

# Group of Microscopy and Microanalysis

Department of Electron Microscopy



Institute of Scientific  
Instruments  
The Czech Academy  
of Sciences

## 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 backscattered diffraction analysis (EBSD)
- Cathodoluminescence (CL)

### Excellence

- Imaging of samples (biological specimens) without metal coating in standard vacuum high resolution SEM
- Imaging of materials at low energies of impact electrons

### Mission

Be in the forefront in the development of new high resolution SEM imaging methods and analysis for different kind of materials even at low energies.

## UP-TO-DATE ACTIVITIES

### Research focus

- Experimental and theoretical activities related to imaging of specimens with electrons of energy below 1000 eV, fit for high resolution imaging without metal coating. Imaging in reflected and transmitted detection mode
- Determination of precise component compound of the sample with energy dispersive analysis
- Determination of precise crystallographic orientation, defect studies, phase and grain boundary identification in many materials with electron back scattered diffraction
- STEM imaging
- Cathodoluminescence imaging and spectroscopy

### Main capabilities

#### Basic research

- Generation of signal electrons and their detection mechanism in SEM

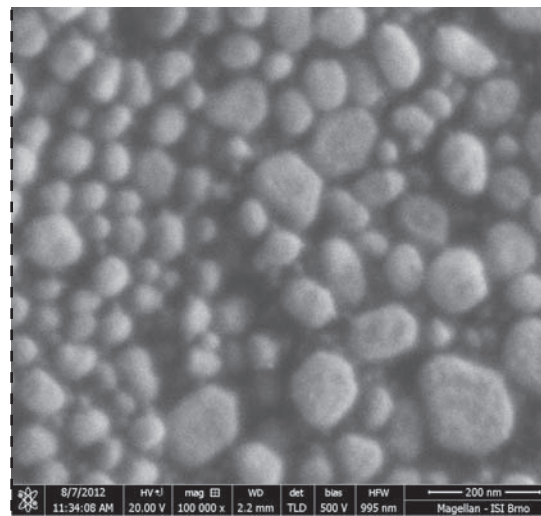
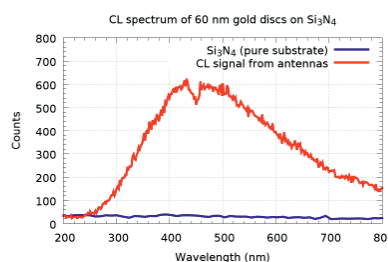
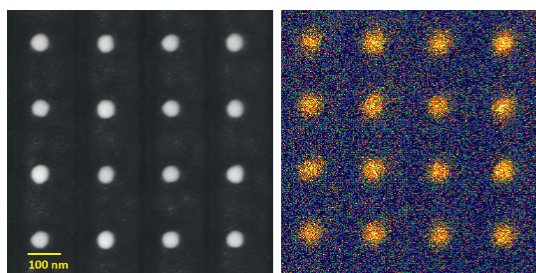
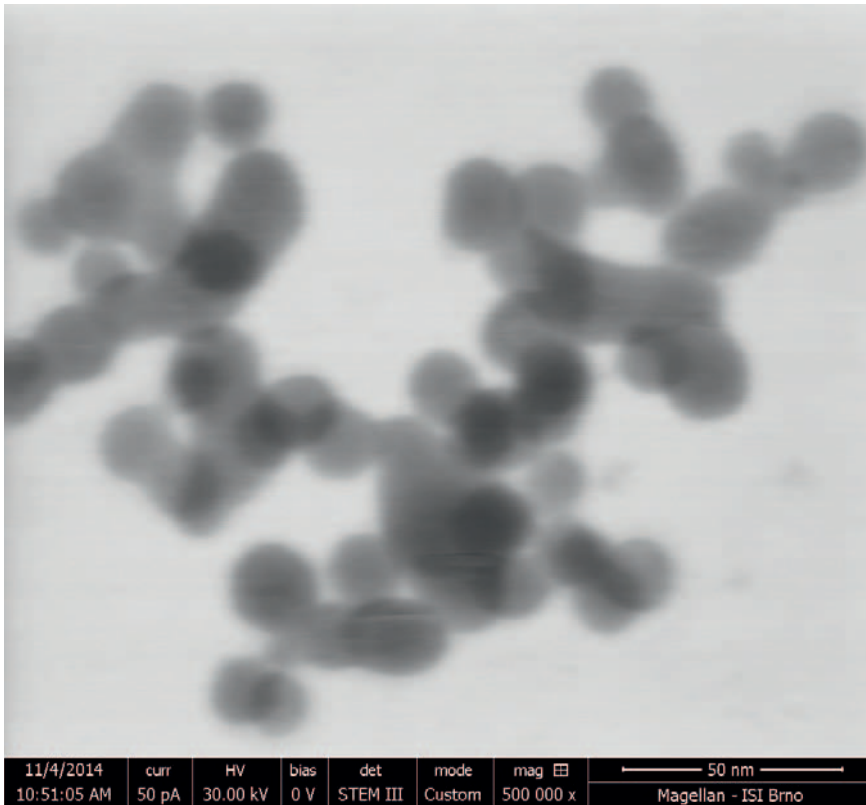


