



2nd Symposium on Innovation, cooperation in technology
and international transfer of technology

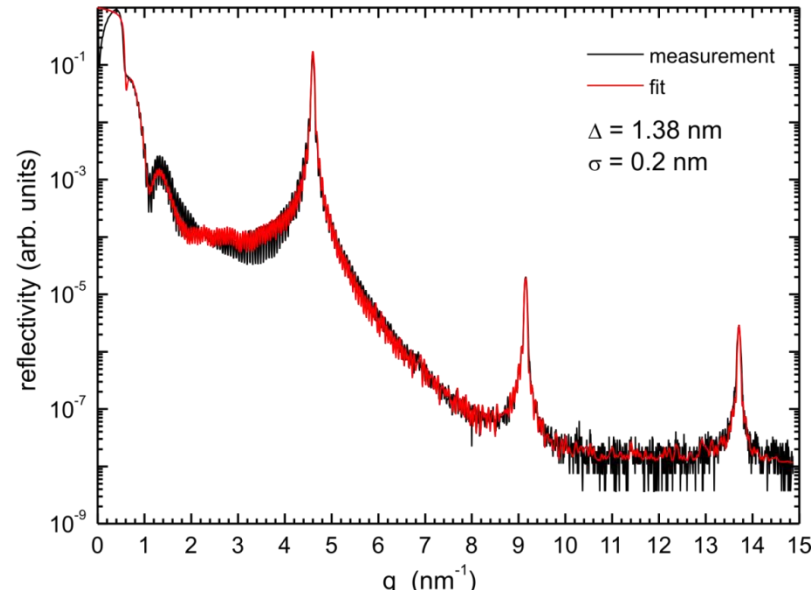
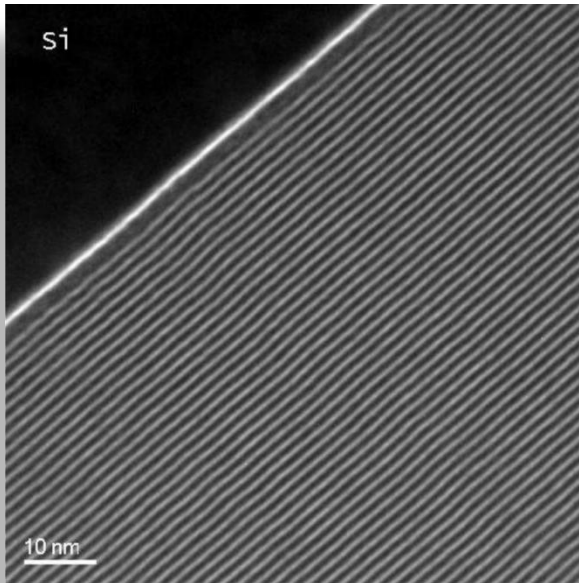
APPLIED RESEARCH OF MULTILAYERS AND NANOPARTICLES

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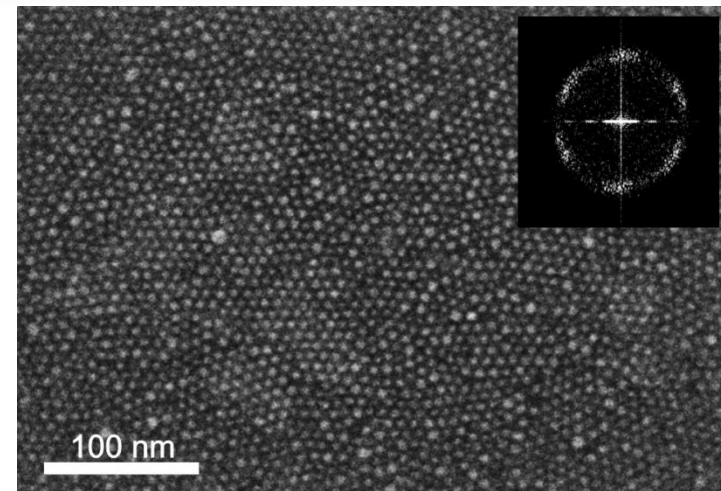
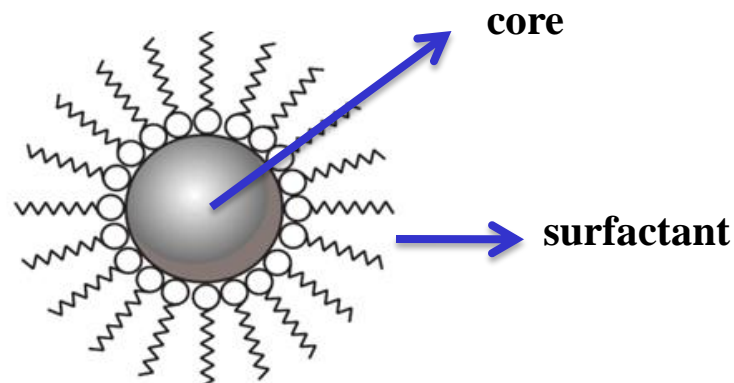
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- **Introduction into Multilayers and Nanoparticles**
 - **Innovations harvested from the applied research**
 - **Summary**
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Applied Research of Multilayers and Nanoparticles



