Two decades of micro-nanotechnologies

Romanian institute's award-winning achievement in competitive innovation…

In 2012 the National Institute for R&D in Microtechnologies (IMT-Bucharest, or the acronym IMT) will mark 20 years since its set-up as one of the R&D institutions pioneering the approach towards microtechnologies. This was just one year before the inclusion (in 1994) of the revolutionary field of microsystem technologies (MST) in the EU research grant programmes. Notably, IMT was the first R&D organisation in Eastern Europe that approached the microtechnologies field. Today, IMT is a well established R&D national institute, with state-of-the-art experimental facilities benefiting of highly skilled and multidisciplinary scientific and technical personnel, widely connected and with a solid national and European reputation. The current mission of the institute relates to micro and nanotechnologies, in close connection with some of the key enabling technologies (KET), namely micro-nanoelectronics, photonics and nanotechnologies (www.imt.ro). The institute's founding and its subsequent trajectory were managed by Professor Dan Dascalu, CEO and President of the Board until 2011. Currently, IMT is managed by Dr Raluca Müller.

As a national R&D institute (since 1996), IMT is an organisation of public interest in Romania, being able to access public funding from national and European programmes. IMT is currently coordinated by the Department for Higher Education, Research and Development of the Romanian Ministry of National Education. In practice, IMT is autonomous, acting as a non-profit research company. The activities are multi-focused, ranging from science and technology (S&T) development and innovation in micro-nano-bio technologies, to integration of R&D with education and training, to support for, and cooperation with, industrial partners – strategic partnerships, services, project collaborations, national and international networking.

Dynamics

The dynamics of IMT-Bucharest has been ensured by the three main development priorities designated by the management, that is; personnel recruiting, training and motivation; continuous focus on infrastructure growth and modernisation; and attraction of competitive project grants. These factors were intertwined and have fostered each other's development.

The starting asset of IMT was the highly qualified scientific and technical personnel that came both from the electronic components research community, and from the local microelectronics industry. This allowed early significant success rates in winning national (2000-2004) and international (2005-2011) grants and, thereby, an accelerated pace in the development of an advanced infrastructure (2006-2009).

These achievements were essential to create the appeal of the organisation and thereby ensure a continuous influx of valuable researchers with national and international background in multidisciplinary advanced research. During the last three years, the number of PhDs has doubled, reaching the 50% ratio (44 researchers). One can notice here a notable success in reintegrating Romanian researchers specialised abroad: 35% from the new PhDs obtained their qualifications in universities abroad (Europe, USA, Singapore, Japan).

With a first EC grant gained in 1998, IMT's management introduced in 2004 a special accent on participation in EC Framework Programme grants. The prioritisation has been of valuable impact, with a continuous increase in the number and depth of FP participations: 15 in FP6, 12 in FP7, another 11 in FP7-related (JTU-ENIAC, MNT ERA, COST, Eureka, Leonardo da Vinci). Between 2007 and 2012, about 20% of the organisation revenues were coming from international projects. IMT was the first Romanian entity to lead a FP7-REGPOT project (MIMOMEMS Center of Excellence), while the 2011 'Innovation Union Competitiveness Report of EC' placed IMT-Bucharest in the top five – the only national institute – of 'Most active organisations in terms of EC contribution granted to the FP7 research projects'.

The interval 2006-2009 was of major importance for the development of the new experimental infrastructure under a new open-access concept. State-of-the-art processing, characterisation and CAD-CAE facilities worth more than €7m were installed, ensuring a complex and complete R&D cycle for micro and nanotechnologies. This included two clean room areas and one 'gray' area totalling about 700m^2, complete mask shop, electron beam nanolithography, physical and chemical depositions and etching, broad range of nano-bio analysis and characterisation, rapid prototyping, combined reliability testing – all these are keywords for the new IMT centre for Micro and NAnoFABrication (IMT-MINAFAB facility, details at www.imt.ro/MINAFAB).

The launching in 2009 of this open facility brought about a rather fast radically increased interest from industry and academia. Through the Science and Technology Park for Micro and Nanotechnologies (MINATECH-RO) – set-up by a consortium with just two partners:

IMT (housing most of the park area), and University 'Politehnica' of Bucharest – IMT provides office spaces and priority to experimental facilities for a few companies (latest example being Honeywell Romania), as well as the possibility to install their own equipment in the technological area.

