NATIONAL INSTITUTE OF RESEARCH & DEVELOPMENT FOR TECHNICAL PHYSICS

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The National Institute of Research and Development for Technical Physics (NIRDTP) of Iaşi belongs to the network of national institutes coordinated by the Ministry of National Education.

The ***mission of NIRDTP Iaşi*** is to conduct research, development, and innovation activities in the field of materials with novel structures and properties, devices, apparatus and equipments based on such materials, new preparation methods and characterisation techniques and nondestructive evaluation, electrical and magnetic separation methods, and special materials and devices with applications in engineering, medicine and biotechnology.

The implementation of these research activities is based on the work conducted in the frame of ***national*** (Ministry of National Education) and ***international*** (European Commission, bilateral governmental agreements, access to international research facilities, US Government) ***programmes***, as well as technological development contracts with Romanian and international ***companies***.

The scientific and technological research activities comprise:

(1) *fundamental research*:
   a. new models and phenomena
   b. new theoretical aspects;

(2) *applied research*:
   a. new materials and applications,
   b. new research-development equipments;

(3) *technological research*:
   a. novel technologies for manufacturing new advanced materials including nanomaterials and nanostructured (nanocomposite) materials;
   b. design and fabrication of new devices and technological equipments;

(4) *laboratory-scale production*:
   a. materials, devices, systems, and
   b. equipments for laboratory research and small-scale production activities.

The main ***research and development objectives*** are:

- ***preparation and characterization of advanced materials with special physical properties and structures*:** crystalline, amorphous, nanostructured/ nanocomposite, and nanodimensional materials;
- ***applications based on advanced materials*:** sensors, transducers, actuators, measuring systems;
- ***applications based on new phenomena, including the magnetic*:** nondestructive testing methods and magnetometry.

The main ***scientific and technological research directions*** at ***NIRDTP Iaşi*** concern the development of:

- **new magnetic micro-and nanodimensional materials,** e.g.: *micro-and nanowires*; *nanowire arrays*; *micor- and nanopowders*; *nanocomposites and mesoporous materials*; *multilayer thin films*;
- **new bulk amorphous, nanocrystalline or nanocomposite materials,** e.g.: *high-coercivity bulk amorphous materials*; *bulk amorphous and nanocomposite soft magnetic materials*; *new bulk shaped permanent magnets*;

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- **new multidisciplinary applications based on novel advanced multifunctional materials** prepared at ***NIRDTP Iaşi***, e.g.:
  (i) **magnetic sensors** (electric and magnetic field, flowmeters, etc.);
  (ii) **spintronic devices**;
  (iii) **sensors for (bio)medical applications**;
  (iv) **sensors and actuators based on magnetoelastic effects**;
  (v) **non-destructive control sensors**, etc.

Scientific and technological results developed in the last 10 years have been valorised through:

- over **360** published papers in ISI quoted journals;
- **12** patent applications and **22** granted patents;
- **13** technologies transferred to **9** research institutions and companies.

MOST RELEVANT PROJECTS

(I) *NANOSENS - "Upgrading the Capacity of NIRDTP to Develop Sensing Applications for Biomedicine using Magnetic Nanomaterials and Nanostructured Materials"*

- FP7-REGPOT-2012-2013-1 / Grant Agreement No. 316194
- EC Contribution: ***2,422,076.00 €*** (2013 – 2016)

AIM: to upgrade the research and innovation capacity of the ***NIRDTP Iași*** to the highest European level in ***microsensors for medical applications and biosensors based on magnetic nanoparticles and nanowires***.

The activities will increase visibility of ***NIRDTP Iași***, society/regional responsiveness and innovation potential for the most advanced topics of microsensors and biosensors:

- *microsensors for medical applications*: acoustic microsensors based on nano- and microwires for medical applications; implantable magnetic microsensors based on nanostructured materials for medical applications.
- *biosensors based on nanoparticles and nanowires*: sensors based on nanosized detection elements for applications in nanomedicine; biosensors based on multilayered nanowires for the detection of biomolecules.

The core activities are ***twinning partnerships*** with six European top level specialist research organisations: Sheffield Centre for Advanced Magnetic Materials and Devices within the Department of Engineering Materials, ***University of Sheffield***, United Kingdom; Department of Materials for Information Technologies in the ***Instituto de Ciencia de Materiales de Madrid***, Spain; ***Instituto de Engenharia de Sistemas e Computadores para os Microsistemas e as Nanotecnologias*** (INESC-MN), Lisbon, Portugal; Nanobioelectronics & Biosensors Group in the ***Institut Català de Nanotecnologia***, Barcelona, Spain; Solid State Physics group within the Department of Physics and Astronomy, ***University of Glasgow***, United Kingdom; Materials Science Electron Microscopy Department at the ***University of Ulm***, Germany.

