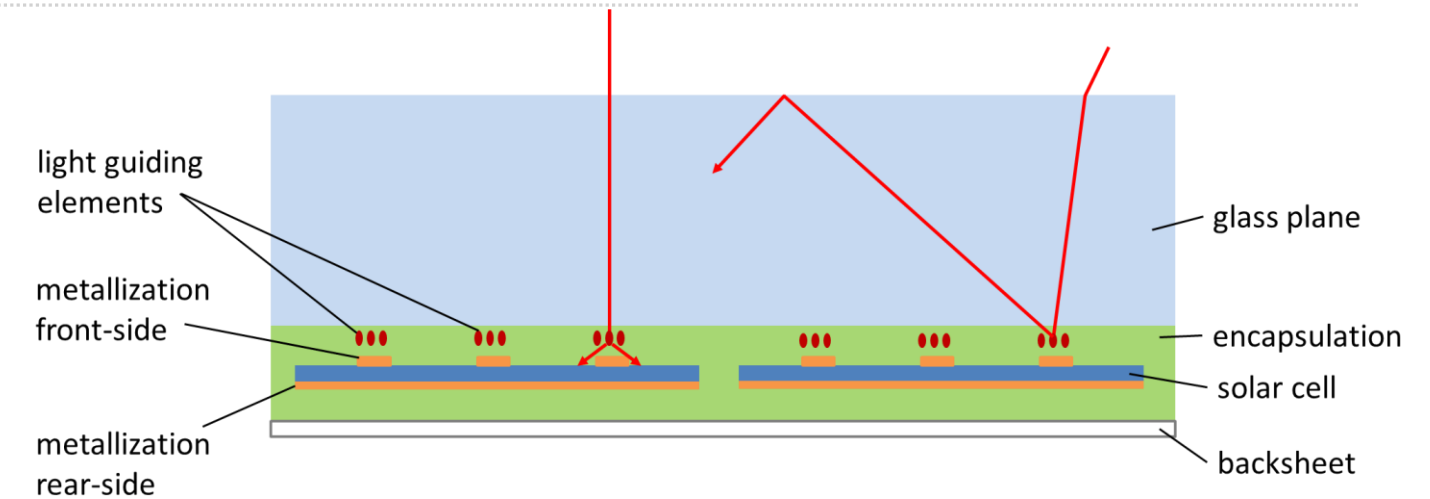
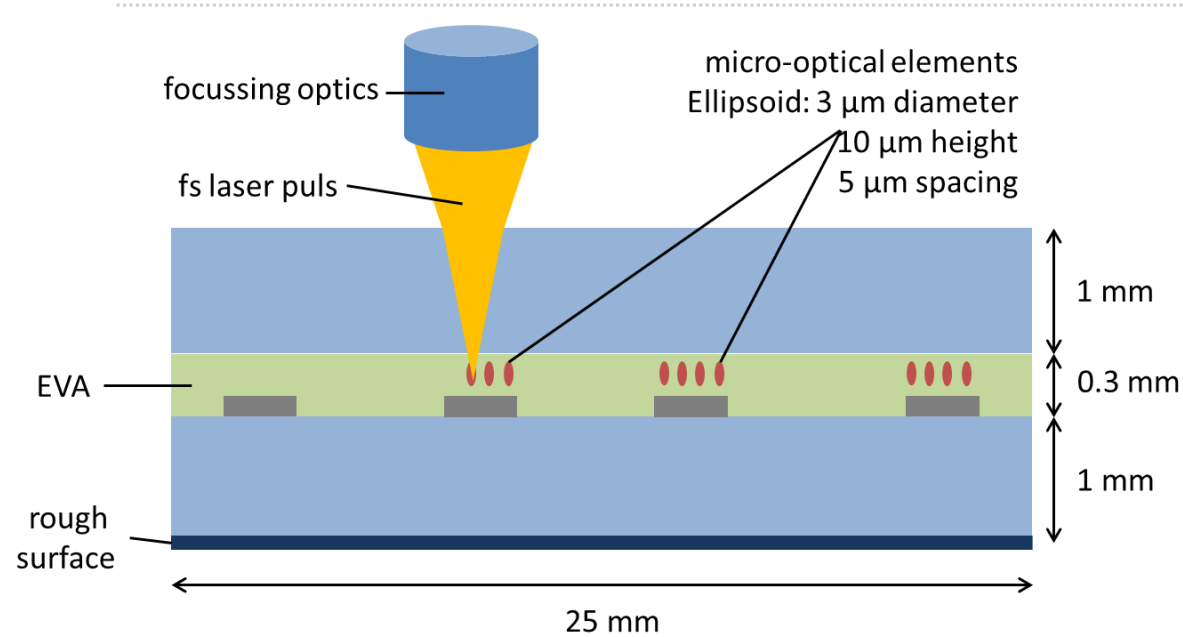


