Group of Thin Layers

Department of Electron and Plasma Technologies

ISI CAS Institute of Scientific Instruments The Czech Academy of Sciences

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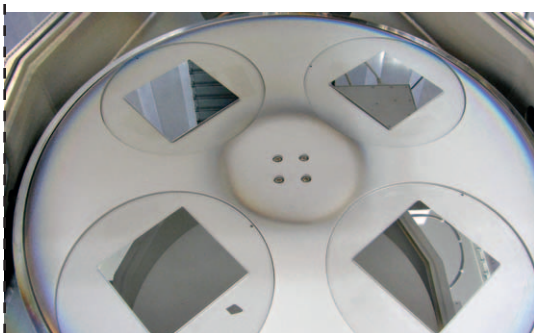
Computer controlled magnetron sputtering system Aurion

THEMATIC RESEARCH FOCUS

Research area

- Deposition of thin films by magnetron sputtering
- Dynamic impact testing of coated components and bulk materials

Aurion chamber



Excellence
- Multilayers for x-ray and EUV optics
- Precise nanostructures as a tool to magnetic field sensing, electrochemical sensors, and plasmonics
- Dynamic impact testing

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 instrumentation for testing of impact resistance of various materials. The technological support of other departments on the ISI CAS.

UP-TO-DATE ACTIVITIES

Research orientation & focus
- Sputtering and characterization of nanostructured layers used in soft x-ray lasers
- Deposition of precise nanostructures used in sensors
- Deposition of nanostructured coatings for plasmonics
- Deposition of multi-layered systems for x-ray and EUV optics
- Dynamic impact testing of coated systems and/or various bulk materials

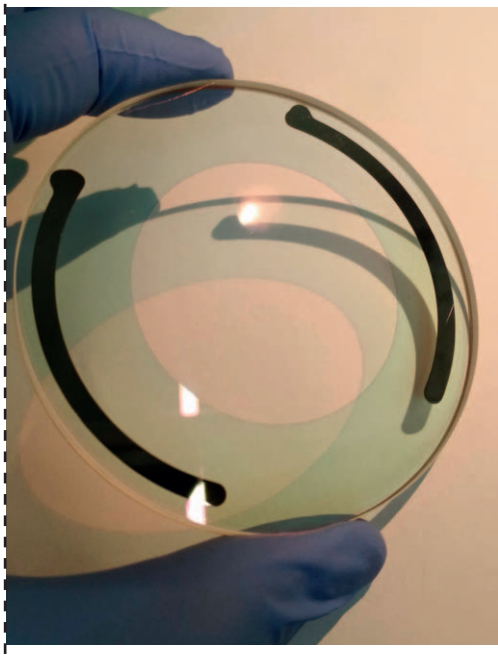
Main capabilities
Basic research
- Study of deposition of thin films, thin films growth, and optical properties of thin films
- Study of structures intended as various types of sensors
- Study of mechanisms of dynamic impact wear of materials

Applied research
- New types and features of the multi-layered systems for x-ray and EUV optics
- Wear resistant and impact resistant coatings used in mechanical engineering, automotive industry, defence industry, and power engineering
- Impact resistance and impact lifetime of industry used materials and 3D printed components

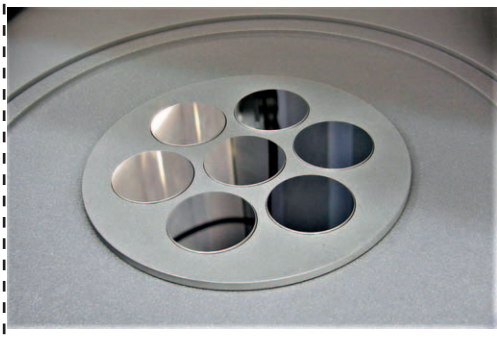
Fields of group activities
- Material science (study of coating/substrate system under dynamical load)
- Measuring instruments (construction of impact testers)
- Renewable energy (solar cells, testing of protective coatings used in boilers)
- Automotive industry and mechanical engineering (wear resistant and impact resistant coatings)
- Optics (multilayer x-ray and EUV optics)
- Co-organisation of Workshops on X-ray and EUV Optics and applications

