Group of Microscopy and Microanalysis
Department of Electron Microscopy

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THEMATIC RESEARCH FOCUS

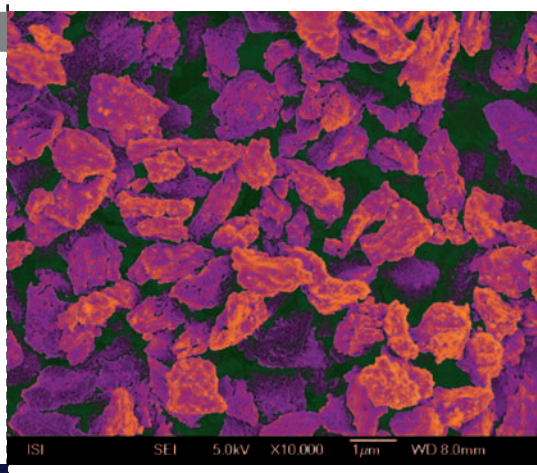
Research area
– High resolution scanning electron microscopy (SEM)
– Imaging of nonconductors in SEM
– Low energy SEM
– Scanning transmission electron microscopy (STEM)
– Energy dispersive X-ray analysis (EDX)
– Electron backscatter diffraction analysis (EBSD)

Excellence
– Imaging of nonconductors (biological specimens) without conductive coating in standard vacuum high resolution SEM.
– Imaging of materials at low energies of incident electrons.

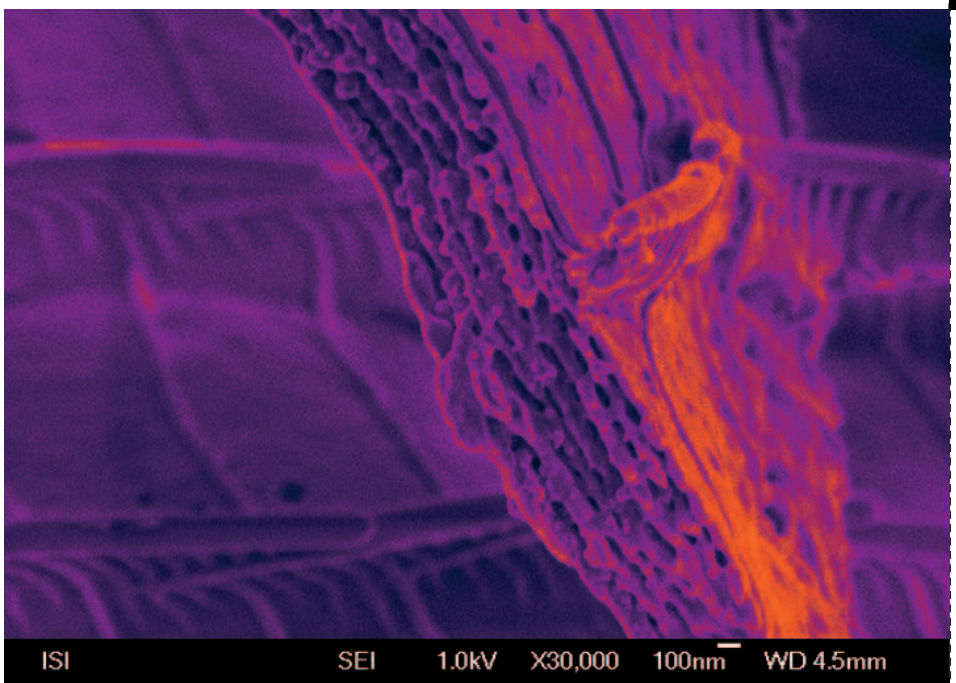
Mission
Development of new high-resolution SEM imaging methods for various kinds of materials at low energies.

DEVELOPED TECHNOLOGIES

Content of research
– Experimental and theoretical activities aimed at the imaging of specimens by electrons with energy below 1000 eV, suitable for high-resolution imaging of nonconductors without conductive coating. Imaging in reflection and transmission mode.
– Elemental analysis of the sample by means of Energy Dispersive X-ray (EDX) spectroscopy.
– Determination of crystallographic orientation, defect studies, phase and grain boundary identification by means of Electron Backscatter Diffraction (EBSD).