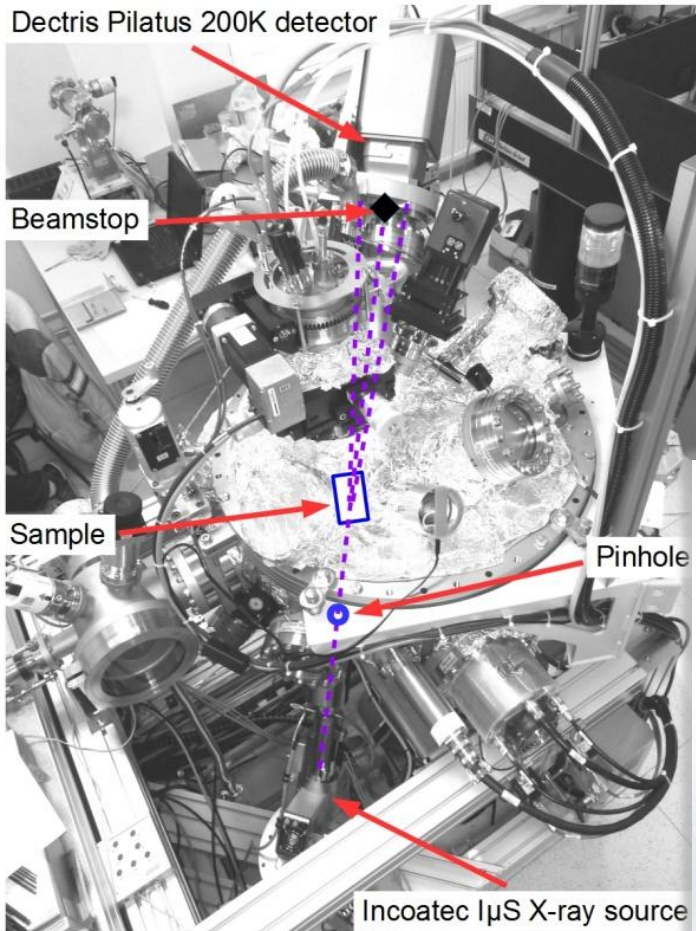
P. Siffalovic et al., in *X-Ray Scattering*, C. M. Bauwens, Ed. (Nova Science Publishers, New York, 2011).

**Nanoparticles - metal or oxide core
organic envelope (oleic-acid, oleylamin)**

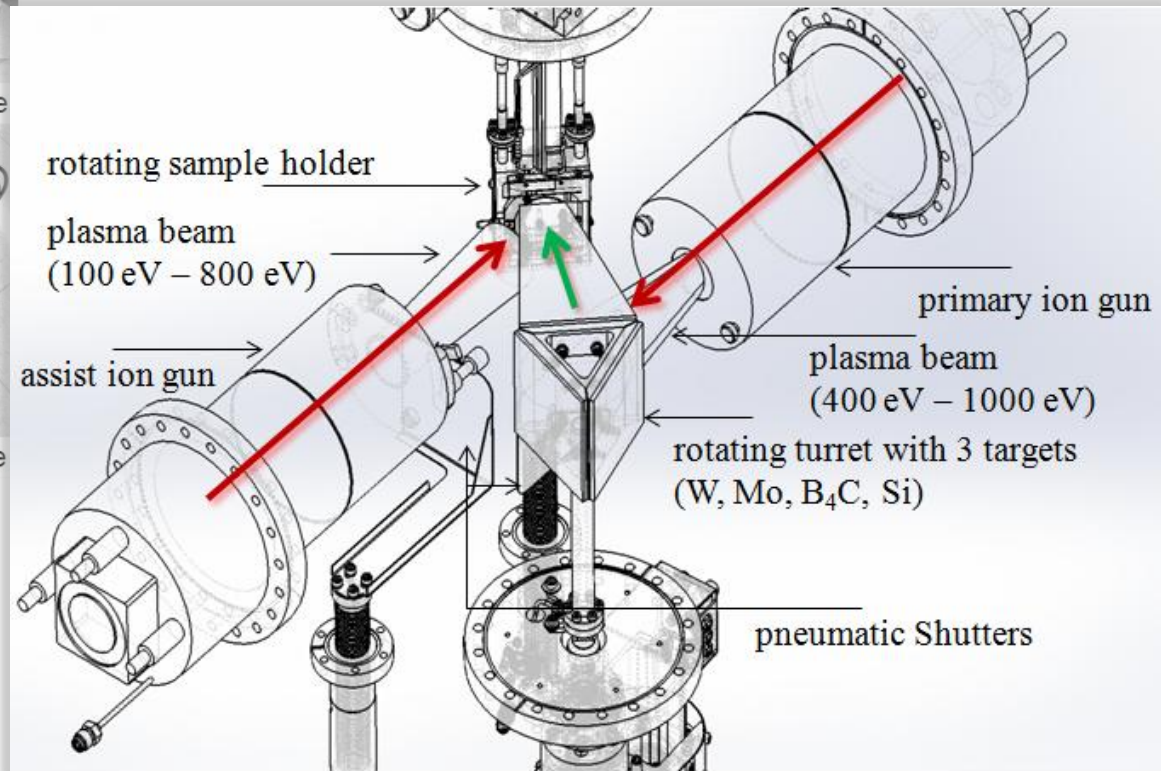


P. Siffalovic et al., in *Smart Nanoparticles Technology*, A. Hashim, Ed. (INTECH, Rijeka, 2012).

Advanced X-ray Optics and Nanoscale Metrology



Fabrication of dedicated EUV and hard X-ray mirrors for research facilities

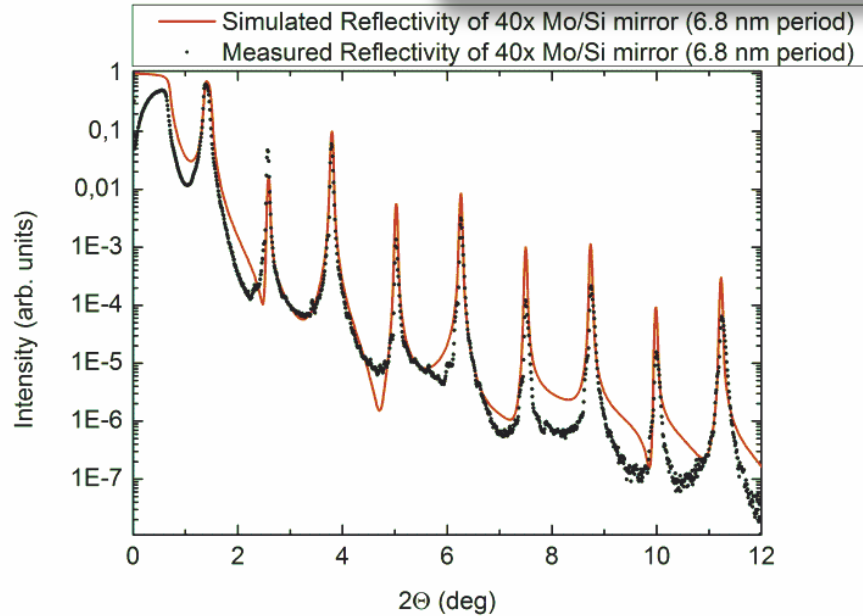


Parameters of sputtering:

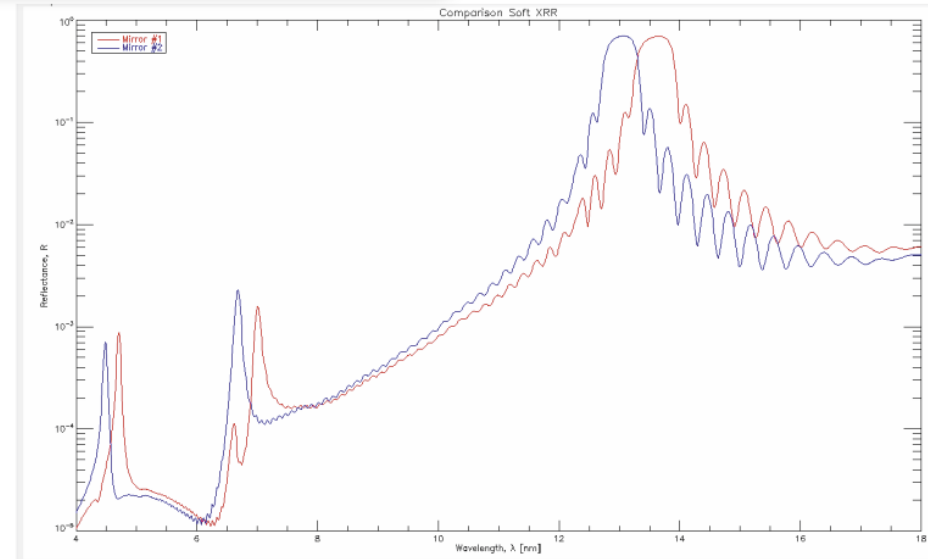
- vacuum base pressure 2×10^{-8} mbar
- working pressure 4×10^{-4} mbar
- total current density 1.83 mA/cm^2
- sputtering rates 0.014 nm/s for W
 0.005 nm/s for B₄C

Advanced X-ray Optics and Nanoscale Metrology

Fabrication of dedicated EUV and hard X-ray mirrors for research facilities

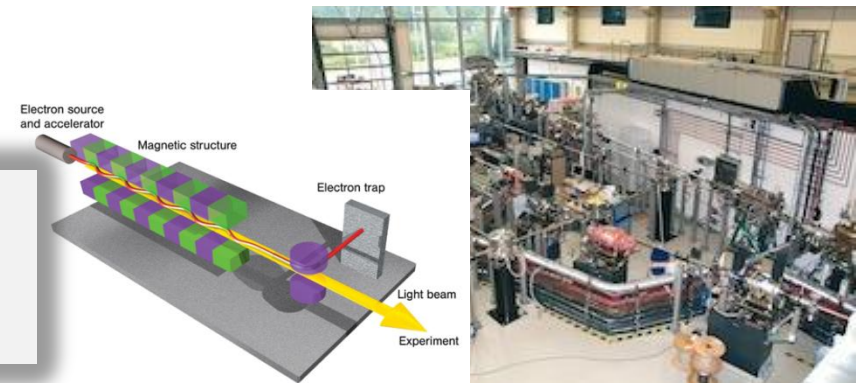


Comparison of the measured and simulated reflectivity of the 40x Mo/Si multilayer mirror of 6.9 nm period.



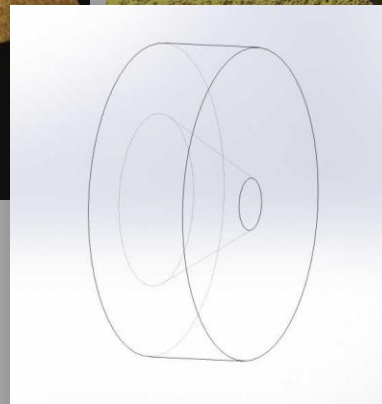
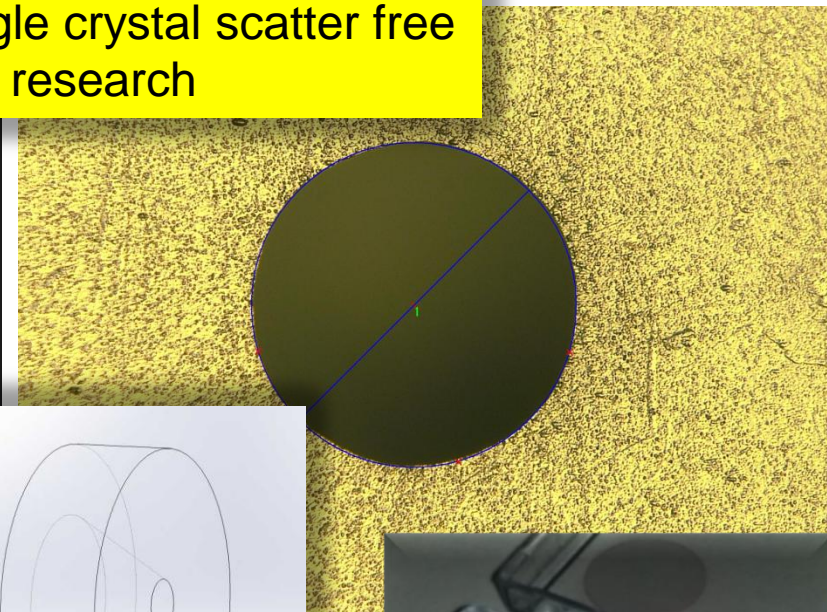
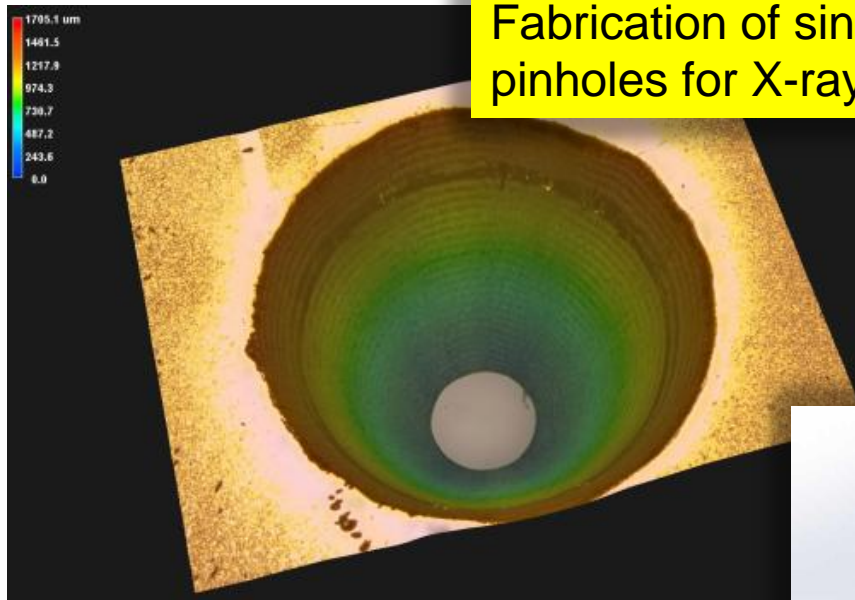
Comparison between two simulated soft X-ray Mo/Si mirrors with small differences in the period thicknesses (6.75 nm and 7.05 nm respectively).

