

## Staff

International Centre of Electron Microscopy for Materials Science (IC-EM) was created on 1st June 2010.

The Centre is a non-faculty unit of the AGH University of Science and Technology (AGH-UST), acting in co-operation with foreign partners.

The leading unit of the Centre is the **Faculty of Metals Engineering and Industrial Computer Science**.

The leading foreign partner is the **Forschungszentrum Jülich (FZJ), Germany**.



### Scientists:

Prof. Dr Aleksandra Czyrska-Filemonowicz - Head  
Adam Kruk, DSc. - Deputy Head  
Dr Grzegorz Cempura  
Joanna Karbowniczek, MSc.  
Dr Oleksandr Kryshtal  
Dr Grzegorz Michta  
Dr Bogdan Rutkowski  
Dr Urszula Stachewicz  
Dr Kinga Majewska-Zawadzka  
Dr Maciej Ziętara  
and  
Prof. Władysław Osuch  
Prof. Dr Philippe Buffat - visiting  
Prof. Dr Franco Rustichelli - visiting

### Laboratory assistants:

Adam Gruszczyński, MSc.  
Krystyna Płońska-Niżnik

### Administration:

Katarzyna Kurek, MSc.

### PhD students:

Krzysztof Cieszyński, MSc.  
Oskar Dziuba, MSc.  
Joanna Karbowniczek, MSc.  
Sebastian Lech, MSc.  
Dipl. Ing. Jennifer Lopez Barrilao (FZJ)

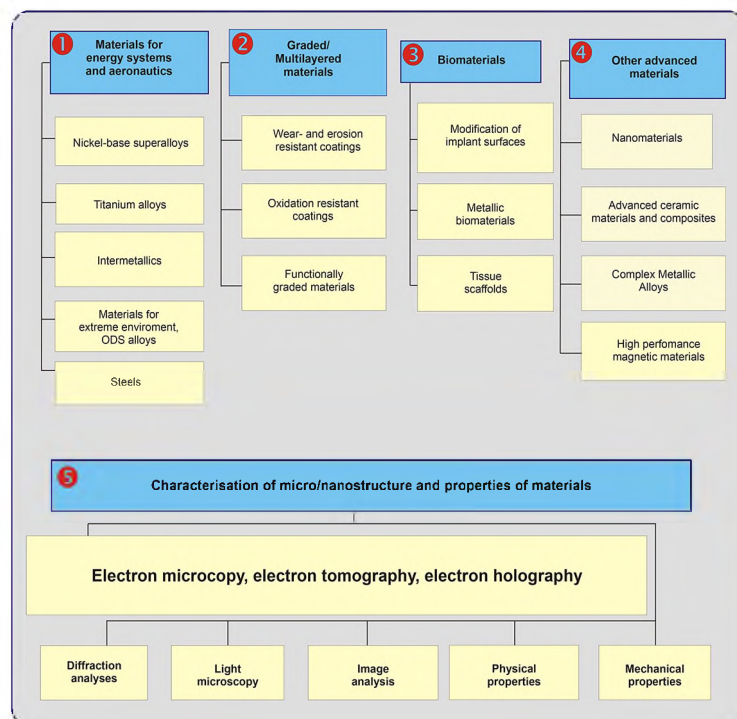
## Agreement of Co-operation

of the International Centre of Electron Microscopy for Materials Science  
with the Forschungszentrum Jülich signed on 30th October 2010 in Jülich

## IC-EM research activities



From the left:  
Professor Dr. Lorenz Singheiser, director of the Institute for Energy- and Climate Research at the FZJ,  
Professor Dr. Dr. Harald Bolt, Member of the Board of Directors for Scientific Division (FZJ),  
Professor Dr Tomasz Szmuc, Vice-Rector for Cooperation of the AGH-UST,  
Professor Dr Aleksandra Czyrska-Filemonowicz, Head of the IC-EM.







#### 4 Transmission electron microscopes:

- **Titan Cubed G2 60-300 (FEI)** advanced probe Cs corrected (S)TEM for analytical high resolution microscopy at high (300 kV) and low (60 kV) voltage
- **Tecnai G2 20 TWIN (FEI)** with:
  - Precession electron diffraction DigiStar and ASTAR for orientation and phase mapping
  - STEM-HAADF and EDX microanalysis system TIA
- **JEM-2010ARP (JEOL)** equipped with:
  - STEM-ASID and EDX microanalysis system INCA
  - CCD camera Orius™ SC1000
- **JEM-200CX (JEOL)**

#### 2 Scanning electron microscopes:

- **Merlin Gemini II (ZEISS)** equipped with:
  - FEG and EDX microanalysis system: Quantax 800
  - EBSD: Quantax CrystAlign 400
- **FIB-SEM NEON® CrossBeam 40EsB (ZEISS)** equipped with:
  - FEG SEM column, SE, BSE and EsB modes
  - EDX microanalysis system Quantax 200