By the implementation of this project, ***NIRDTP Iasi*** will:

- ***enhance its human potential*** by employing 7 experienced researchers, 1 intellectual property and innovation manager, as well as organising know-how exchanges and trainings for existing and new staff with twinning partners;
- ***enhance its technology potential*** by purchasing a scanning Auger nanoprobe equipment, upgrading its RF sputtering equipment with laser ablation capabilities, and purchasing a gel electrophoresis system;

- ***enhance its scientific visibility*** through supported promotion activities, and by organising dissemination workshops and scientific conferences/meetings.

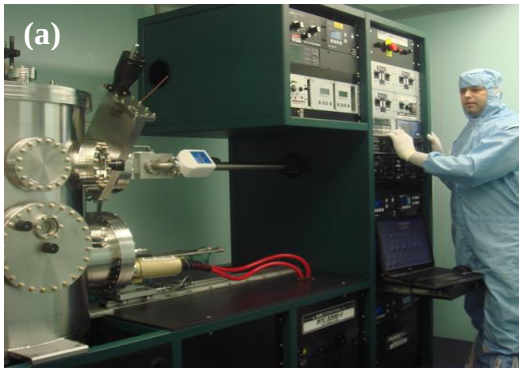
(II) ***MAGNESENS – "Euroregional Advanced Research Centre for Sensors and Sensor Systems based on Magnetic Micro and NanoMaterials"***

- Structural Funds: SOP-IEC/A2-O.2.2.1 / Contract no. 255/28.09.2010
- EC and Romanian Government contribution: ***4,588,235.00 €*** (2010-2013)

AIM: to establish at the ***NIRDTP Iaşi*** an **Euroregional Advanced Research Centre for Sensors and Sensor Systems based on Magnetic Micro and Nanomaterials** which will ***constitute a reference centre*** in the field of sensors, ***unique at the national level***. The **MAGNESENS Centre** integrates the specific R&D activities of the *Materials, processes and innovative products* thematic area with the aim to enhance the economic competitiveness by creating an innovative society based on knowledge, emergent in the North-East region of Romania, with positive impact in the European Research Area (ERA). The project is contributing to the development and modernisation of the infrastructure for enhancing the quality and efficiency of R&D and innovation activities at ***NIRDTP Iasi***.

The ***Centre*** comprises five laboratories, two modernised and three newly created ones:

1. Laboratory for the Preparation of Thin Films and Nanostructuring (Thin Film Deposition Equipment **(a)**; Laser Lithography System; ***Ultra-High Resolution Electron Beam Nanolithography Workstation*** **(b)**; ***Clean Room facilities*** **(d)**)



2. Electron Microscopy Laboratory (CrossBeam System - high resolution Field Emission-Scanning Electron Microscopy (FE-SEM), Focussed Ion Beam (FIB), gas injection system (GIS); ***Ultra-High Resolution Transmission Electron Microscope – UHR-TEM*** **(c)**; facilities for samples preparation by ion polishing and FIB)

3. Laboratory for Sensors and Sensor Networks based on Microdimensional Magnetic Materials (***Magnetically Shielded Room facilities*** **(e)**)

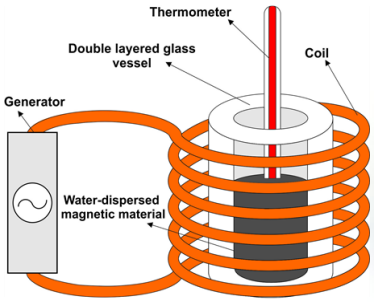
4. Laboratory for Magnetoresistive Sensors based on Magnetic Micro- and NanoMaterials (***Magnetically Shielded Room facilities*** **(e)**)

5. Laboratory for Magnetic Biosensors and Magnetic Sensors for Medicine (***Magnetically Shielded Room facilities*** **(e)**).

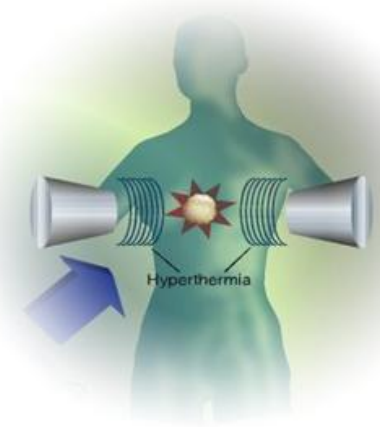
(III) ***HYPERTHERMIA - „Low Curie Magnetic Particles for Hyperthermia Applications***"