X-ray mirrors developed and delivered to Free-electron laser facility in Hamburg, Germany



Advanced X-ray Optics and Nanoscale Metrology

Fabrication of single crystal scatter free pinholes for X-ray research



Fabrication method:

- masking of Ge using washable polymers
- UV nanosecond laser ablation
- Ultrasound cleaning
- Two step chemical SSD removal
 - pre-etch in isotropic etchant ($\text{HF}:\text{HNO}_3:\text{H}_2\text{O}$)
 - final etch in anisotropic etchant ($\text{HCl}:\text{H}_2\text{O}_2:\text{H}_2\text{O}$)

Advantages over ion-beam processing:

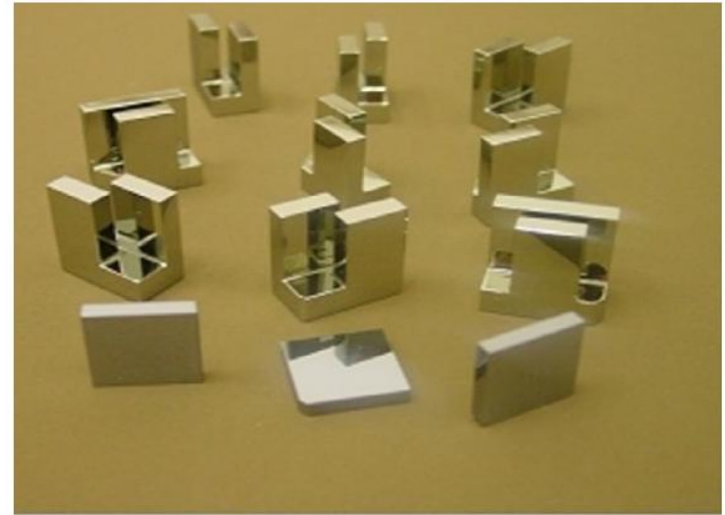
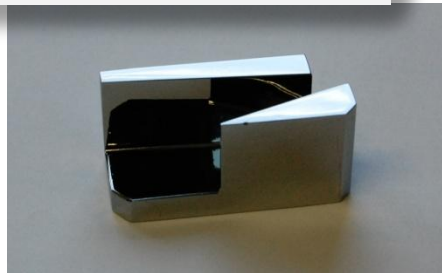
- no vacuum
- ability to scale-up the production
- cost-effective solution

Customers:

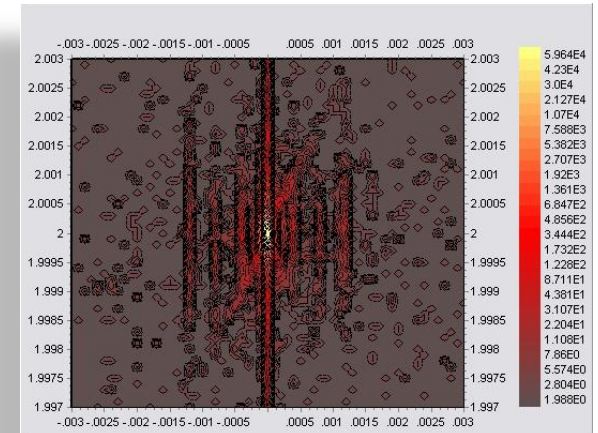
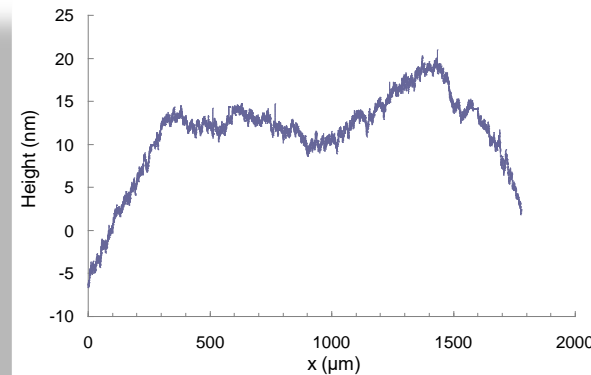
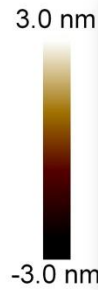
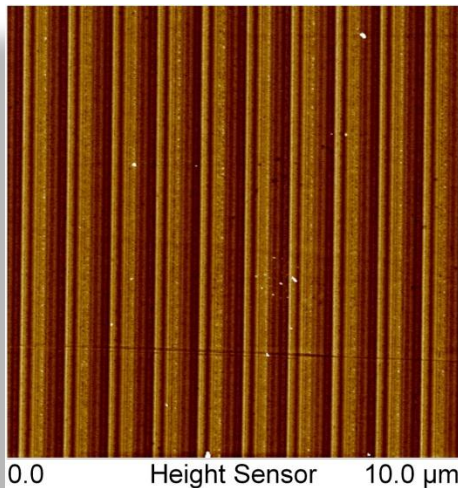
- University Leoben, Austria
- NSRRC, Hsinchu, Taiwan
- Institute of Physics and Material Science, Vienna

Advanced X-ray Optics and Nanoscale Metrology

Application of single point diamond turning technology (SPDT) technology for cutting-edge X-ray optics



- Single-bounce FzSi (100) and (111) reference crystals
- Symmetrical two-bounce Ge(220)/(440) monochromators
- Three-bounce Ge(220) analysers



a) surface roughness - by AFM. b) surface height profiles - better flatness in SPDT. c) RSM showing grating truncation rods - surface texture seen by AFM.



