OP Research and Development for Innovations

2007–13

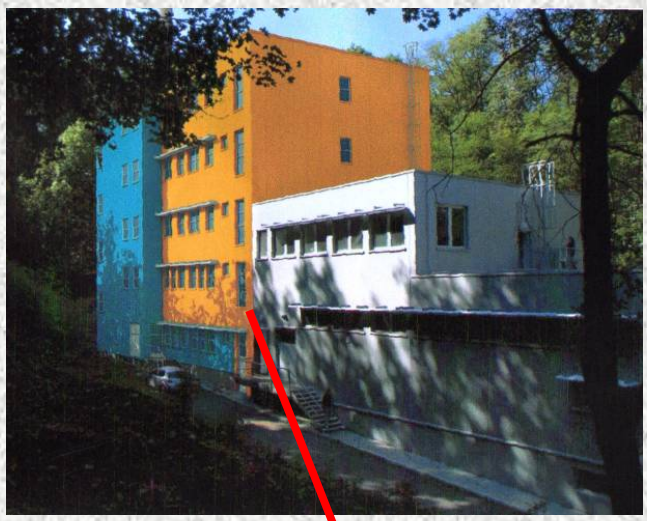
MINISTERSTVO ŠKOLSTVÍ, MLÁDEŽE A TĚLOVÝCHOVY

DEVelopment of Infrastructure for Smart Engineering Materials Research /DEVISER/

A Czech structural funds project aimed for building a new public research infrastructure called

Laboratory of Functional Materials

In Rez near Prague, Czech Republic in the years 2010-13



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A European structural fund research infrastructure project of Nuclear Physics Institute of the ASCR and Institute of Physics of the ASCR

in collaboration with SMEs

The existing facility in the Rez campus (20 km from Prague downstream by the Vltava river) is planned for reconstruction into a modern 6 floor laboratory building for ~45 scientists

Laboratory of Functional Materials /LFM/

The aim of the project DEVISER is to build a Laboratory of Functional Materials (LFM) as a regional R&D centre with cutting edge experimental facilities for:

- **applied research in the field of functional materials and their industrial applications**
- **plasma thin film technologies and techniques for surface modification of industrial materials**
- **development of modern non-destructive methods of material characterization for industrial applications.**

Organisation of the Laboratory of Functional Materials

M: Functional Engineering Materials

- M1: Materials and Technologies for Medical Devices
- M2: Functional Materials and Composites for Engineering Applications
- M3: Advanced metallurgy & rapid manufacturing of metalic parts
- M4: Mechanical testing
- M5: Microdevices
- M6: Laser processing of materials
- M7: Metallography
- M8: CAD design and prototyping

V: Plasma Technologies of Thin Films and Coatings

- V1: Thin Film technologies for coatings of medical devices
- V2: Thin Film technologies for microdevices
- V3: Nanocrystalline CVD dimant and nanostructurized surfaces

D: Nondestructive evaluation methods

- D1: X ray and neutron diffraction
- D2: Electron and optical microscopy
- D3: Ultrasonic, IR and other NDE methods

S: Management and Support Facilities

- S1: Management LFM
- S2: Operational section
- S3: Project and business section
- S4: IPR, human resources and education section
- S5: Mechanical workshop