- absorbed by cell
- cell reflection
- glass reflection
- metallization
- gaps between cells
- corners (pseudosquares)
- frame



The solution #1: Light guiding elements on module level

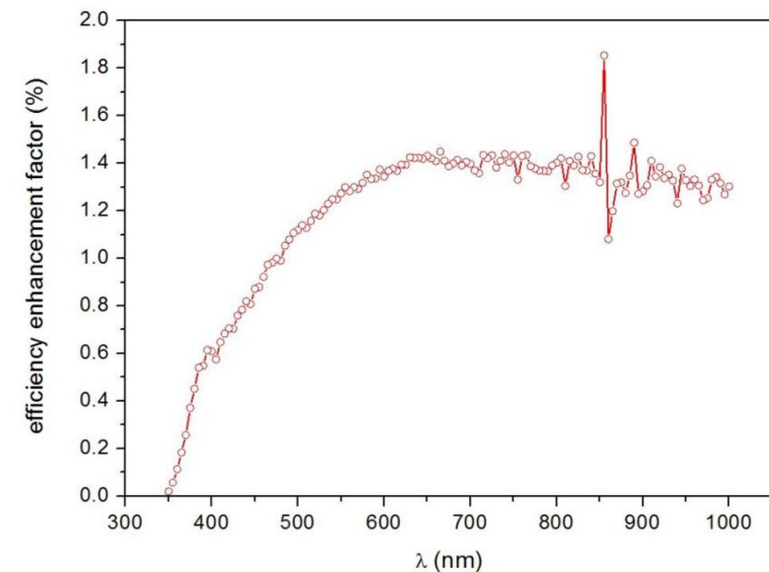
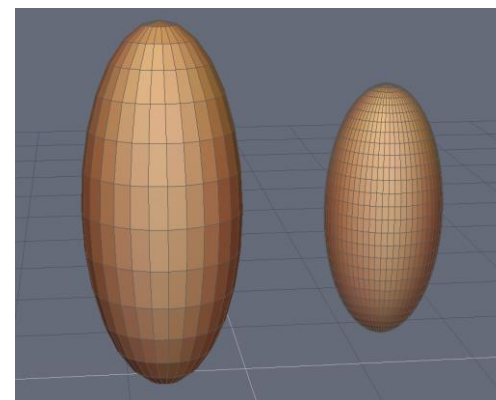
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Formation by laser scribing process