Integra TDS, s.r.o.

Network of Applied Research of Diffractive X-ray Optics

Direct impact: delivery of new improved optics to world known companies.



Integra TDS, s.r.o.

Wednesday, 31 July 2013

MAIN MENU

- ▶ ABOUT COMPANY
- ▶ PRODUCTS
- ▶ GALLERY
- ▶ PROJECTS
- ▶ CONTACTS
- ▶ VOLNÉ MIESTA

About company

Website under construction

Integra TDS, s.r.o. is a small company specialized in precise crystallographically oriented shaping of crystals, mainly germanium and silicon. As a kind of spin-off from academic research milieu its team started with preparation of monochromators for X-ray diffractometry in 1997. In its present legal form it acts since 2005. In addition to a big industrial player in the field of X-ray diffractometers its customers are research, university, and synchrotron laboratories.

Through its staff it has a number of collaborations and has been involved in numerous national and international research projects. It has expertise in various specialized X-ray optics not only for diffractometry, but also for other fields of laboratory and synchrotron X-ray techniques and technology, including

- HRXRD
- reflectometry
- SAXS, GISAX
- X-ray imaging
- low background sample supports.

The European X-Ray Laser Project XFEL (Hamburg, DE)



BRATISLAVA
SAV
SLOVAKIA

INSTITUTE OF PHYSICS
Slovak Academy of Sciences



European Synchrotron Research Facility ESRF(Grenoble, FR)



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Interimistic Head

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Room: 208

Themes : in-situ X-ray scattering on micro- and nano-scaled materials, structure and mechanical properties of thin films, structure-property relationship in biological materials, application of synchrotron radiation

Methods : XRD, SAXS, WAXS, GISAXS



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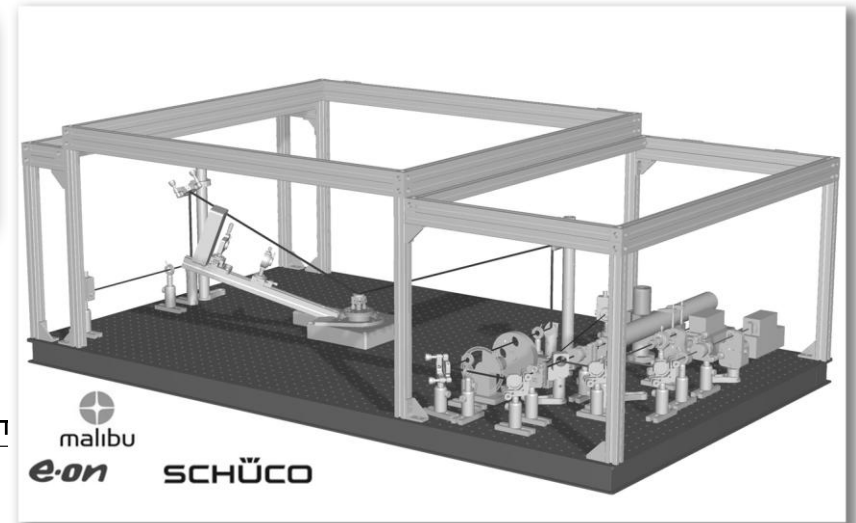
Process Engineering

Mechanical Processes are one main field of activity. Many metals are processed by rolling, bending or deep drawing operations. We analyse this class of problems through finite element computations. Frequently these computations are highly nonlinear, incorporating effects as contact, friction, wear, large displacements, finite strains and/or instabilities.

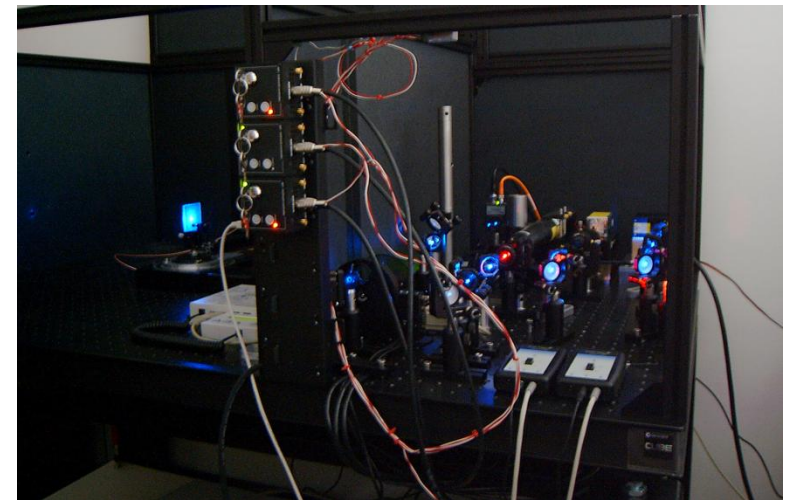
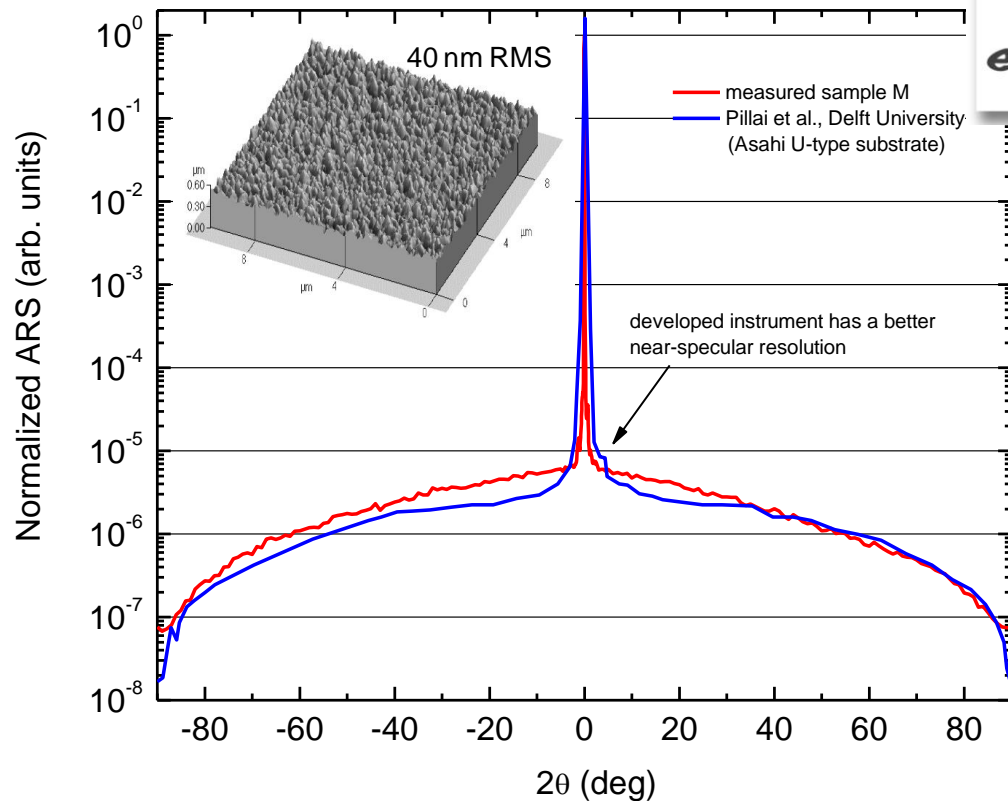
SolutionDEPL LAGS_C
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Surface Metrology for Solar Cell R&D