Purpose of the Laboratory of Functional Materials

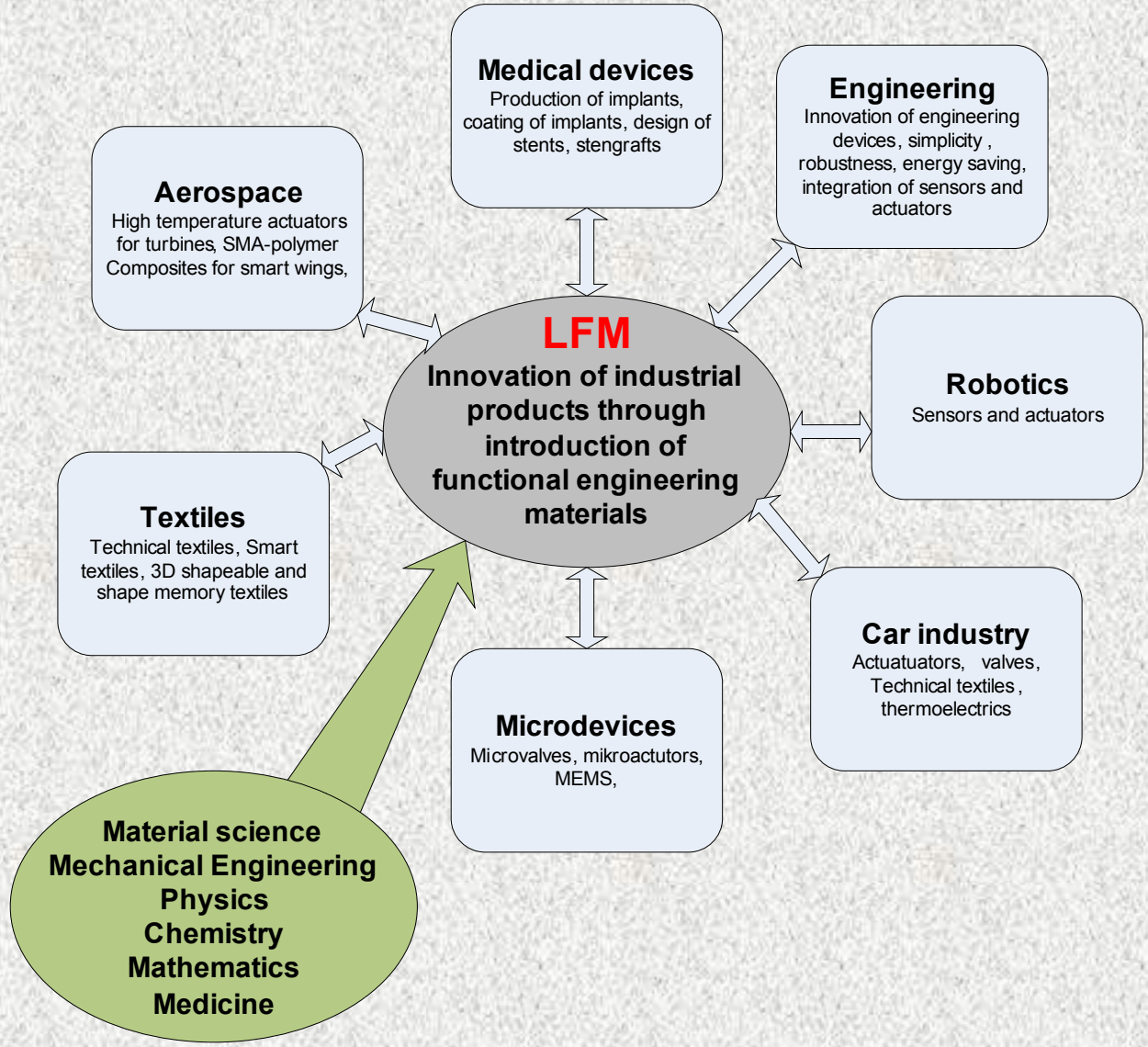
LFM will be involved in collaborative R&D with industrial partners aiming at innovation of their products through introduction of functional engineering material technologies.

1. Functional engineering materials are expected to be introduced in wide range of industrial sectors. Because of that the LFM will become a multidisciplinar research facility where material scientists, mechanical engineers, chemists, mathematicians and medical doctors will collaborate on research projects.

2. It is expected that LFM will mainly collaborate with SMEs since these show by far strongest interests in the idea of innovations through functional engineering materials.

3. R&D in the LFM will concentrate on materials for medical devices. This is a sector dominated by SMEs in the Czech Republic. Though it has enormous growth potential, it needs support from state to mobilize research and development to survive in this extremely competitive field. LFM in collaboration with research team at universities active in this field will provide such support. Strategic aim is to create in the Czech Republic a research community center for materials for medical devices similar to ASM MPMD active in US.

SMEs active in multiple industrial sectors will benefit from collaboration with LFM.



