# Group of Thin Layers

*Department of New Technologies*

ISI CAS Institute of Scientific Instruments The Czech Academy of Sciences


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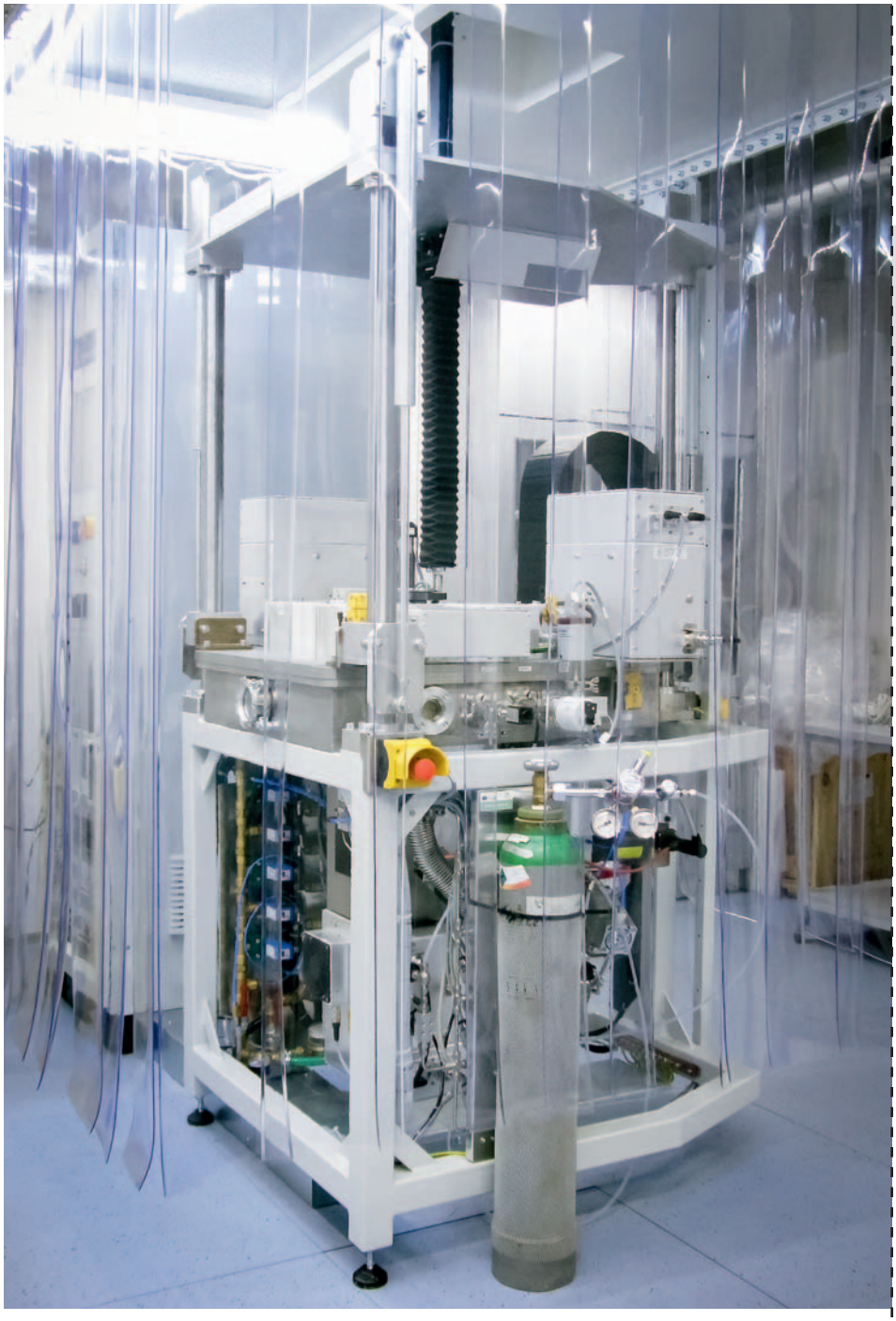


*Computer controlled magnetron sputtering system Aurion*

## THEMATIC RESEARCH FOCUS

**Research area**

Deposition of thin films by magnetron sputtering and their dynamic impact testing

*Aurion chamber*

### Excellence
- Multilayer x-ray and EUV optics
- Precise Au/Fe/Au nanostructures as a tool to magnetic field sensing
- Self-organized growth of nanocrystals
- Dynamic impact testing of thin films

### Mission
Search for new practical application of well – handled technologies, e.g. deposition of x-ray and EUV optics, in particular in new brand of industry (space research), development of unique instruments, and last but not least, the technological support of existing teams on this institute.