Triple-laser Scatterometer developed for thin film Si solar cell research (delivered to Malibu GmbH)



Transmission setup - comparison



Quantum dots for applied lighting research

Innovations driven research of advanced solid state lighting solutions



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Cost effective combination of remote phosphor and quantum dots allows fabrication of high quality (CRI 90+) LED luminaries

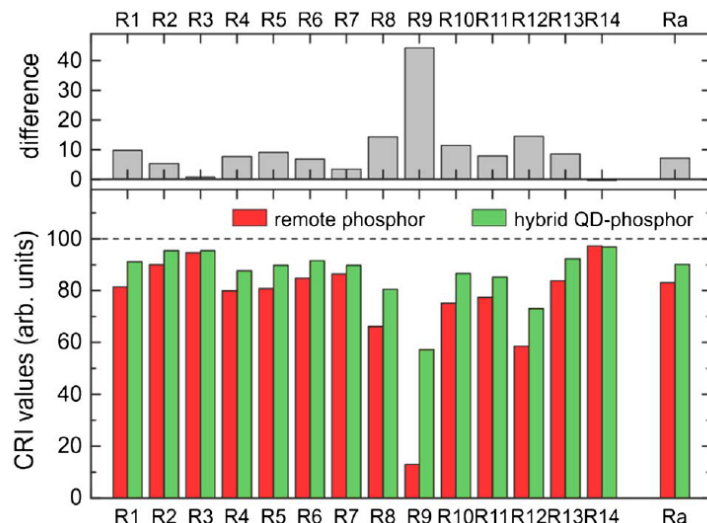
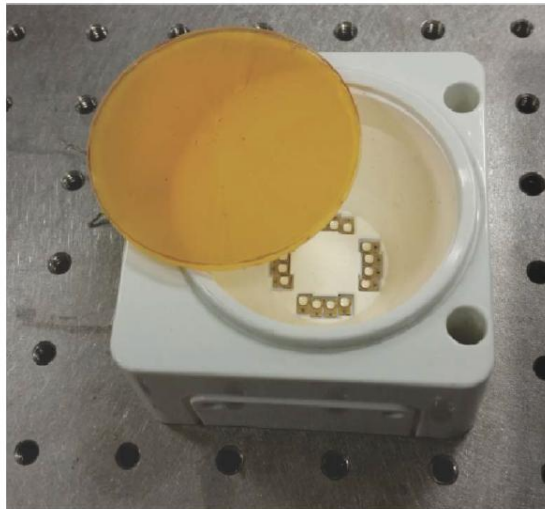
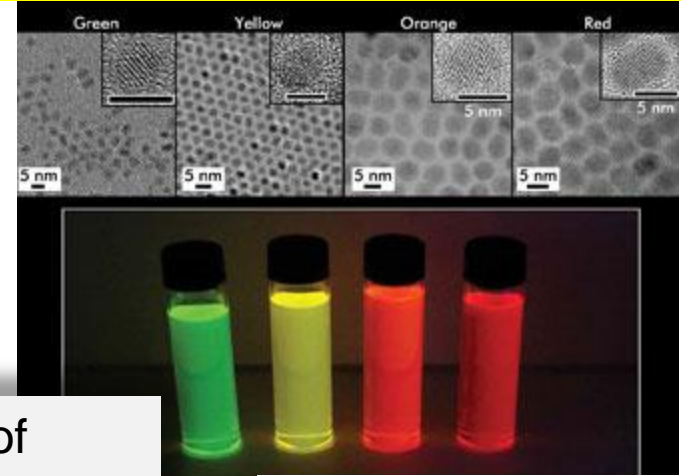