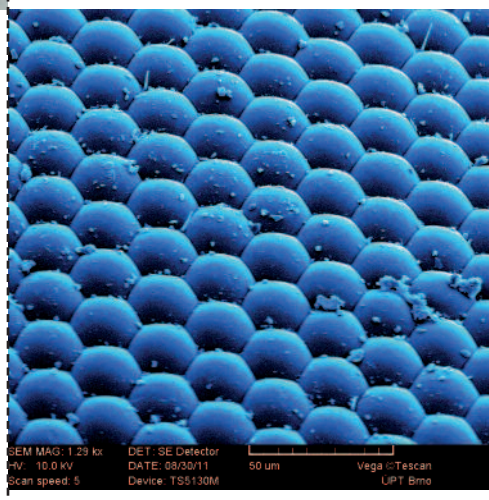


Synthetic diamond powder



Butterfly wing structure

High resolution SEM Jeol 6700F



Eye of a flies

Main capabilities

Basic research

– Generation of signal electrons and their detection mechanisms in SEM

Applied research

– Imaging of metals, alloys, composite materials, polymers, electronics materials, ceramic materials, organic compounds and biological materials
– Complex sample analysis

Fields of research results application

– Materials engineering
– Life-sciences (especially molecular biology, biochemistry)
– Measuring instruments
– Plastics, polymers
– Glass, ceramics

KEY RESEARCH EQUIPMENT

Scanning electron microscopes:

FEI MAGELLAN 400
JEOL JSM 6700F
TESCAN VEGA 5130

Analysers:

Energy Dispersive X-ray (EDX) analyzer (INCA 350 and EDAX Apollo X)
Electron Backscatter Diffraction (EBSD) Analyzer (Hikari)

Other:

Equipment for vacuum evaporation
Equipment for sputter deposition
Cutting machine

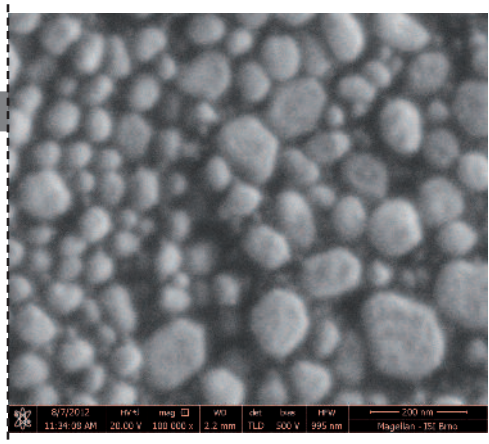
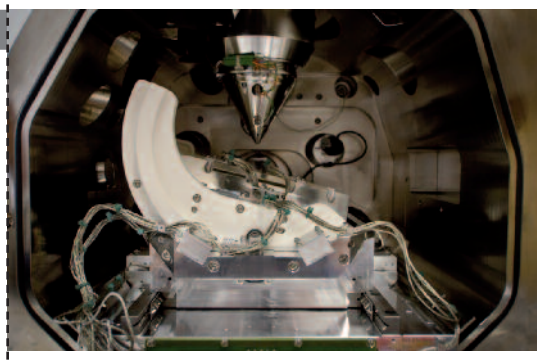