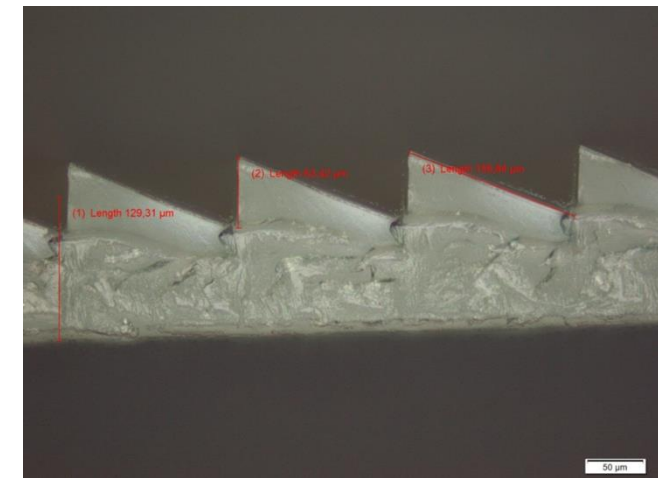
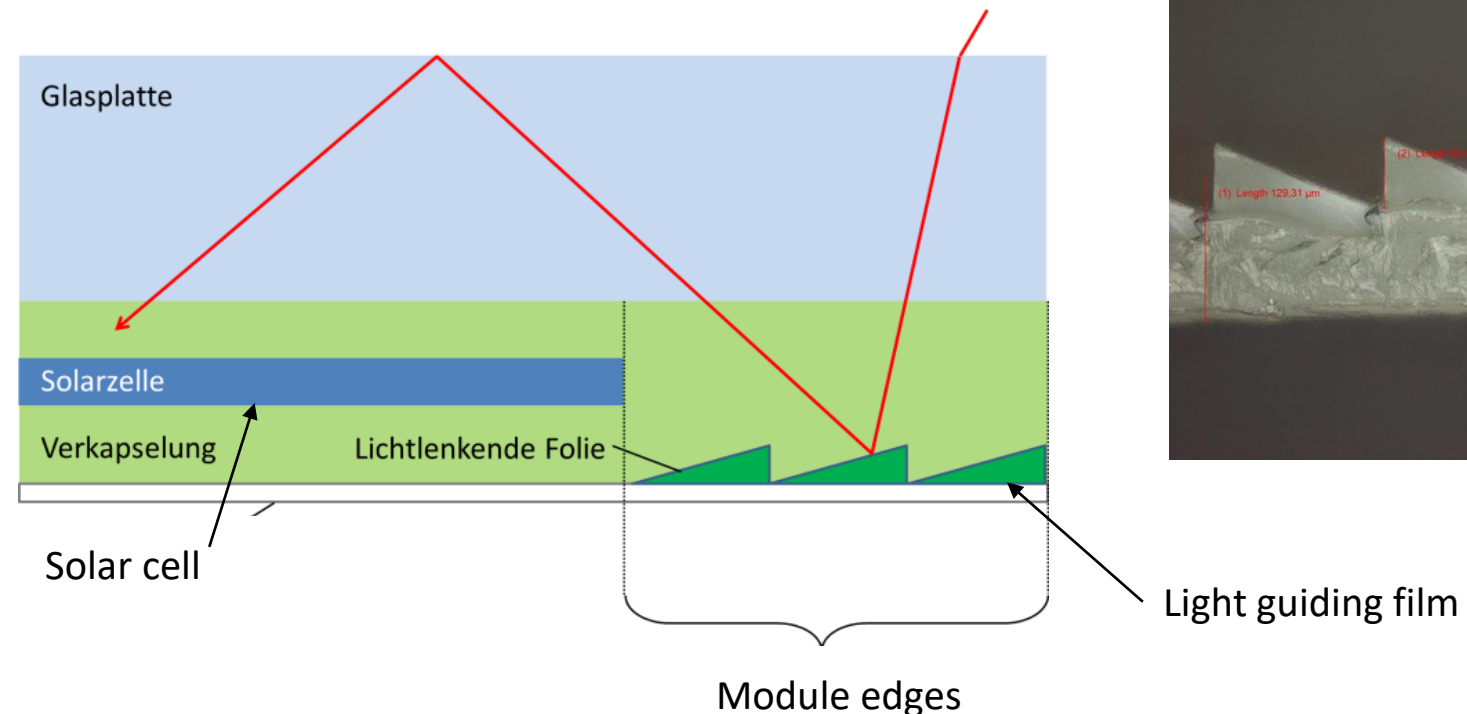
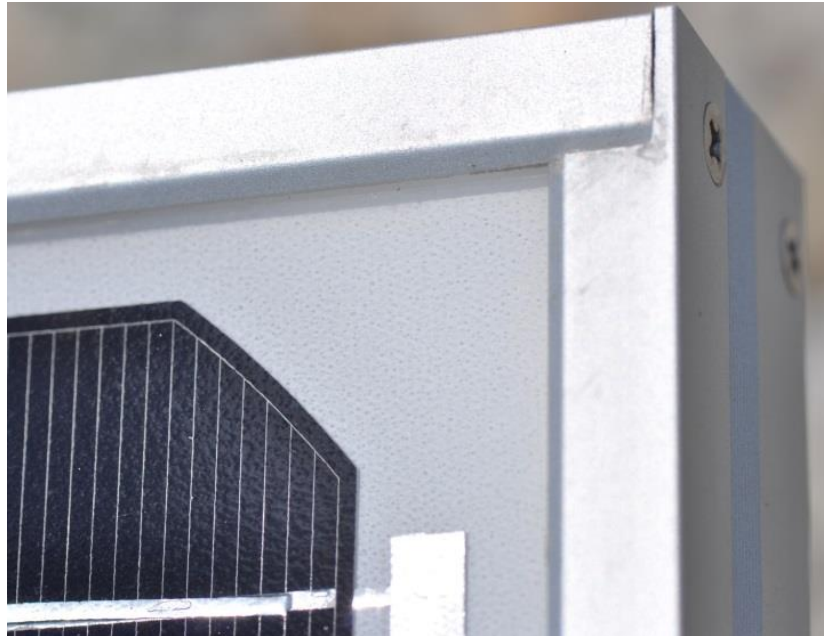
Ellipsoid shape:

- lateral dimension: 1-5 μm
- Axial dimension: 3-20 μm
- Depends on laser power and on scanning speed

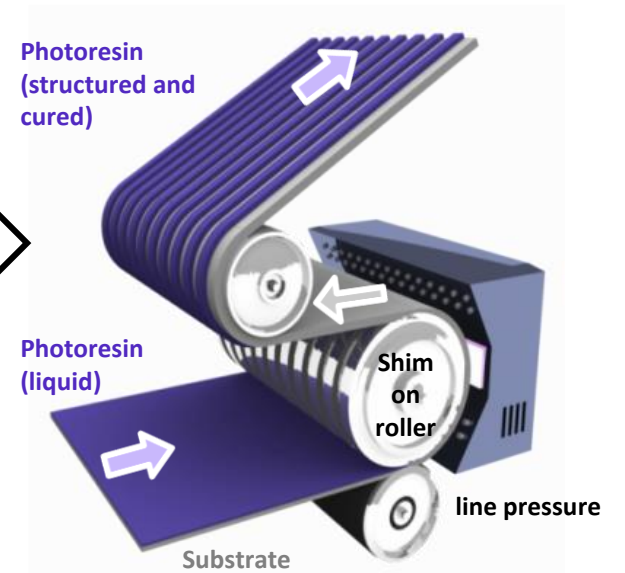
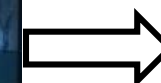
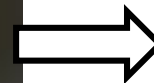
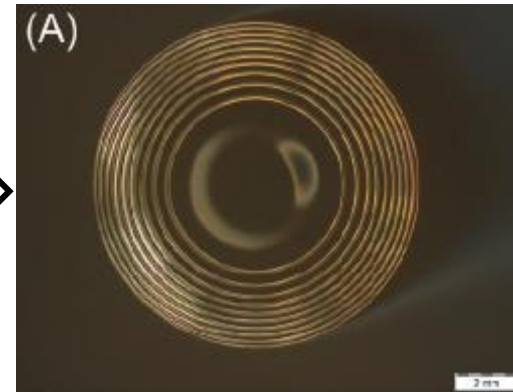
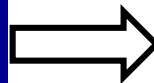
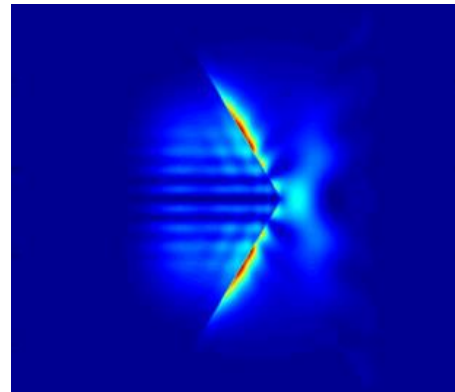


