Continuum Mechanics Division

Our team performs activities in several fields of science, including SMART materials and structures, energy harvesting, dimensional analysis and theory of similarity, structural studies, biomechanics, dynamics of mechanical systems, materials technology (nano-materials, new plastics and their technology, reinforced composite structures, changes in microstructure and material properties, sol-gel technology, smart materials) and many more.

We focus on the application of smart and intelligent materials. Our activities are at the interface of material science and various applications in magneto-active systems that will play a key role in the development of future intelligent or smart systems, combining the areas of electronic system integration, on-chip sensing and actuation, autonomous power scavenging and wireless communi-cations. For many years we have been carrying out investigations involving magneto-vision as Non-destructive Testing (NDT) for materials and constructions. Moreover, our team has experience in energy harvesting (or energy scavenging) systems.

We have experience in researches into high pressure composite vessels for up to 700 bar of nominal working pressure. We are a partner in several international projects like StorHy, InGAS, HyComp, HyCube, which concern compressed hydrogen (CH2) and compressed natural gas (CNG) storage systems.

Additionally, we are using fractal geometry and cellular automate as a tool in different materials essential modelling as well as in dimensional analysis, in particular in composite materials with glass and carbon fibres. Furthermore, we utilize the catastrophe theory in modelling of materials and mechanical constructions' life time.

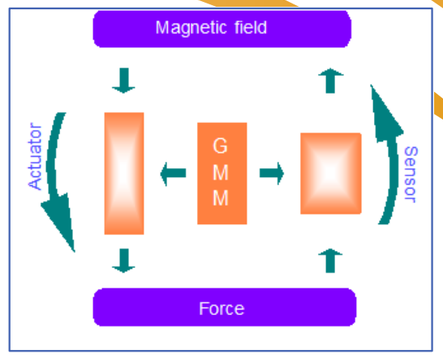
Moreover, we are interested in Structural Health Monitoring (SHM), particularly with the use of optical fibre sensors. Our SHM systems have been applied in the field of Power Engineering, to fluid power boilers, installations of environmental protection (the so-called desulphurisation systems) and as main frames of construction and pressure vessels (up to 700 bar).

Finally, we investigate austenitic steels with martensitic transformation (PIMT), nano-technologies involving thin layers and sol-gel materials.

SMART Materials

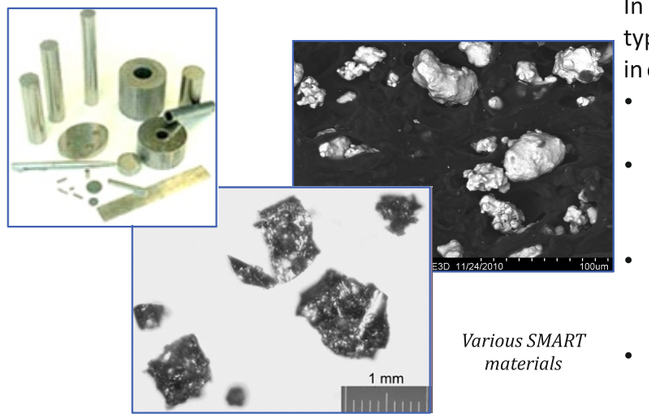
General information

In the last centuries technology and science have made a great development in the design of products using standard, basic materials also called "passive". With the expansion of the materials' market, our team has focused on different types of composites and on entirely new materials called "active" materials, also known as SMART materials. This term denotes the materials (fluids, gels, solids etc.) whose specific properties are changed due to the application of various external physical fields. Many types of SMART materials can be classified in terms of a given property that can be altered, such as conductivity, volume or viscosity.



Giant Magnetostrictive Material as sensor and actuator

Types of materials



Various SMART materials

In our laboratory we have developed numerous types of SMART materials which are very important in our expanding researches:

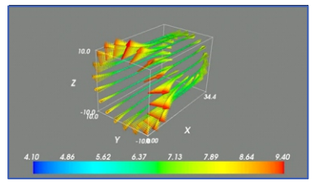
- magnetostrictive materials - under the influence of magnetic field they change their size,
- rheological - under the influence of electric and magnetic fields these materials undergo reversible changes in viscosity or material state.
- piezoelectric - ceramic or polymer materials, which change their dimensions under the influence of an electric field ,
- shape memory alloys (SMA) - materials which change their shape according to changes in temperature.

Applications

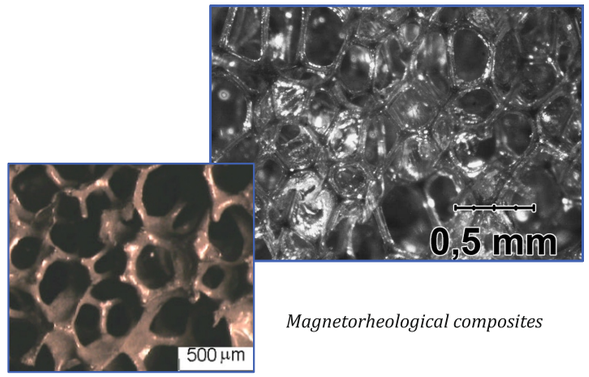
Materials created by us may be used in many applications:

- actuators
- sensors,
- shock absorbers,
- in precision machining,
- in fuel injectors,
- and others.

Our team is also capable of manufacturing dedicated magnetorheological fluids and magnetostrictive composites.



Magnetic image of a SMART composite



Magnetorheological composites