Expertise

1. **Advanced alloy casting and heat treatment**
2. **Material characterisation (SEM, FIB, X-ray and neutron diffraction, DSC, DTA, Thermal wave imaging, photostress analysis)**
3. **Mechanical testing and modeling of materials behavior**
4. **Martensitic phase transformations and related material phenomena (shape memory, TRIP, superelasticity etc.)**
5. **Functional engineering materials (SMA. MSMA, SMP, piezzo, thermoelectrics, smart structures, functional composites etc.)**
6. **Application of functional material technologies in medical, automotive, robotics, textile and microdevice fields**
7. **PVD thin film deposition technologies**
8. **CVD diamond technologies**
9. **Neutron diffraction X-ray and ultrasonic methods for engineering (In-situ neutron diffraction studies, neutron strain scanning, SANS. SAXS, laser coupled ultrasound acoustic emission etc.)**
10. **Microdevice manufacturing and applications**

Technologies

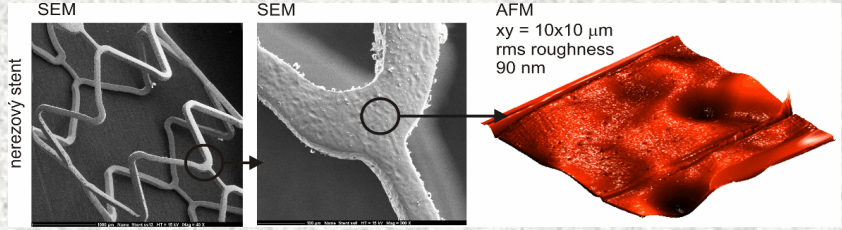
- Vacuum Arc Melting and heat treatments of advanced materials
- Sparc Plasma Sintering of advanced alloys and ceramics
- Selected Laser Melting – rapid manufacturing of metallic parts from CAD
- Electron Beam Melting – rapid manufacturing of metallic parts from CAD
- Direct metal deposition powder feed by laser from CAD
- Plasma vapour deposition of thin films and coatings
- Chemical vapour deposition of diamond thin films
- Microdevice technologies (clean room, thin film deposition, lithography, etching, FIB sectioning, microwelding etc.)

Direct Metal Deposition process by laser using TRUMP DMD equipment

SPS 2000 SYNTEX equipment for sintering of intemetalics, ceramics, advanced functionally graded materials, amorphous materials, thermoelectrics, nanocomposites.

Removable partial dental parts made using 3D scanning advanced CAD and SLM (MCP Realizer)

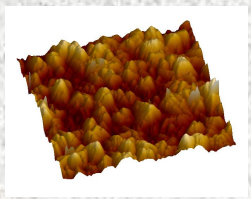
A customized Lattice CMF Implant manufactured from Ti6Al4V directly on an ARCAM EBM machine

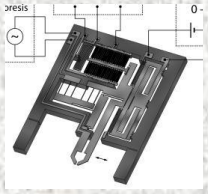


Thin film deposition -surface of medical stent covered by biocompatible CVD nanocrystalline coating

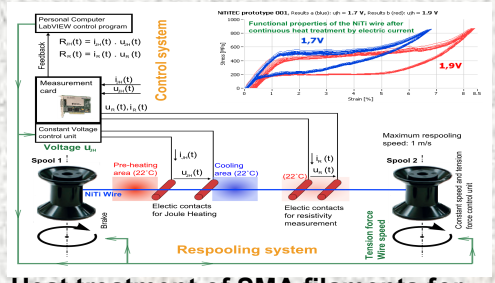
Methods

- Mechanical testing laboratory equipped with various testing machines dedicated mainly to testing small samples in wide temperature range, thermo-electro/magneto mechanical loads, dynamic and fatigue test, microdevice tests, medical device tests.
- Material evaluation, inspection and characterization by dedicated NDE methods based on laser coupled ultrasound, X-ray and neutron diffraction, electrical resistance, optical, laser and IR methods etc.
- Production of customized metallic parts from CAD models by advanced layer manufacturing methods (SLM,EBM, Direct metal laser deposition) from metallic powders
- Laser processing of materials (cutting, machining, welding]
- Covering materials by thin films and coatings prepared by Plasma vapour and chemical vapour deposition methods
- Production of microdevices from thin films (clean room, thin film deposition, etching, microcutting, lithography, FIB sectioning, microwelding etc.)

