



NAME : MATERIALS DESIGN DIVISION

INSTITUTION : WARSAW UNIVERSITY OF TECHNOLOGY

COUNTRY : POLAND

Profile :

The Materials Design Division (MDD) of Warsaw University of Technology is a leading Polish materials research group with strong interest in new materials and technologies and significant achievements in both fundamental and applied activities. The main research topics include: materials characterization and modelling; design and processing of new materials; microstructure optimization; failure and degradation of engineering materials; nanomaterials and biomaterials.

MDD has particular expertise in nano- and micro-structure characterization by direct imaging (TEM, SEM, EMP, AFM) and using methods of stereology and image analysis. Quantitative characterisation is a basis for modelling of materials and properties. The Materials Design Division (MDD) owns medium level High Performance Cluster dedicated for ab initio and FEM modelling supported by licensed software, including Ansys and Abaqus. For higher computation power MDD cooperates with Interdisciplinary Centre for Mathematics which operates a super-computer.

The extensive research programs carried out at MDD are financed by the Ministry of Science and Higher Education, the EC, NATO and industrial partners. The permanent staff of the Division consists of about 40 persons supported by 50 PhD students. These two figures make the Division one of the largest university-based groups in the field of materials science and engineering in Europe, and provide a critical mass and good opportunity to participate in ambitious research projects.

Activities :

- **Education** - the University offers 3 levels of studies in the field of materials science and engineering and awards the following degrees: B.Sc. M.Sc. and PhD. General training activities are supported by post-graduation courses dedicated to specific subjects of materials science (e.g. non-destructive techniques) and workshops, seminars and conferences.
- **Research and development** - these activities aim at obtaining new materials and technologies leading to industrial innovations and high added value products and involve interdisciplinary research including: processing, modelling, structure and properties characterisation, application
- **Services to the industry** - MDD offers: in-service monitoring of materials degradation processes, analysis of materials failure, development and/or optimisation of new materials technologies.

Expertise on following materials :

- metals and alloys
- ceramics
- polymers
- composites
- nanomaterials
- biomaterials
- materials for extreme environments
- intermetallics

Actual research domains concerning materials technology / Competences :**1. Nanosciences and nanotechnologies**

- fabrication methods of nanomaterials (severe plastic deformation, mechanical alloying, nanocrystallization from amorphous state, special techniques for nanopowders consolidation, electrodeposition);
- high strength nanostructured metallic materials,
- polymers modified with nanoparticles
- nano-scale characterization of materials microstructure

2. Bioengineering

- fabrication of scaffolds for tissue engineering
- degradation studies of biomaterials
- nanostructured titanium for implants
- chemical surface modifications of metallic implants
- design and development of shoulder prosthesis
- development of new ceramic-polymer composites for dental applications

3. Functional and tailored materials

- multilayered and particle ceramic-metal composites
- intelligent materials (magnetorheological elastomers)
- materials for extreme environments
- intermetallics

4. Multiscale modeling

- ab initio
- molecular dynamics
- Monte Carlo
- FEM

5. Degradation of engineering materials

- phenomena: fatigue, creep, corrosion
- non destructive testing
- observations of changes microstructures



Available research infrastructure :

Facilities for material characterization and testing:

- Scanning electron microscope HITACHI S-5500 with spatial resolution 0.4 nm equipped with EDS and the possibility of working in transmission mode,
- Scanning electron microscope HITACHI S-3500N with low-vacuum mode equipped with EDS, secondary and backscatter electron detectors, Robinson detector and module for in-situ observation of the materials under loading,
- scanning-transmission electron microscope JEOL JEM 1200 EX equipped with EDS
- high resolution transmission electron microscope JEOL JEM 3010, (300 kV, resolution 0.19nm), equipped with EDS (ISIS by Oxford Instruments Ltd.) for chemical analysis in nanovolumes and a possibility of CBED (Converged Beam Electron Diffraction), and advanced image analysis system equipped with specialized software for micro- and nanostructure analysis
- X-ray diffractometers
- High Resolution Scanning Auger Microprobe Microlab 350
- Atomic Force Microscope Nanoscope Multimode IIIA
- X-Microanalyser Cameca SEMPROBE SU-30
- Microhardness and hardness testers,
- Tensile tests machines including the possibility of straining micro-specimens
- Light microscope NIKON EPIPHOT 200
- Hydraulic Testing Setup for cycling testing
- Nanoindenter and scratch tester HYSITRON
- Furnaces for high temperature mechanical testing
- FTIR
- thermal analysis (DSC, TGA, DMA)
- Non-destructive testing techniques including: acoustic emission systems, ultrasonic detectors, eddy current detectors

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