Group of Thin Layers

Department of New Technologies

ISI ASCR Institute of Scientific Instruments AS CR, v. v. i.

THEMATIC RESEARCH FOCUS

Research area

Deposition of thin films by magnetron sputtering and their dynamic impact testing, microfluidic field-flow fractionation

Excellence

– Multilayer X-ray and EUV optics
– Self-organized growth of nanocrystals
– Dynamic impact testing of thin films
– Microfluidic field-flow fractionation

Institute of Scientific Instruments
of the ASCR, v.v.i.
Academy of Sciences of the Czech Republic
Královopolská 147, 612 64 Brno,
Czech Republic
http://ebt.isibrno.cz/en/about-us

Head: Dr. Jaroslav Sobota
Phone: +420 541 514 256
E-mail: Jaroslav.Sobota@isibrno.cz

Expert: Prof. Josef Janča
Phone: +420 541 514 523
E-mail: Josef.Janca@isibrno.cz

Computer contgrolled magnetron sputtering system Aurion

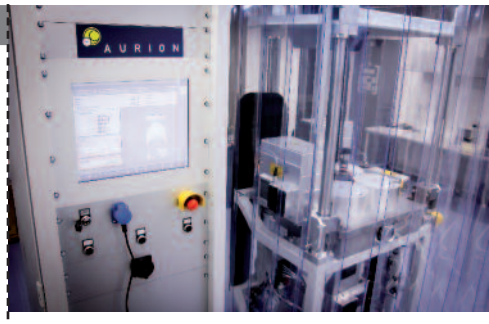
Mission

Search for new practical applications of technologies we excel in, e.g. deposition of x-ray and EUV optics, in particular in new branches of industry (space research), development of unique instruments, and last but not least, the technological support of teams at ISI.

DEVELOPED TECHNOLOGIES

Content of research

– Creation and characterization of nanolayers used in soft X-ray lasers
– 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
– Microfluidic apparatus for the separation, analysis and characterisation of nano- and microparticles



Computer contgrolled magnetron sputtering system Aurion

Main capabilities

Basic research

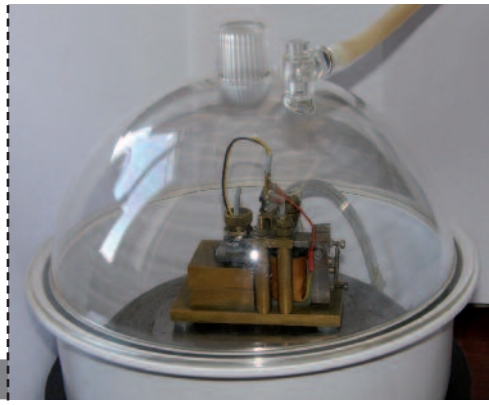
– Study of self-organized growth of nanocrystals
– Study of mechanisms of dynamic impact wear of films / substrate systems
– Study of thermal diffusion of macromolecules, nano- and microparticles by microthermal field-flow fractionation

Applied research

– New types and features of the multilayer X-ray and EUV optics
– Electrochemical sensors
– Solar cells
– Wear-resistant coatings in automotive industry
– Development of microfluidic apparatus for the separation, analysis and characterisation of nano- and microparticles

Fields of research results application

– Materials science (study of the 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)



Impact tester in chamber with controlled atmosphere

KEY RESEARCH EQUIPMENT

List of devices

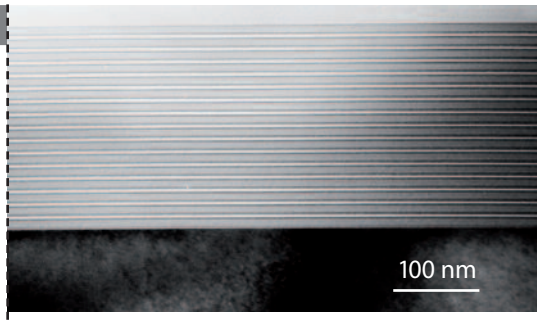
– Computer controlled magnetron sputtering system Aurion equipped with two RF and one DC magnetrons with a diameter of 150 mm for the development and production of multilayer X-ray and EUV optics
– Magnetron sputtering system Leybold Heraeus- Z550 equipped with three RF magnetrons with a diameter of 150 mm for the development and production of the wear resistant coatings
– Magnetron sputtering system equipped with one RF. magnetron with a diameter of 75 mm for the development and production of electrochemical detectors
– Confocal microscope Olympus 3100 (magnification max. 14 400 ×)
– Calotest – CSM Instruments

– Impact tester for the evaluation of impact resistance of the coating/substrate system
– Microfluidic apparatus for the separation, analysis and characterisation of nano- and microparticles
– Disc polishing and grinding machine MTH kompakt 1031 + head APX010

ACHIEVEMENTS

Production of 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 the deposition of x-ray or EUV optical elements composed of different materials, such as Sc/Si, Ni/C or C/Si with the same repeatability.