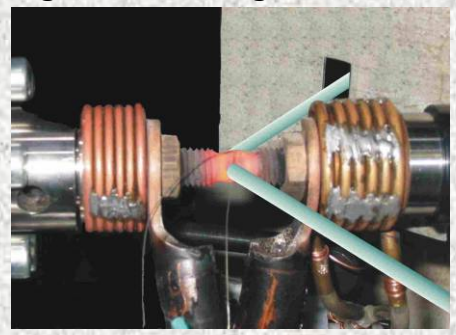




Thin film deposition, characterization and processing for microdevice production

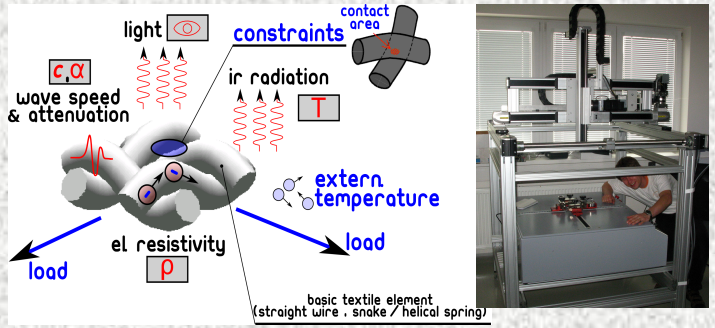


Heat treatment of SMA filaments for textile processing



In-situ neutron diffraction under high temperature and stress

Mechanical testing laboratory, INSTRON ElectroPulse E3000 testing machine



Noninvasive inspection of smart technical textiles by combination of optical, laser, IR, ER and ultrasonic methods using a machine vision system CIRVIS

Neutron strain scanner for evaluation of residual stresses in engineering components

Key services

- **Certificated testing of mechanical properties** of materials for medical devices (implants, stents, stentgrafts, tribological tests of surfaces etc.)
- **Mechanical testing** (static, dynamic, thermomechanical, fatigue, VHS, multiaxial)

- **Phase and structure analysis** by combined X-ray and neutron diffraction methods
- **Evaluation internal stresses** in engineering materials by neutron strain scanning
- **Evaluation inhomogeneities in engineering materials** by small angle neutron (SANS) and X-ray (SAXS) scattering methods

- **DLC, diamond and Ti oxide coating of nonplanar surfaces**
- **Applications of microdevice** technologies (clean room, thin film deposition, etching, microcutting, nanolitography, FIB, microwelding etc.)
- **Characterisation of thin films and coatings** (AFM, microraman, elipsometry, profilometr, electrical resistance etc.)
- Services of **metallography lab + high resolution SEM & FIB + Optical microscope with Image analyser**

- **Digitization of 3D parts**
- **CAD prototyping** of 3D components and visualizing by SLA/3D printer
- **CNC laser machining** from CAD models
- **Laser micromachining**
- **Laser cutting, welding**,
- **Direct metal deposition** powder feed by laser from CAD
- **Conventional and CNC machining** from CAD models
- **Customized building of metallic parts** (SLM, EBM) from CAD models

- **Drawing of thin metallic filaments** for textile applications
- **Flattening ribbons** from round metallic filaments
- **Continuous heat treatment of thin NiTi metallic filaments** for textile applications
- **Evaluation of responses of smart textile and composite structures** to thermomechanical stimuli using purposely built equipment (visual and IR cameras and laser profilometer mounted on a robotic system)

Services already offered to industrial partners

- **Innovation of industrial products through introduction of function SMA components**
- **Thermoechanical testing of thin metallic filaments in tension, torsion, combined tension-torsion and dynamic tension using self developed dedicated equipment MITTER, ATTUT and AVUT**
- **Final thermomechanical treatment of SMA filaments for production of smart textiles using self developed equipment NiTiTEC (patent pending)**
- **Evaluation of responses of activated smart structures, composites and textiles using self developed equipment CIRVIS – a robotic system featuring optical, IR cameras and laser profilometer moving over biaxial testing rig**
- **Neutron strain mapping - evaluation of spacial distribution of residual stresses in engineering components**
- **Evaluation of inhomogeneities in engineering materials and components by SANS**

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