Image of gold on carbon test specimen at the lending energy of 20 eV

Gold disk antenna-SEM image with SE detector – Cathodoluminescence (CL) panchromatic image-measured CL spectrum



*NaYF<sub>4</sub> nano particles imaged with STEM brightfield detector*

### Applied research

- Imaging of samples of various properties and specific requirements on their observation (metals and alloys, composite materials and polymers, electronics materials, ceramic materials, natural and biological materials)
- Complex sample analysis

### Sub-fields of group activities

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

## KEY RESEARCH EQUIPMENT

### List of devices

#### Scanning electron microscopes:

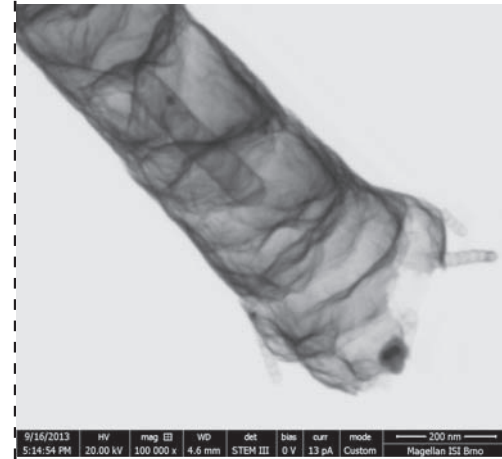
- FEI MAGELLAN 400
- JEOL JSM 6700F
- TESCAN VEGA 5130

#### Analysers:

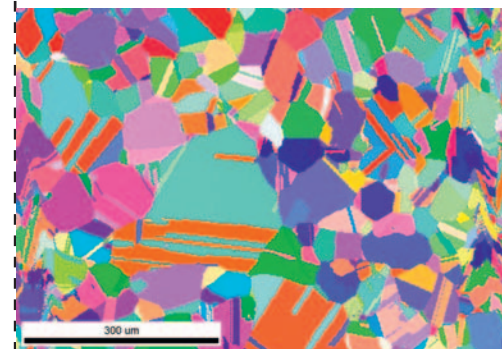
- Energy dispersive analyzer of X-rays (INCA 350 and EDAX Apolo X)
- Electron Back Scattered Diffraction Analyzer (Hikari)
- Cathodoluminescence detector (Gatan MonoCL)

#### Others:

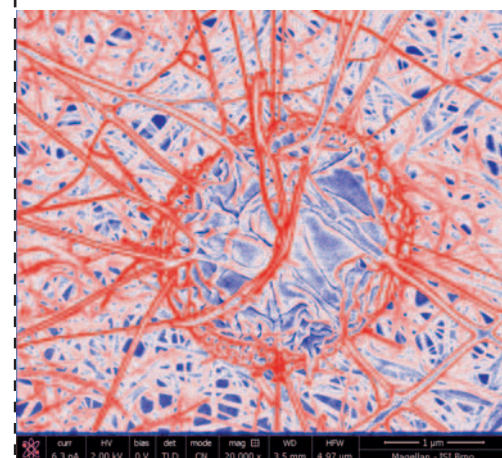
- Evaporators
- Sputters
- Cutting machine



*Carbone multiwall nano tube imaged with STEM bright field detector*



*Different orientations of polycrystalline copper imaged with EBSD detector*



*Thorium „brain“ imaged with charged neutralisation method*



## ACHIEVEMENTS

### ■ Mastering of original methods of imaging nonconductive specimens with electrons of energy below 1000 eV without their metal coating.

This method reveals the real nanostructure and microstructure of the studied sample. Recently we have focused on microstructure of dielectric layers, tissue sections, plasmonic nanoparticles, natural photonic crystals with interesting optical properties.