The infrastructure development and the accumulated expertise allow IMT-Bucharest to provide increasingly complex educational activities in cooperation with universities: undergraduate, MSc and PhD studies, as well as 'hands-on training'. IMT was active in a Marie Curie training-by-research network and also in the Leonardo programme and in 'Eurotraining'. Since October 2009, the institute specialists have been fully covering a number of disciplines in the new MSc programme organised by the University 'Politehnica' of Bucharest. Since 2010, IMT has coordinated a programme of postdoctoral studies in micro and nanotechnologies, financed from structural funds (2010-2013). The institute is organising the annual Conference for Semiconductors (CAS), an IEEE event (CAS 2012 was the 35th edition), now largely devoted to micro and nanotechnologies.

Highlights from R&D projects

One of the topics addressed by the Nanobiotechnology Lab (Centre of Nanotechnologies, associated also with the Romanian Academy of Sciences) is called nanosafety, that is, the study of the risks to environment and health associated with products incorporating nanomaterials. The lab (led by Dr Mihaela Kusko) currently takes part in two FP7 projects focused on nanotoxicology.

The NanoSustain project (2009-2013) focuses on sustainable design, use, recycling and final treatment of few classes of nanomaterials such as: nanocellulose-based materials and products (e.g. paper additive); nanoTiO2-based products (paint applications); nanoZnO-based composites (glass coatings); MWCNT-based products (epoxy plates; solar cells). A comprehensive characterisation of nanoZnO has been realised using complementary physico-chemical methods, providing useful information towards better control of dosing during biotoxicological tests.

NanoValid is a large project (30 partners, 24 from Europe) devoted to validating the measurements and toxicity test methods. In cooperation with international standardisation bodies and the industry, advanced physico-chemical characterisation methods for organic and inorganic nanomaterials are studied, aiming at developing a set of reliable reference methods and materials for the fabrication, hazard identification and exposure assessment of engineered nanomaterials (EN). The work packages with IMT involvement are establishing how different suspension media influence the properties of nanomaterials, and moreover, if there is a correlation between their physico-chemical properties and the induced toxicological effects.

The Micromachined Structures, Microwave Circuits and Devices Lab (led by Dr Alexandru Müller) belongs to the Centre of Excellence MIMOMEMS (initially financed by the REGPOT-2007-1 programme). The lab also participated in four FP7 projects and three nanoelectronics PPP projects (European Nanoelectronics Initiative Advisory Council) and is part of an associate European laboratory, together with other two centres: LAAS-Toulouse (France) and FORTH, Heraklion (Greece).

The group is at its highest R&D maturity and operates with top of the line facilities for testing and validation of micro and millimetre wave devices. The strong and stable cooperation with many of the most important research teams and industrial partners from Europe has ensured the development of solutions beyond the state-of-the-art in various topics connected to the actual needs of Europe's scientific and industrial development. Two examples of European FP7 cooperation are the MEMS-4-MMIC and SMARTPOWER projects.

The MEMS-4-MMIC consortium includes research institutes (IEMN-France; IMT Bucharest-Romania; FOI-Sweden; VTT-Finland) and industrial partners (IMST-Germany; OMMIC-France; SAAB-Sweden). The aim of the project was the integration of radio frequency micro-electro-mechanical systems (RF-MEMS) onto monolithic microwave integrated circuits (MMICs) to create highly integrated multifunctional building blocks for high-value applications, such as receiver front-end for automotive applications (collision avoidance radar). The IMT-Bucharest team contributed with the electromagnetic modelling, design and characterisation of millimetre wave components and circuits up to 110GHz.

The goal of the currently running SMARTPOWER integrated project is to develop novel power modules for industrial inverters and radio frequency transmitters, respectively. These key electronic components will be developed by using novel semiconductors (silicon carbide, gallium nitride) that allow operation at much higher temperature than silicon. IMT is involved – together with FORTH, Heraklion and Thales TRT (that coordinates the project) – in the design, manufacture and characterisation of a novel sensor for temperature monitoring. In order to comply with the special sensitivity and operating conditions, a highly sophisticated principle has been devised that also requires advanced technological processing.

National Institute for R&D in Microtechnologies
IMT Bucharest

Tel: +40 21269 0778, ext. 19

radu.popa@imt.ro
www.imt.ro