

Multi-Material Micro Manufacture: Technologies and Applications (4M)

Project coordinator: Dr. Stefan Dimov - Cardiff University

The main aim of 4M is to develop Micro- and Nano-Technology (MNT) for the batch-manufacture of micro- components and devices in a variety of materials into user-friendly production equipment, processes and manufacturing platforms for incorporation into the factory of the future. To achieve this, 4M will integrate the currently fragmented European R&D capacity in non-silicon microtechnologies into a Virtual Centre of Excellence for MNT process and product development. The establishment of such world class expert resource and infrastructure at European level will be crucial to the future of European companies engaged in satisfying the growing demand for portable, wireless communication products and many lifestyle, health and transport related systems incorporating MNT. The foundations for a new European industrial sector and the achievement of sustainable, commercial and societal benefits for its citizens are the overall goals of 4M. The network has **30 partner**' organizations, including **16 core partners** - each an internationally recognized centre of excellence (**Belgium: KU Leuven; France: CEA; Germany: IMTEK, IZM, FZK, IPT, IBMT, IMM, Erlangen; Netherlands: TNO; Spain:**

TEKNIKER; Sweden: IVF and KTH; UK: Cardiff, Cranfield, RAL) and **14 associate partners (Bulgaria: BAS; Denmark: DTU; France: LPMO; Germany: IZFM, HSG-IMAT and BLZ; Hungary: BUTE; Italy: Naples; Romania: IMT; Slovenia: UL; Sweden: IMEGO; UK: Bath and SCU)**. 165 researchers together with initially 80 PhD students will perform the 4M Joint Programme of Activities, organized into eight specialist technology and application cluster groups: polymers, metals, ceramics, packaging and assembly, metrology, microfluidics, micro-optics, microsensors and actuators. The establishment of the expertise resource will have an impact on interdisciplinary education and training, on work practices in society and on quality of life. 4M will develop strategic links to research organisations and manufacturing companies involved in complementary and supporting activities and connect to existing and new national programmes and will thus have a major impact on the development of the ERA in MNT. Contact will be maintained with other related centres of excellence outside of the network to ensure that knowledge and excellence are spread throughout

the EU. The 4M network will have a policy of training researchers from outside the network, including the use of distance computer-based learning, in order to counteract the shortage of skilled human resource in the MNT area and to generally spread knowledge and excellence beyond the network partners.

The distinguishing characteristics of the research and development activities in 4M are:

- A "top down" approach in reducing the feature size of micro-structures towards nanoscale
- Process characterisation to build up the necessary prerequisites for process modeling and simulation
- Development of "hybrid" micro/nano manufacturing methods; Manufacture of multi-material "hybrid" microsystems
- Material characterisation; Interfacing/packaging solutions for connecting micro/nano devices to their operating environment
- Wide range of applications in different industrial sectors with their specific requirements
- Design for manufacture and assembly.

Excerpt from the Network Presentation by Dr. Stefan Dimov, EURONET WORKSHOP, Sinaia, Romania, September, 2003

4M Objectives

Component Microtechnologies

- Micromachining:
- Microfabrication:
- Metrology
- Packaging & Assembly

Innovative Integration and Development of Hybrid Technologies

Capabilities for Multi-Material Micro Manufacture:

- Miniaturisation
- Serial Production
- Rapid Prototyping
- Future Product Platforms

Business Needs and Requirements

Drivers:

- Manufacturing capabilities:
- Product competitiveness:
- Legislation and Environment
- Cost
- Quality and conformance
- Resource exploitation

Applications:

- **Micro-fluidics:** biological, medical, pharmaceutical and chemical engineering applications
- **Micro-Optics:** telecommunication, biotechnological, instrumentation and medical applications
- **Micro-sensors and actuators:** applications in medicine, biomedical field, health and safety, environment and process control.

IMT-Bucharest expertise and involvement in 4M



Dr. Carmen Moldovan (cmoldovan@imt.ro) presenting the 4M Network at EURONET Workshop, on behalf of the coordinator, Sinaia, September, 2003

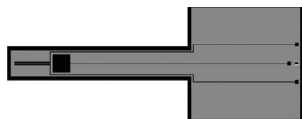
- integrating activities: Establishment of Synergistic Links with on-going Nationally and EC Funded Projects, Development of Virtual and Interactive Working Methods, Mobility and Exchange of researchers, Setting up a WEB portal for Collaborative Working
- polymer and ceramics processing
- micro-fluidics - micro-manufacture platforms for high pressure & high temperature applications; micro-fluidic manufacturing operations: compatible tooling and machining processes
- micro-optics - manufacturing of micro-moulds with free form



Microprobe for recording of cells and tissues electrical activity

surfaces in different kind of materials; assembly and testing of micro-optical systems

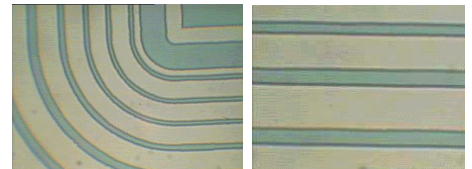
- micro-sensors and actuators - simulation and design (COVENTOR, IE 3D Fidelity, ANSYS, OptiFDTD), micromachining, thin layers deposition, photolithography, masks fabrication, SEM, AFM, electrical characterization, packaging
- micro-components produced in different materials including IC-compatible ones



CHEMFET Sensor for pH, K⁺, Na⁺, Mg⁺², Ca⁺² determination

IMT-Bucharest is also involved in a series of **national projects related to**

the activities of 4M. The main fields are **sensors and actuators** (ex: "Technology of manufacturing magnetic field sensors", "Micromachined magneto-transducers", "Micromachined sensor for gas detection", "Modeling and characterization of magnetic microstructures"); **polymers** (ex: "Technologies based on organic thin films for manufacturing of integrated optical components and microwaves for microsystems", "Sensor, pigments, active biological products and catalysts", "Technologies for realization of communication microsystems based on AlIBV and new polyimide materials"); **ceramics**

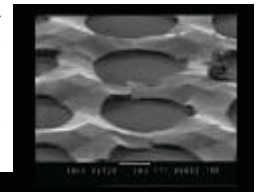


Wave guides obtained from organic-inorganic films based on the system PTEOS+MEMO

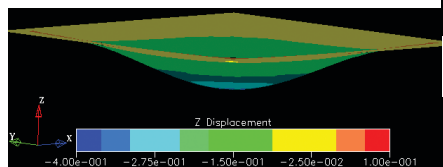


Clean Room of IMT

("Technologies for obtaining and micro-machining of AlN nanostructured thin films with piezoelectrical properties").



Microalveoles on PSG substrate



Simulation (Coventor) of a differential pressure sensor (deflection at 0,1 atm)