The solution #2: Light-guiding Films

- In particular at the edges of PV modules we have a more or less „dead“ area
- By the use of light-guiding films, the module area can be exploited effectively



Micro-optics with Roll-to-Roll UV-Nanoimprint-Lithography



Optical Simulation

Freeform Design

**Maskless Grey
Scale Laser
Lithography**

Mastering of stamp
structures

Step & Repeat

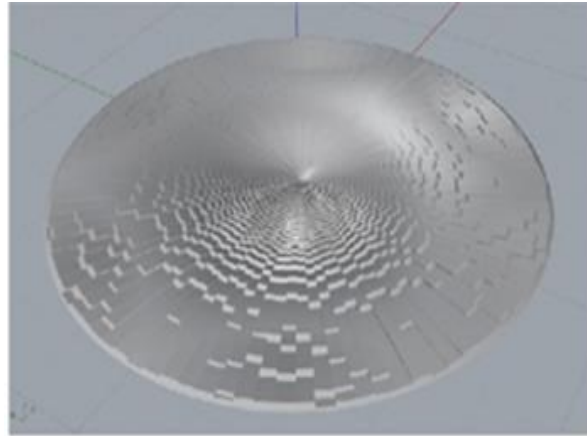
Seamless replication
of polymer shim

R2R-UV-NIL

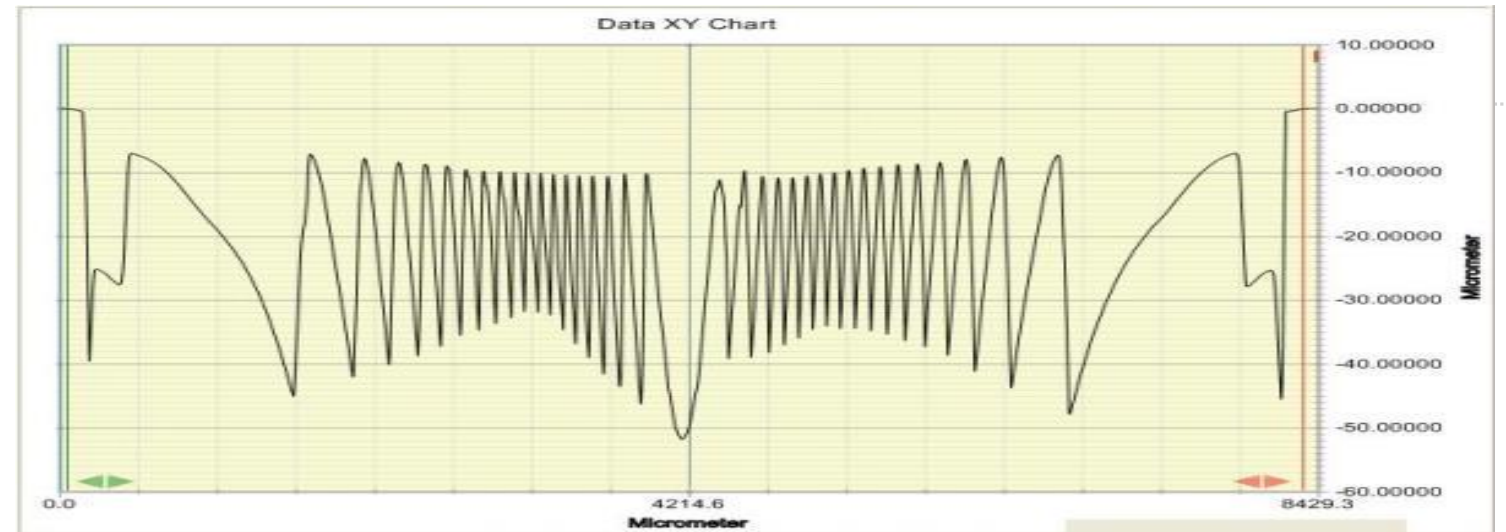
Production of Nano
and Microstructures
on Film

Mastering Process: Grey scale Lithography

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Simulation → CAD model



Mastering tool:

e.g.