- F. Mika, J. Matějková-Plšková, S. Jiwajinda et al.: "Photonic Crystal Structure and Coloration of Wing Scales of Butterflies Exhibiting Selective Wavelength Iridescence", *MATERIALS* **5**, 754–771, 2012
- L. Frank, J. Nebesářová, M. Vancová, A. Paták, I. Müllerová: "Imaging of tissue sections with very slow electrons", *Ultramicroscopy* **148**, 146–150, 2015
- J. Buršík, M. Soroka, R. Uhrecký, R. Kužel, F. Mika, Š. Huber: "Thin (111) oriented  $\text{CoFe}_2\text{O}_4$  and  $\text{Co}_3\text{O}_4$  films prepared by decomposition of layered cobaltates", *Applied Surface Science* **376**, 209–218, 2016
- O. Brzobohatý, M. Šiler, J. Trojek, L. Chvátal, V. Karásek, A. Paták, Z. Pokorná, F. Mika, P. Zemánek: "Three-Dimensional Optical Trapping of a Plasmonic Nanoparticle using Low Numerical Aperture Optical Tweezers", *Scientific Reports*, **5**, JAN **29**, 08106:1–9, 2015
- J. Buršík, M. Soroka, R. Kužel, F. Mika: "Growth and characterization of thin oriented  $\text{Co}_3\text{O}_4$  (111) films obtained by decomposition of layered cobaltates", *Journal of Solid State Chemistry* **227**, 17–24, 2015

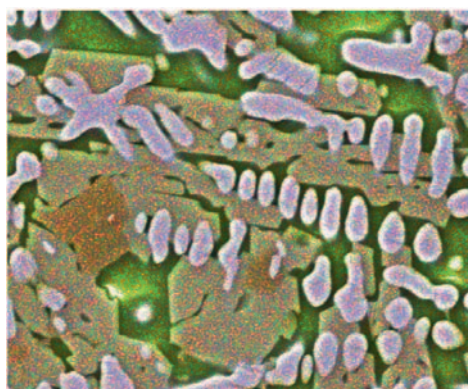
### ■ Mastering of simulation methods for generation of signal electrons and their detection mechanism in SEM.

- F. Mika, Ch. Walker, I. Konvalina, I. Müllerová: "Imaging with STEM Detector, Experiments vs. Simulation", *Microscopy and Microanalysis* **21**, S4, 66–71, 2015
- L. Frank, F. Mika, I. Müllerová: "Optimizing the Recognition of Surface Crystallography", *Microscopy and Microanalysis* **21**, S4, 124–129, 2015

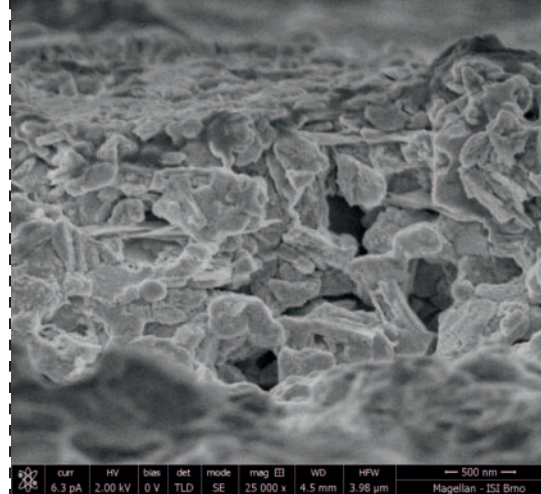
## MAIN COLLABORATING PARTNERS

### Collaboration with academic partners

- Brno University of Technology (Brno, CZ)
- Masaryk University (Brno, CZ)
- Tomas Bata University (Zlín, CZ)
- Institute of Inorganic Chemistry AS CR, v.v.i. (Praha, CZ)
- Institute of Analytical Chemistry AS CR, v.v.i. (Praha, CZ)
- University of Scheffield (Scheffield, UK)
- INP Greifswald e.V. (Greifswald, D)
- Institute of Physics of Materials AS CR, v.v.i. (Brno, CZ)
- University of Toyama (Toyama, Japan)



EDX elemental map of an iron slag. Courtesy of Associate Professor Antonín Rek



Crosssection of dielectric layer imaged without coating



Detail of a Fly imaged with SE detector

Extreme high-resolution SEM Magellan 400



### 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)
- Koito (Žatec, CZ)
- Precision s.r.o. (Zlín, CZ)
- HARIS DIVISION s.r.o. (Psáry, CZ)
- Automotive s.r.o. (Velké Meziříčí, CZ)
- Inventec s.r.o. (Brno, CZ)
- Autopal (Uherské Hradiště, CZ)