Image of gold on carbon test specimen at the lending energy of 20 eV

ACHIEVEMENTS

- **Mastering of original methods of biological specimen imaging without conductive coating.** This method reveals the real nanostructure and microstructure of the studied sample without coating artifacts. Recently we have focused on natural photonic crystals with interesting optical properties present in butterfly wings.
  - Mika, F.; Matějková-Plšková, J.; Jiwajinda, S. et al.; *Photonic Crystal Structure and Coloration of Wing Scales of Butterflies Exhibiting Selective Wavelength Iridescence.* Materials, 5, (2012), p. 754–771
  - Matějková-Plšková, J.; Mika, F.; Shiojiri, S. et al.; *Fine Structure of Wing Scales in Chrysozephyrus Ataxus Butterflies.* Materials Transactions 52, (2011), p. 297–303
- **Imaging of doped structures using SEM to reveal the distribution of dopants in semiconductor devices to improve the control of the manufacturing process and reduce the production costs.**
  - Hovorka, M.; Mika, F.; Mikulík, P. et al.; *Profiling N-Type Dopants in Silicon.* Materials Transactions 51, (2010), p. 237–242
  - Mika, F.; Frank, L.; *Two-dimensional dopant profiling with low-energy SEM.* Journal of Microscopy – Oxford 230, (2008), p. 76–83



Arrangement in the chamber of Magellan 400 SEM

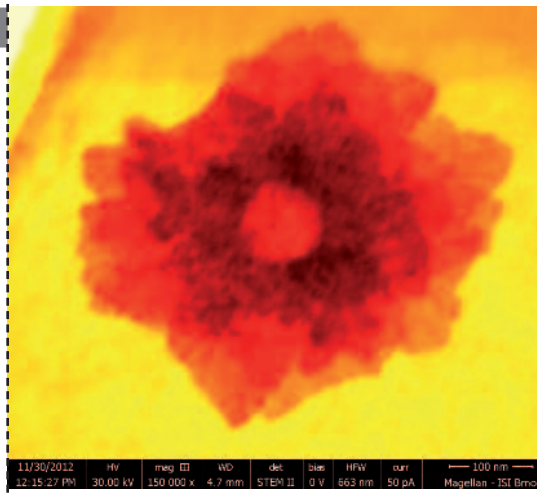
MAIN COLLABORATING PARTNERS

Collaboration with academic partners

Brno University of Technology (Brno, CZ)
Masaryk University (Brno, CZ)
University of Veterinary and Pharmaceutical Sciences (Brno, CZ)
Tomas Bata University (Zlin, CZ)
University of Toyama (Toyama, Japan)
Institute of Inorganic Chemistry ASCR, v. v. i. (Praha, CZ)
Institute of Analytical Chemistry ASCR, v. v. i. (Praha, CZ)
Institute of Physics of Materials ASCR, v. v. i. (Brno, CZ)

Collaboration with companies

Contipro (Dolní Dobrouč, CZ)
Synthesia (Pardubice, CZ)
EID Industrial Diamonds (London, GB)
BVT Technologies, a. s. (Brno, CZ)
Solartec, s. r. o. (Rožnov pod Radhoštěm, CZ)
SURO, s. r. o. (Praha, CZ)
AVX CZECH REPUBLIC, s.r.o. (Uherské hradiště, CZ)
Koito (Žatec, CZ)
Autopal (Uherské Hradiště, CZ)
SHM, s. r. o. (Šumperk, CZ)
Rohde & Schwarz International (Praha, CZ)



Carbon monolayers in STEM mode

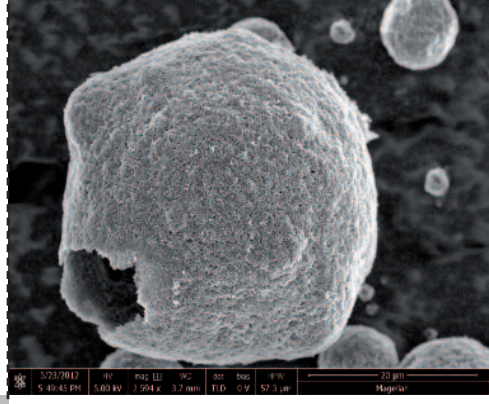
EXPECTATIONS

Offers

- Know-how in the field of scanning electron microscopy imaging and interpretation of results of different detection modes
- Know-how in the field of Energy Dispersive X-ray analysis
- Know-how in the field of Electron Backscatter Diffraction analysis

Requirements

- Collaboration with industrial partners in common projects dedicated to applied science
- Knowledge and technologies for materials analysis
- New complementary technologies



Organic pigment without coating

Extreme high-resolution SEM Magellan 400