Grey scale lithography

WL=375nm



min. feature size 200 nm

aspect ratio 1:4

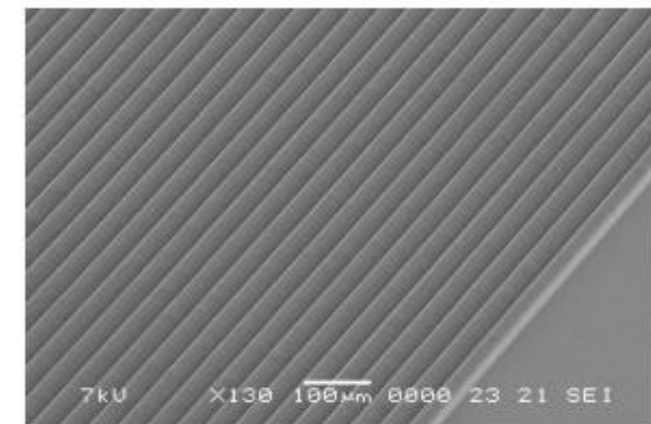
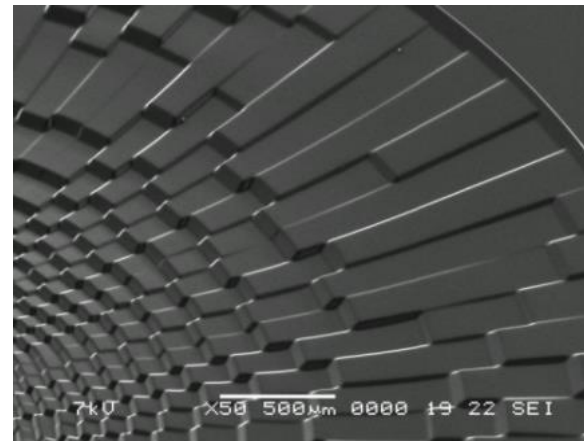


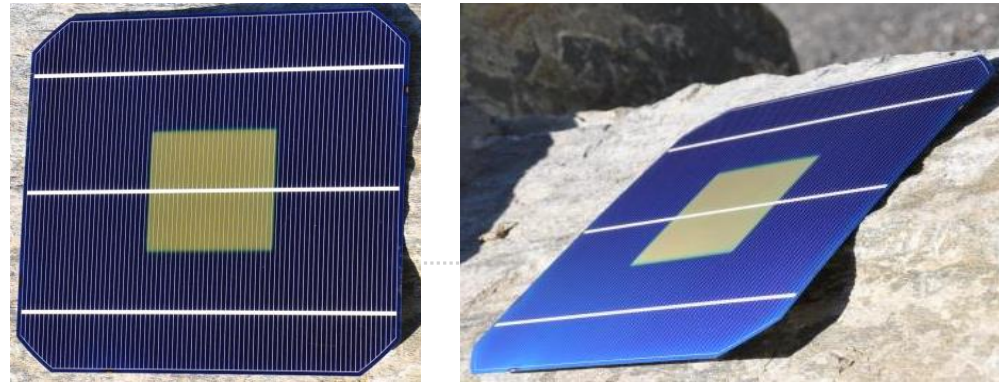
max. structure

height (Z) 60 μm

substrate size 6"