– Protopov, V. V.; Sobota, J.; *X-ray dark-field refraction-contrast imaging of micro-objects.* Optics Communications, Vol. 213, Issue 4–6, p. 267–279
– Kolacek, K.; Straus, J.; Schmidt, J.; Frolov, O.; Prukner, V.; Shukurov, A.; Holý, V.; Sobota, J.; Fořt, T.; *Nano-structuring of solid surface by extreme ultraviolet Ar8+ laser.* Laser and Particle Beams, Vol. 30, Issue 1, p. 57–63
– Jakubczak, K.; Mocek, T.; Rus, B.; Polan, J.; Hřebiček, J.; Sasická, M.; Sikocinski, P.; Sobota, J.; Fořt, T.; Pina, L.; *Beam properties of fully optimized, table-top, coherent source at 30 nm.* Opto-electronics Review, Vol. 19, Issue 2, p. 169–175
– Krčmář, J.; Holý, V.; Horák, L.; Metzger, TH.; Sobota, J.; *Standing-wave effects in grazing-incidence x-ray diffraction from polycrystalline multilayers.* Journal of Applied Physics, Vol. 103, Issue 3



Cross section of the Si/C multilayer on silicon substrate

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

– Sobota, J.; Grossman, J.; Bursiková, 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, Vol. 20, Issue 4, p. 596–599
– Fořt, T.; Vitu, T.; Novák, R.; Grossman, J.; Sobota, J.; Vyskočil, J.; *Testing of the Impact Load and Tribological Behaviour of W–C: H Hard Composite Coatings.* Chemické listy, Vol. 105, Special Issue SI, p. S102–S104

Our group was one of a few laboratories discovering nanocomposite principle applied on thin films. We find it possible to use this principle in practice and at present we participate in this field in industry-oriented research.

– Vorlíček, V.; Široký, P.; Sobota, J.; Peřina, V.; Železný, V.; Hrdina, J.; *C:N and C:N:O films: Preparation and properties.* Diamond and Related Materials, Vol. 5, Issue 3–5, (1996), p. 570–574
– Jensen, H.; Sobota, J.; Sorensen, G.; *A study on film growth and tribological characterization of nanostructured C–N/TiNx multilayer coatings.* Surface & Coatings Technology, Vol. 94–5, Issue 1–3, (1997), p. 174–178
– Sobota, J.; Sorensen, G.; Jensen, H.; Kuběna, J.; Holý, V.; *Temperature stability of C-N/NbN nanocomposite multilayers.* Diamond and Related Materials, Vol. 9, Issue 3–6, (2000), p. 587–591
– Sobota, J.; Bochníček, Z.; Holý, V.; *Friction and wear properties of C–N/MeNx nanolayer composites.* Thin Solid Films, Vol. 433, Issue 1–2, (2003), p. 155–159
– Sobota, J.; Grossman, J.; Bursiková, 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, Vol. 20, Issue 4, (2011), p. 596–599

Our group is one of the few laboratories in Europe developing microfluidic apparatuses for the separation, analysis and characterisation of nano- and microparticles.

– Janča, J.; Ananieva, I. A.; Sobota, J.; Dupák, J.; *Ultra-micro-thermal field-flow fractionation.* International journal of Polymer Analysis and Characterization, Vol. 13, Issue 3, p. 232–239
– Janča, J.; Berneron, J. F.; Stejskal, J.; *Effect of Particle-Particle Attractive and Repulsive Interactions on the Retention in Field-Flow Fractionation.* International Journal of Polymer Analysis and Characterization, Vol. 15, Issue 8, p. 536–543
– Janča, J.; Stejskal, J.; *On the retention mechanisms and secondary effects in microthermal field-flow fractionation of particles.* Journal of Chromatography A, Vol. 1216, Issue 52, p. 9071–9080

Microfluidic apparatus

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)
– Czech Technical University in Prague (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, GR)

Collaboration with companies

– Solartec s. r. o. (Rožnov pod Radhoštěm, 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)
– Watrex Praha s. r.o. (Praha, CZ)

EXPECTATIONS

Offers

– We offer testing of functional properties of thin coatings under dynamic load, development and deposition of new types and features of 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, study of thermal diffusion of macromolecules, nano- and microparticles by microthermal field-flow fractionation.