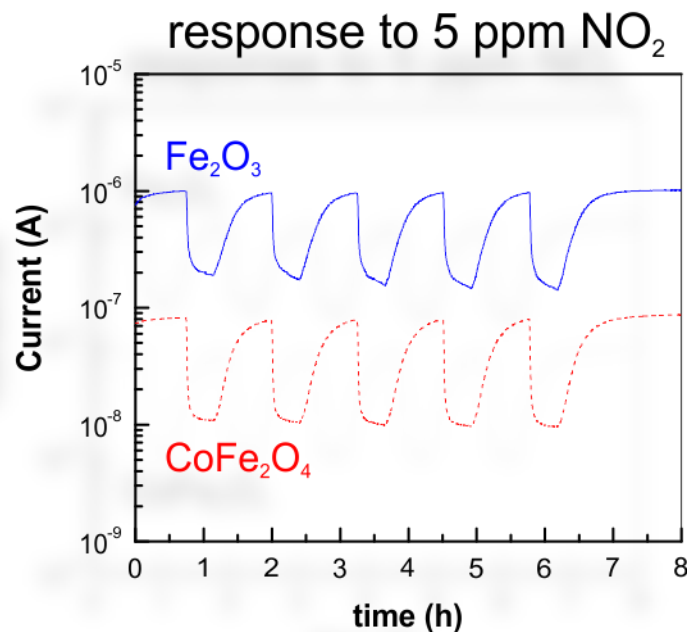
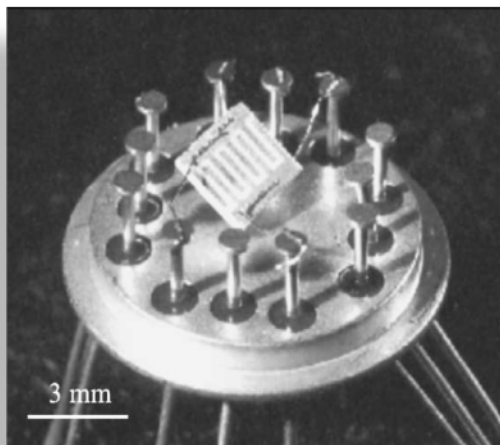
Fig. 5. Calculated CRI values for remote phosphor and hybrid QD phosphor. Top chart shows the absolute differences of CRI values.



Thin layer of low-cadmium ZnCdSe alloyed quantum dots deposited onto a commercial remote phosphor module Fortimo LED manufactured by Philips that offers a cost-effective LED solution with 90+ color-rendering index. For details, see Siffalovic *et al.*, pp. 7094-7098.

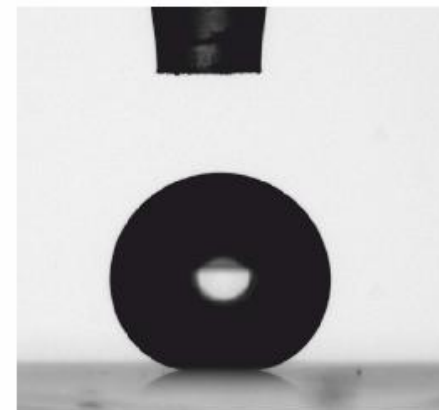
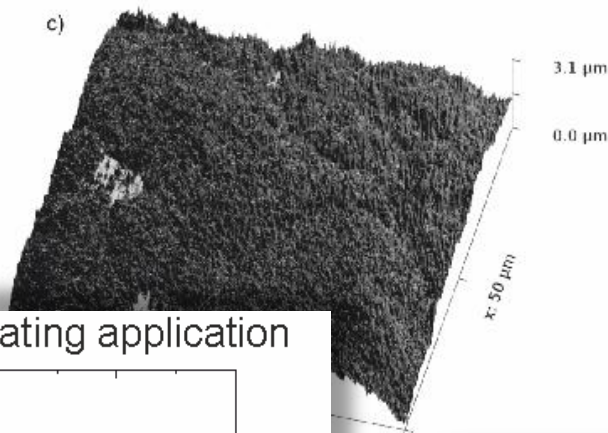
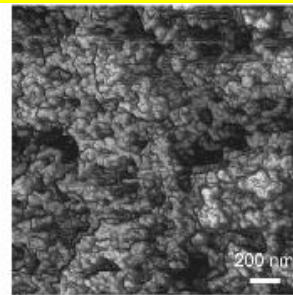
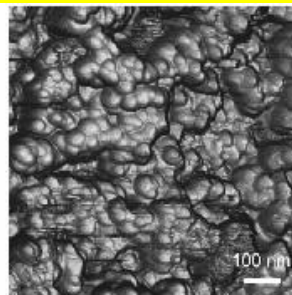
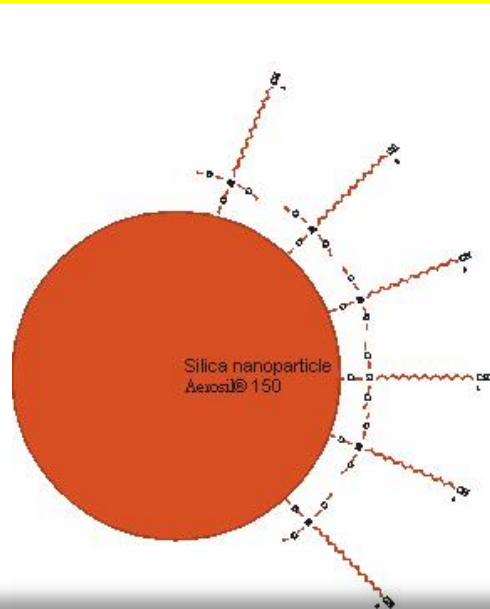
Metal oxide nanoparticles as sensors for explosives