KEY RESEARCH EQUIPMENT

List of devices
- Magnetron sputtering system Aurion equipped with two RF and one DC magnetrons (Ø 152 mm) enabling development and production of the multi-layered and nanostructured coatings (x-ray and EUV optics, magnetic field sensing)
- Magnetron sputtering system Leybold Heraeus – Z550 equipped with three RF magnetrons (Ø 152 mm) enabling development and production of the wear resistant coatings (e.g. DLC-based coatings)
- Magnetron sputtering system equipped with one RF magnetron (Ø 76 mm)
- 3D laser confocal microscope Keyence VK-X 1100
- Laser confocal microscope Olympus LEXT OLS-3100
- Calotest – CSM Instruments
- Disc polishing and grinding machine MTH kompakt 1031 + head APX010

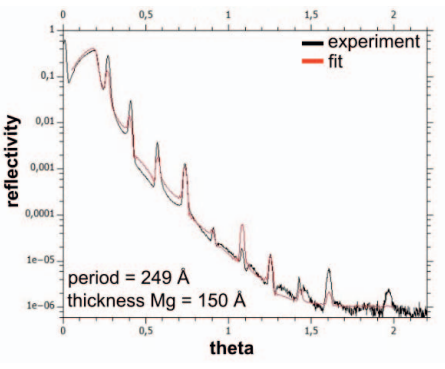


ITO transparent conductive coatings on glass.



Example of an Ag-based laser mirror on a glass substrate.

Measurement of X-ray mirror parameters at Cu Ka.



– Contact profilometer Taylor-Hobson with enhanced measurement repeatability
– Dynamic impact tester for evaluating impact resistance and impact lifetime of protective coatings and bulk materials

ACHIEVEMENTS

Preparation of multi-layered systems with an exactly defined layer thickness and the repeatability of the bilayer thickness better than 0.1 nm, used for x-ray or EUV optics.

– Bernstorff S., Holý V., Endres J., Valeš V., Sobota J., Siketić Z., Bogdanović-Radović I., Buljan M., Dražić G.: *Co nanocrystals in amorphous multilayers–a structure study*, Journal of Applied Crystallography, 2013, 46(6), pp. 1711–1721.
– Schmidt J., Koláček K., Štraus J., Frolov O., Prukner V., Melich R., Psota P., Sobota J., Fořt T.: *Reflectivity of a mirror in XUV spectral region (46.9 nm),* Proceedings of the 3rd IW FX & XUVOA, Prague, 2017, O-05.

Deposition of thin films for electrochemical sensors.

– Sbartai A., Namour F., Barbier F., Krejčí J., Kučerová R., Krejčí T., Neděla V., Sobota J., Jaffrezic-Renault N.: *Electrochemical Performances of Diamond Like Carbon Films for Pb(II) Detection in Tap Water Using Differential Pulse Anodic Stripping Voltammetry Technique,* Sensor Letters, 2013, 11(8), pp. 1524–1529.

Deposition of thin films for electron microscopy.

– Konvalina, I.; Paták, A.; Zouhar, M.; Müllerová, I.; Fořt, T.; Unčovský, M.; Materna Mikmeková, E.: *Quantification of STEM Images in High Resolution SEM for Segmented and Pixelated Detectors.* Nanomaterials 2022, 12, 71.

Deposition of films with exactly defined thickness for plasmonics.

– Hlubina P., Gryga M., Ciprian D., Pokorný P., Gembalová L., Sobota J.: *High performance liquid analyte sensing based on Bloch surface wave resonances in the spectral domain,* Optics and Laser Technology, 2022, 145.

Deposition of thin films for low-temperature physics.

– Musilová V., Králík T., Fořt T., Macek M.: *Strong suppression of near-field radiative heat transfer by superconductivity in NbN*, Physical Review B, 2019, 99(2), 024511.