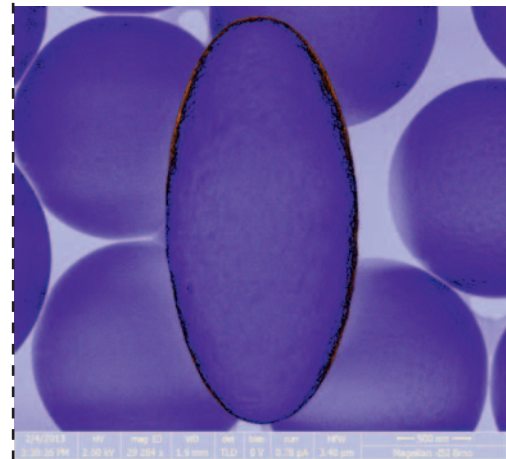
## EXPECTATIONS

### Offers

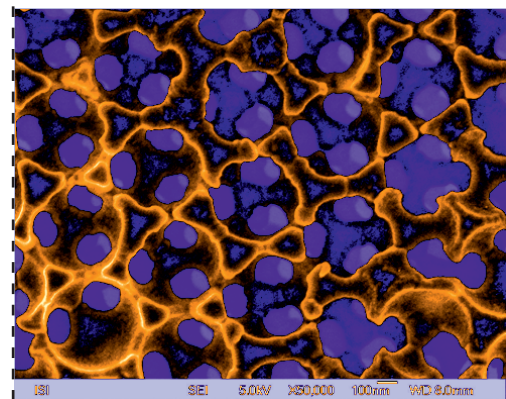
- Know-how in the field of scanning electron microscopy imaging and interpretation of results from different detection modes
- Know-how in the field of energy dispersive X-ray analysis
- Know-how in the field of Electron backscattered diffraction analysis
- Know-how in the field of Cathodoluminescence imaging and spectroscopy

### Requirements

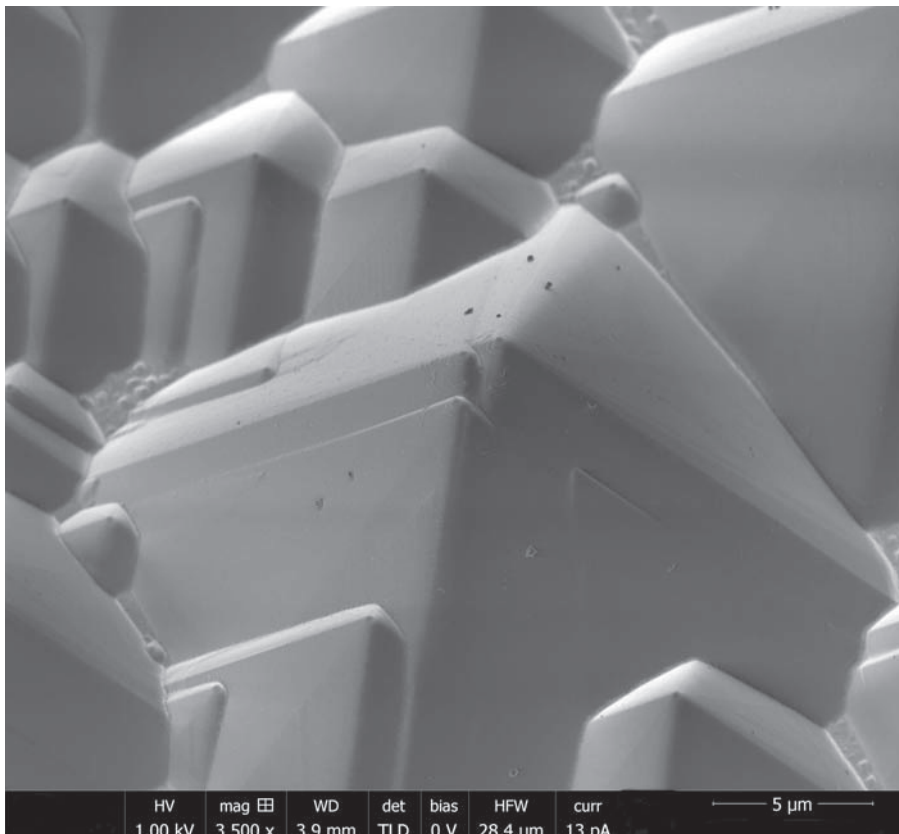
- Collaboration with industrial partners in common projects dedicated to applied science
- Knowledge and technologies for material analysis
- New complementary technologies



*Polystyrene spheres and ellipsoids*



*Gold sensor imaged with SE detector*



*Solar panel*