#### Scanning probe microscope Dimension 3100 SPM

#### 2 Light microscopes (ZEISS):

- Axio Imager M1m
- Stereo Discovery
- Image analysis software

#### Comprehensive TEM sample preparation laboratory (with NanoMill 1040)

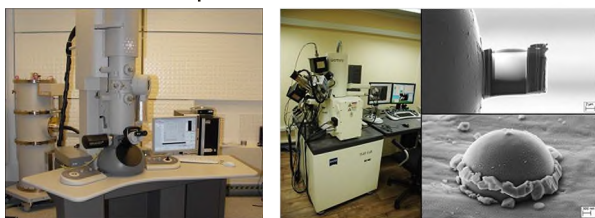
#### Mechanical testing facilities: MTS, Instron

#### Nondestructive testing systems

- Ultrasonic flaw detector
- Eddy-current system, acoustic emission

#### Software package for thermodynamic calculations - Thermo-Calc

#### Biomaterials Laboratory



## Research infrastructure

### Analytical high resolution (70 pm) transmission electron microscope Titan<sup>3</sup> G2 60-300



- new X-FEG Schottky high brightness source with a monochromator
- high resolution STEM-HAADF unit with a new dodecapole DCOR probe Cs corrector
- new ChemiSTEM EDX system based on a 4 windowless Silicon Drift Detectors (Super X) with enhanced acquisition efficiency and speed for low dose, high spatial (atomic) resolution and fast chemical element mapping
- GIF Quantum 693 electron energy filter for EELS spectroscopy and EFTEM imaging
- new FEI precession electron diffraction
- dual-axis tomography
- off-axis electron holography, Lorentz lens
- full remote access operation (TARO)



INNOWACYJNA GOSPODARKA  
NARODOWA STRATEGIA SPÓJNOŚCI

UNIA EUROPEJSKA  
EUROPEJSKI FUNDUSZ  
ROZWOJU REGIONALNEGO



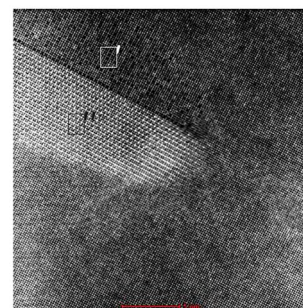
Acquisition of an advanced analytical transmission electron microscope  
for analyses of materials nanostructure and chemical composition investigation  
at the atomic scale

Project POIG.02.01.00-12-016/08

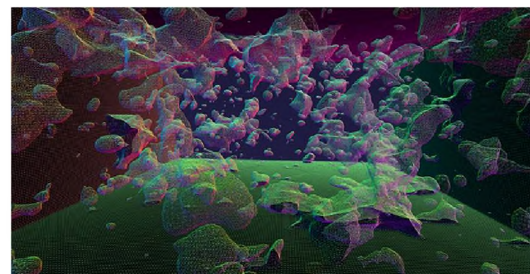
Project leader: Prof. Aleksandra Czyrska-Filemonowicz

## Expertise in characterisation of micro/nanostructure and properties of materials

- Light microscopy, quantitative metallography
- Scanning electron microscopy
- Transmission electron microscopy
  - Quantitative characterisation of microstructure by Analytical Electron Microscopy down to atomic scale
    - Energy Dispersive X-ray Spectroscopy (EDX) micro/nano analysis
    - Electron Energy Loss Spectroscopy (EELS) and Energy Filtered TEM (EFTEM) imaging
    - STEM/EDS and STEM/EELS elemental mapping
  - Electron diffraction analyses
    - Selected Area Electron Diffraction (SAED), Convergent Beam Electron Diffraction (CBED), micro- and nanodiffraction ( $\mu$ D, nD)
    - Precession Electron Diffraction (PED); orientation and phase mapping
  - High Resolution TEM (HRTEM)
  - Cs corrected high resolution STEM-HAADF
  - Electron holography and Lorentz microscopy
- Electron tomography (EDX, HAADF, EFTEM) and FIB-SEM tomography
- Scanning Probe Microscopy for surface analysis (SPM)
- Computer aided image analyses: JEMS, Digital Micrograph, AnalySIS 3.2, Aphelion, ImageJ, Avizo Fire 6 and others
- Mechanical properties tests
- Non-destructive examination of materials
  - Ultrasonic
  - Eddy-currents
  - Acoustic emission



High resolution STEM-HAADF image of  $\gamma'$  and  $\gamma''$  precipitates in Ni-base superalloy IN718 for aeronautics



3D visualisation of TiC particles and pores in W-base alloy for fusion reactors (FIB-SEM tomography)

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