LS deposited nanoparticle multilayers for gas sensing

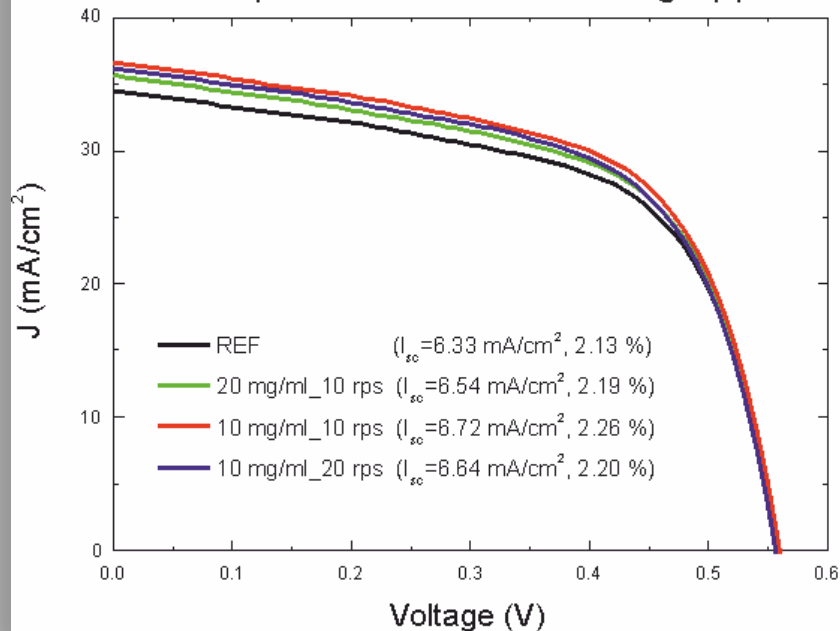


Application of the conductive layers composed of metal oxide nanoparticles can be exemplified on the latest generation of the Fe-O nanoparticle-based gas sensors like SO₂, NOX, CO, O₃ and CH₄. The NO₂ sensors are of primary importance for public security as they detect trace amounts of the explosives like EGDN, TNT, PETN, RDX, etc.

Superhydrophobic Smart Layers for Thin Film Solar Cells



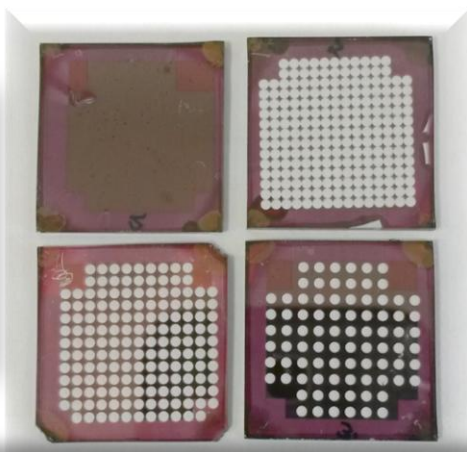
6% PCE improvement after coating application



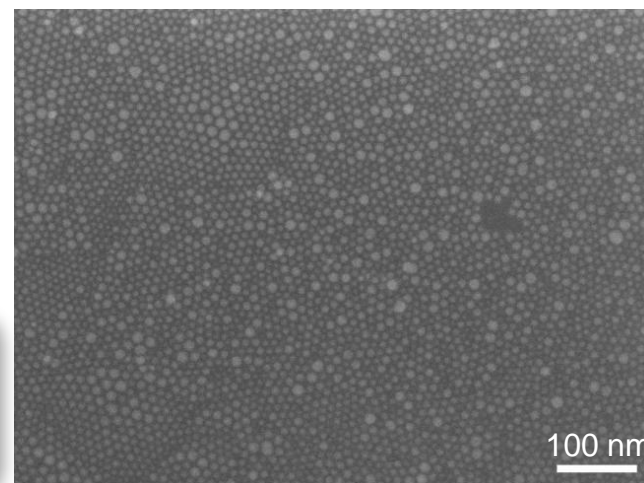
Nanoparticle Smart Layers:

- prolong the maintenance interval
- increase the power conversion efficiency

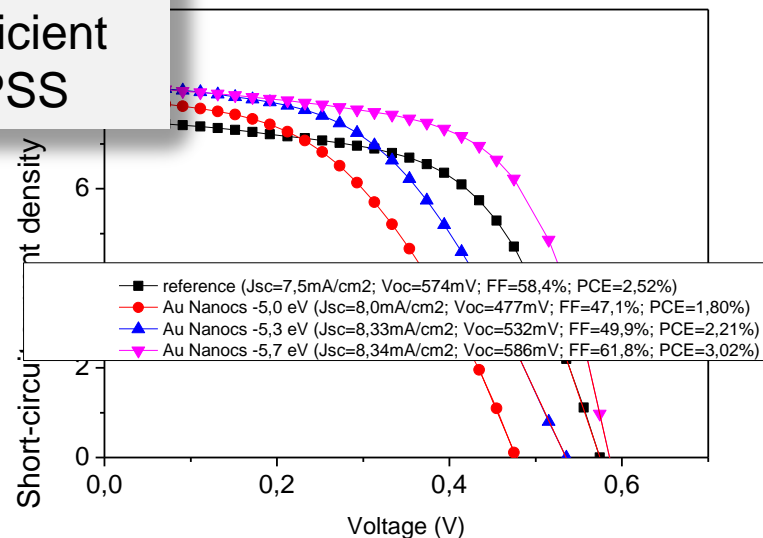
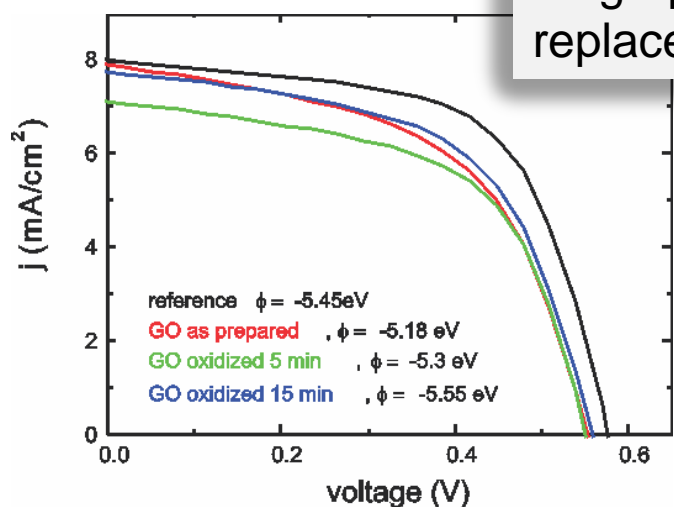
Plasmonic Nanoparticles Imbedded Into Semi-transparent OSC



plasmonic and semitransparent polymer solar cells



new hole transport layer based on graphene oxide as efficient replacement of PEDOT:PSS



The Department of Multilayers and Nanostructures is active in the following fields of applied research

- Self-assembled nanoparticle layers for sustainable future technologies including gas sensors, solar cells, solid state lighting, construction materials ...
 - Innovative reflective and diffractive X-ray optics for research facilities and industry
-

Thank you for your attention

- **PhD positions available in our research group in Bratislava**