writing speed 1 cm^2/h



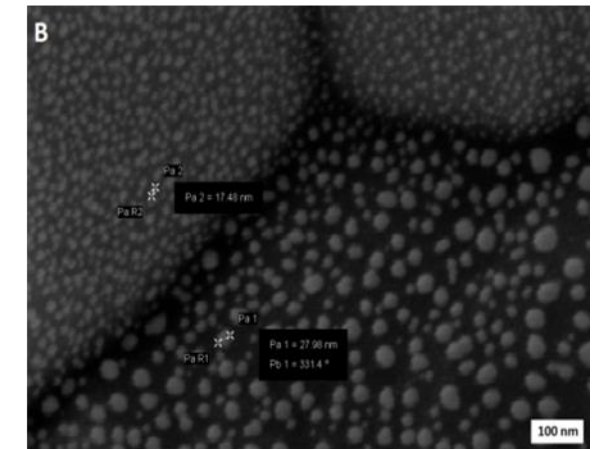
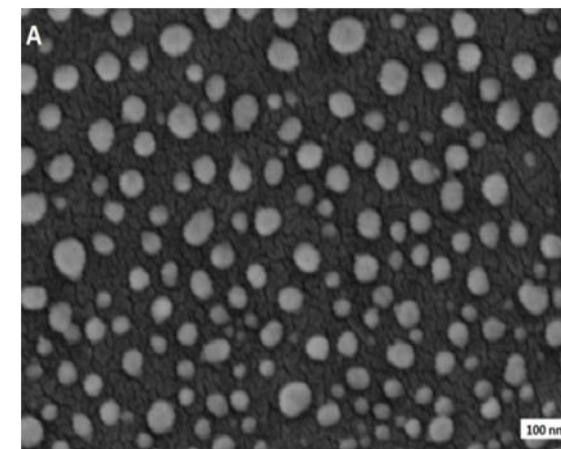


Coloring of industrial solar cells

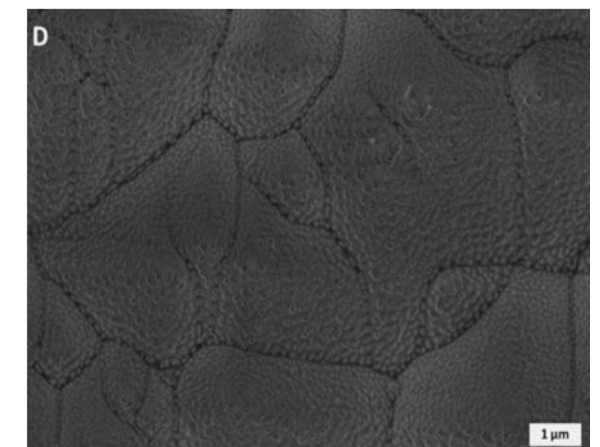
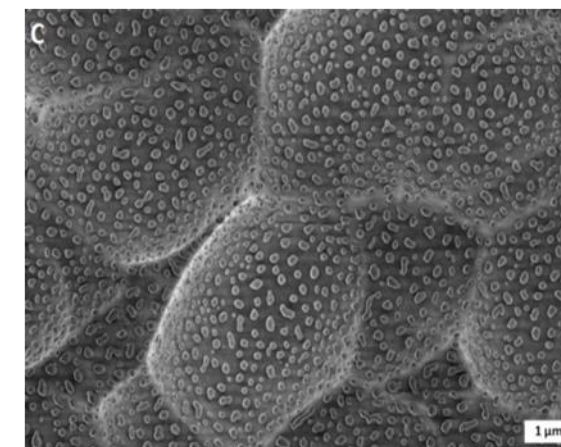
Ag nano-particles on c-Si solar cells

- The colour of industrial c-Si solar cells can be tuned by applying plasmonic effects (Ag nano-particles)
- The plasmonic colour does not depend on angle of observation
- Current losses
- V_{OC} or FF not significantly decreased
- Power loss due to coating → less than 10%
- Alternative plasmonic colors could be realized with other materials than Ag

40 seconds
Ag sputtering



120 seconds
Ag sputtering



Funding opportunities for our customers

	ACTPHAST4.0	FlexFunction2Sustain	Phabulous
	Photonics Innovation Hub	OITB	ICT pilot line
Technical focus	Photonics	Nano-functionalized plastic and paper surfaces	optical free-form microstructures
JR Expertise	Optical design and simulation, Laser based Lithography, Laser Ablation, R2R-UV-NIL, Step&Repeat UV-NIL, Laser and Plasma processing, AFM characterization and White Light Interferometry, Photocurable polymers and inks, biodegradable polymers		
Offered services	Funded innovation projects in Photonics	Materials development, production and testing	Prototype and product development, production processes
Size of project	< €100.000	< €100.000	<€150.000
Homepage	www.actphast.eu		https://phabulous.eu/

Thank you for your attention

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