## UP-TO-DATE ACTIVITIES

### Research orientation & focus
- Creation and characterization of nanolayers used in soft x-ray lasers
- Deposition of precise Au/Fe/Au nanostructures as a tool to magnetic field sensing
- Deposition of thermally stable nanostructured DLC coatings
- Coating technology of thin passivation and antireflection layers, production of crystalline solar cells
- Deposition of multilayer x-ray and EUV optics
- Dynamic impact testing of thin films

### Main capabilities
**Basic research**
- Study of self-organized growth of nanocrystals
- Study of structures intended as magnetic field sensors
- Study of mechanisms of dynamic impact wear of films / substrate systems

**Applied research**
- New types and features of the multilayer x-ray and EUV optics
- Electrochemical sensors
- Solar cells
- Wear resistant coatings in automotive industry

### Fields of group activities
- Material science (study of coating/substrate system under dynamical load)
- Measuring instruments ( construction of impact testers and microfluidic apparatus)
- Renewable energy (Solar cells)
- Automotive industry (Wear resistant coatings in automotive industry)
- Optics (multilayer x-ray and EUV optics)

## KEY RESEARCH EQUIPMENT

### List of devices
- Computer controlled magnetron sputtering system Aurion equipped with two r.f. and one DC magnetrons 152 mm in diameter enabling development and production of the multilayer x-ray and EUV optics
- Magnetron sputtering system Leybold Heraeus - Z550 equipped with three r.f. magnetrons 152 mm in diameter enabling development and production of the wear resistant coatings
- Magnetron sputtering system equipped with one r.f. magnetron 76 mm in diameter enabling development and production of the electrochemical detectors
- Confocal microscope Olympus 3100 (magnification max. 14.400x)

- Calotest - CSM Instruments
- Impact tester for evaluating impact resistance of coating/substrate system
- Disc polishing and grinding machine MTH kompakt 1031 + head APX010

## ACHIEVEMENTS

**Our group is one of a few laboratories in Europe capable to produce multilayered systems with an exactly defined individual layer thickness, which can be used for x-ray or EUV optics. The repeatability of the bilayer thickness of the Mo/Si multilayer is better than 0,1 nm. We master also deposition of x-ray or EUV optic elements composed of different materials, such as Sc/Si, Ni/C or C/Si with the same repeatability.**

- V. V. Protopov, J. Sobota: *"X-ray dark-field refraction-contrast imaging of micro-objects",* OPTICS COMMUNICATIONS **213**, 4–6, 267–279
- K. Koláček, J. Štraus, J. Schmidt, O. Frolov, V. Prukner, A. Shukurov, V. Holy, J. Sobota, T. Fort : *"Nano-structuring of solid surface by extreme ultraviolet Ar8+ laser",* LASER AND PARTICLE BEAMS **30,** 1, 57–63
- K. Jakubczak, T. Mocek, B. Rus, J. Polan, J. Hřebíček, M. Sasická, P. Sikocinski, J. Sobota, T. Fořt, L. Pina: *"Beam properties of fully optimized, table-top, coherent source at 30 nm",* OPTO-ELECTRONICS REVIEW **19**, 2, 169–175
- J. Krčmář, V. Holý, L. Horák, TH. Metzger, J. Sobota: *"Standing-wave effects in grazing-incidence x-ray diffraction from polycrystalline multilayers",* JOURNAL OF APPLIED PHYSICS **103**, 3

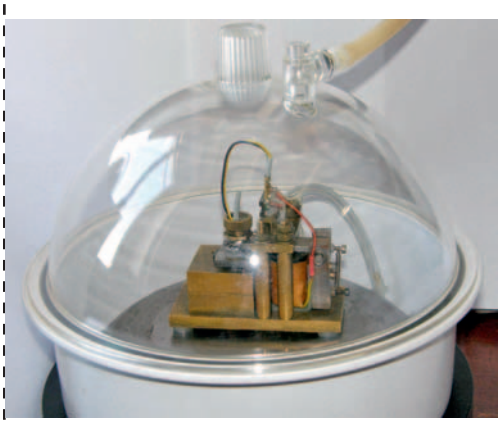
**Our group is one of a few laboratories in Europe capable to evaluate impact resistance of coating-substrate system using impact tester developed in our laboratory in collaboration with Brno University of Technology.**

- J. Sobota, J. Grossman, V. Bursiková, L. Dupák, J. Vyskočil: *"Evaluation of hardness, tribological behaviour and impact load of carbon-based hard composite coatings exposed to the influence of humidity"*, DIAMOND AND RELATED MATERIALS **20**, 4, 596–599
- T. Fořt, T. Vitu, R. Novák, J. Grossman, J. Sobota, J. Vyskočil: *„Testing of the impact load and tribological behaviour of w-c:h hard composite coatings",* CHEMICKE LISTY **105,** Special Issue: SI Supplement: 2, 102-104

**Our group was one of a few laboratories discovering nanocomposite principle applied on thin films. We find possibility to use this principle in practical use and at present we participate in this field in industrially oriented research.**