Deposition of thin films with an exactly defined thickness for interferometry and metrology.

– Pikálek T.; Fořt T.; Buchta Z.: *Detection techniques in low-coherence interferometry and their impact on overall measurement accuracy*, Applied Optics, 2014, 53(36), pp. 8463–8470.

Deposition and study of nanocomposite and carbon-based wear-resistant films for industry.

– Sobota J.; Grossman J.; Buršíková V.; Dupák L.; Vyskočil J.: *Evaluation of hardness, tribological behaviour and impact load of carbon-based hard composite coatings exposed to the influence of humidity,* Diamond and Related Materials, 2011, 20(4), pp. 596-599.

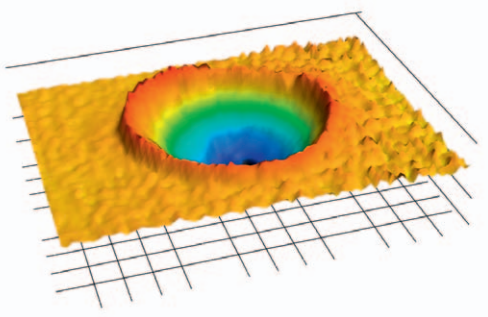
Investigation of the response of materials to the repeated dynamic impact using dynamic impact tester; analyses of impact wear and impact lifetime of various types of coated specimens (e.g. PVD films, HVOF coatings, HVAF coatings, etc.) and bulk materials.

– Daniel J., Žemlička R., Grossman J., Luemkemann A., Tapp P., Galamand C., Fořt T.: *Comparison of Lifetime of the PVD Coatings in Laboratory Dynamic Impact Test and Industrial Fine Blanking Process,* Materials, 2020, 13(9), 2154.
– Daniel J., Grossman J., Houdková Š., Bystrianský M.: *Impact Wear of the Protective Cr3C2-Based HVOF-Sprayed Coatings,* Materials, 2020, 13(9), 2132.

Cross section of the Si/C multilayer on silicon substrate

Impact tester in chamber with controlled atmosphere

Impact crater displayed by laser confocal microscope.



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 collaboration in the areas of our expertise. Deposition of thin films and multilayers with exactly defined thickness from various materials. Deposition and development of new types of nanostructured thin films for optics, x-ray and EUV optics, sensors, plasmonics, metrology, mechanical engineering and industry, etc. Testing of impact wear and impact lifetime of various types of coated specimens and bulk materials. We also offer a 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, deposition of thin films and dynamic impact testing of coated specimens and bulk materials.

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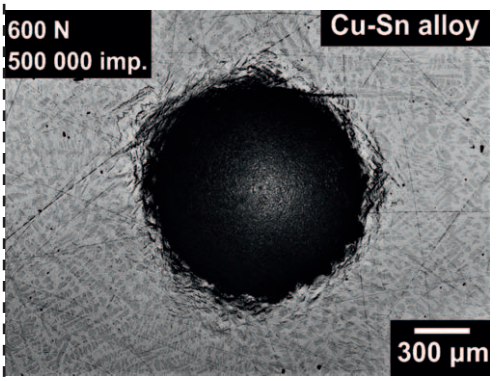
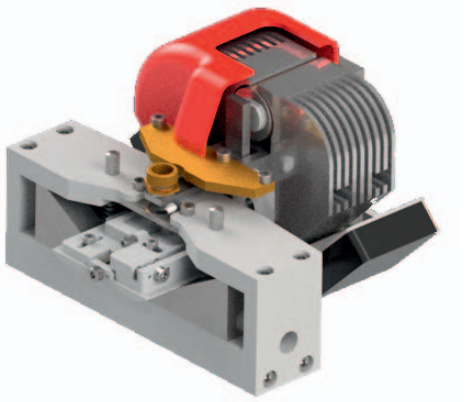


Example of impact crater on the Cu-Sn alloy.



New prototype impact tester.