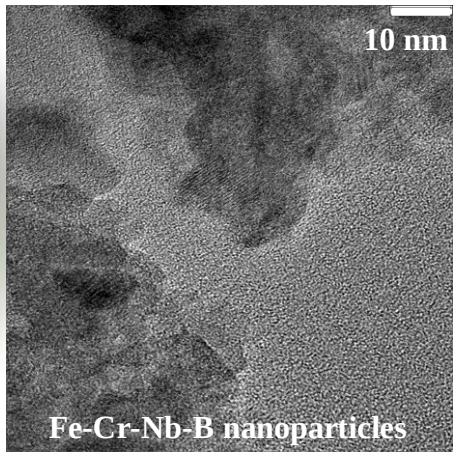
- PN-II-PT-PCCA-2011-3 / Contract no. 148/2012 - Coordinator: NIRDTP Iași
- ***445,000.00 €*** (2012-2015)

AIM: to prepare a new type of magnetic micro- and nanoparticles (i.e. Fe-Cr-Nb-B alloy) with low Curie temperature (T_C), which allows a rigorous control of the temperature within the range 40-60ºC. The presence of such particles in a tumour allows the heating up to the T_C of the particles, slightly higher than the human body temperature (42-44°C), with an accuracy of up to 0.5ºC, leading to the regression of the malignant tumour.



Magnetic-induction hyperthermia unit





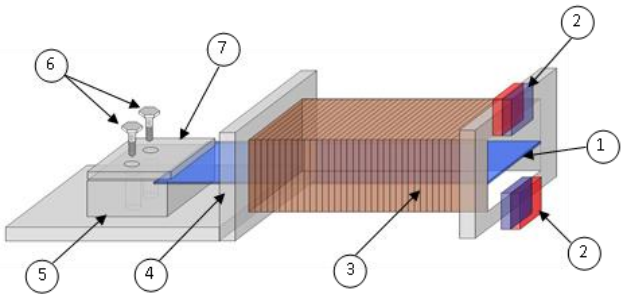
The research activities of the **HYPERTHERMIA project** are conducted in partnership with two higher education institutions: University of Medicine and Pharmacy "Gr.T. Popa" of Iaşi and "Alexandru Ioan Cuza" University of Iaşi.

(IV) ***STREAM – "Small Energy Harvester based on Magnetostrictive Amorphous and Nanocrystalline Materials"***

- MNT-ERA.NET Programme / Contract no. MNT-ERA NET 7-059 - Coordinator: NIRDTP Iași
- Project value: ***425,000 €*** (2012-2014)

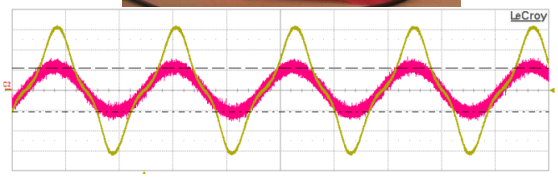
AIM: *to develop, optimize and commercially exploit the prototype of a novel* ***energy harvesting device*** *with increased power conversion efficiency and higher output power based on magnetic ribbons.* The associated objective is to test and demonstrate the operation of the prototype both

as an individual device and as part of an energy harvesting array of similar devices in supplying power to a wireless sensors network or to an autonomous sensor or array of autonomous sensors.



Design features:

(1) multilayer amorphous ribbons beam anchored at only one end of cantilever;
(2) permanent magnets;
(3) coil; (4) coil housing;
(5) fixing support; (6) fixing screws.
(7) fixing plate



Voltage(yelow)/acceleration(red) vs. time.

The research activities of the **STREAM project** are conducted in partnership with the Institute of Experimental Physics of the Slovak Academy of Sciences, Košice and GRADIENT SRL, Iaşi, Romania.

(V) *VitriMetTech – "Vitrified Metals Technologies and Applications in Devices and Chemistry"*

- FP7-PEOPLE-2013-ITN / Grant agreement no.: 607080 - Coordinator: Universita Degli Studi di Torino, Italy
- Project value: ***3,465,780.12 €*** (2013-2017)

AIM: to educate a group of young researchers to implement methods for cutting edge research on new metallic glasses (e.g. Fe, Mg, Al, Ti-based), also in bulk form, and their amorphous/crystalline composites, for functional, bio-mechanical, chemical and structural micro-part applications. Transfer of results to industrial companies will boost innovation in a part of the Metal sector of the European manufacturing industry.

VitriMetTech comprises five Research Projects which are designed to achieve the following objectives: (1) *soft magnets with low or zero-magnetostriction for use in inductors and toroid-shaped or flat transformers;* (2) *highly magnetostrictive alloys to exploit magneto-mechanical coupling for energy harvesting and cantilever devices;* (3) *bio-corrodible Mg-based bulk vitrified metals for implants free of toxic elements and with low elastic modulus;* (4) *nano-porous metals made from metallic glass precursors for electro- and heterogeneous catalysis, enhanced Raman spectroscopy, flexible electrodes and actuators*; (5) *improving the mechanical properties of vitrified metals for the above applications.*

Partners: 11 of the best European academic research teams and 6 private sector companies, from Italy, France, Germany, Greece, Poland, Switzerland, Romania and United Kingdom.