- V. Vorlíček, P. Široký, J. Sobota, V. Peřina, V. Železný, J. Hrdina: *"C:N and C:N:O films: Preparation and properties",* DIAMOND AND RELATED MATERIALS **5,** 3–5, 570–574, 1996
- H. Jensen, J. Sobota, G. Sorensen: *"A study on film growth and tribological characterization of nanostructured C-N/TiNx multilayer coatings"*, SURFACE & COATINGS TECHNOLOGY **94–5**, 1–3, 174–178, 1997
- J. Sobota, G. Sorensen, H. Jensen, J. Kubena, V. Holý: *"Temperature stability of C-N/NbN nanocomposite multilayers",* DIAMOND AND RELATED MATERIALS **9**, 3–6, 587–591, 2000
- J. Sobota, Z. Bochníček, V. Holý: *"Friction and wear properties of C-N/MeNx nanolayer composites",* THIN SOLID FILMS **433**, 1–2, 155–159, 2003
- J. Sobota, J. Grossman, V. Bursiková, L. Dupák, J. Vyskočil: *"Evaluation of hardness, tribological behaviour and impact load of carbon-based hard composite coatings exposed to the influence of humidity",* DIAMOND AND RELATED MATERIALS **20**, 4, 596–599, 2011


*Cross section of the Si/C multilayer on silicon substrate*



*Impact tester in chamber with controlled atmosphere*

## MAIN COLLABORATING PARTNERS

### Collaboration with academic partners

- Masaryk University (Brno, CZ)
- Institute of Physics of Materials of the ASCR, v.v.i. (Brno, CZ)
- University of West Bohemia (Plzeň,CZ)
- Institute of Physics of the ASCR, v.v.i. (Praha, CZ)
- Institute of Photonics and Electronics (Praha, CZ)
- Czech Technical University in Praha (Praha, CZ)
- Charles University (Praha, CZ)
- Institute of Plasma Physics (Praha, CZ)
- Tomas Bata University (Zlín, CZ)
- PALS – Prague asterix laser system (Praha, CZ)
- The University of Sheffield (Sheffield, UK)
- Aristoteles University of Thessaloniki, (Thessaloniki, Greece)

### Collaboration with companies

- Solartec s.r.o. (Rožnov pod Radhošťem, CZ)
- HVM Plasma Ltd. (Praha, CZ)
- Rigaku Innovative Technologies Europe, s.r.o. (Praha, CZ)
- Czech Metrology Institute (Brno, CZ)
- VUHZ a.s. (Dobrá, CZ)
- Research and Testing Institute (Plzeň,CZ)

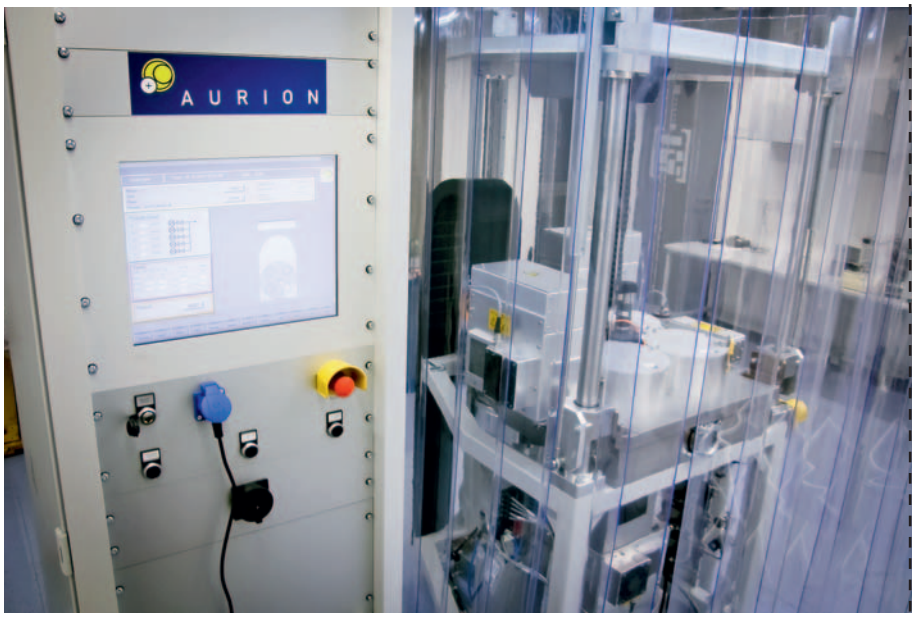
## EXPECTATIONS

### Offers

- We offer testing of functional properties of thin coating under dynamic load, development and deposition of new types and features of the multilayer x-ray and EUV optics, coatings used in photovoltaic solar cells, etc.
- Partnership in international projects

### Requirements

We look for cooperation with academic partners as well as companies in the fields of EUV and x-ray optics, photovoltaic solar cells, testing of thin films.

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