Expanding micro and nanotechnologies

Emerging and future microsystems and nanodevices...

The Institute of Microelectronics (IMEL) has been established in 1986 as one of the eight research Institutes of the National Center for Scientific Research 'Demokritos' (NCSR 'D), a multidisciplinary research centre under the General Secretariat for Research and Technology. The centre is located at Aghia Paraskevi, 12km from Athens and 5km from the University of Athens and the National Technical University of Athens.

The IMEL's mission is to perform medium to long-term research in micro and nanotechnology, thus contributing to the development of novel microsystems and nanodevices used in high-added value products with a wide range of applications. Simultaneously, IMEL supports related educational activities in Greece, collaborates with industrial partners and offers services to external users.

With more than 25 years of research and development experience, IMEL is now established as the main organisation in Greece with full capability in micro and nanotechnology and system design, fabrication, characterisation and testing. At a European level, moreover, it constitutes one of the most highly-competitive research institutes in the above fields. The excellent staff at the IMEL is composed of a small number of experienced senior scientists, surrounded by a large number of young researchers.

The central micro and nanofabrication facilities operating at the IMEL include a full silicon processing laboratory in a clean room area of 300m^2 that is adequate for the realisation of conventional and advanced devices on silicon substrates. Recently,

advanced electron beam lithography equipment has been purchased, enabling the realisation of nanometre size devices where quantum phenomena prevail. Satellite laboratories include electrical and optical characterisation, organic materials and resist processing, as well as advanced imaging equipment (scanning electron and scanning probe microscopes).

Contribution of IMEL to microelectronics research

Microelectronics is facing many challenges leading towards the extension of its impact from the well-known computer and telecommunications sectors to other fields, such as health, the environment, energy and automotive. This broadening of applications necessitates the integration of different functions (electronic, optical, mechanical, bio-chemical) on the same chip or in the same package, providing many opportunities for multidisciplinary research.

Silicon is the basic material in use for these miniaturised systems, and its functionality is continuously being enhanced by the addition of new materials. While the development of microsystems enlarges the application field of microelectronics, the need for low-power, faster and denser electronic functions pushes the technology limits of electronic devices to nanoscale dimensions. Although silicon is still the workhorse of this technology, many rivals are on the horizon, such as III-V semiconductors and carbon-based materials, eg. graphene. At present, it is not at all clear when, if ever, silicon will be replaced by another material.

IMEL researchers – having realised the need for the multidisciplinary approach that is required for emerging and future microsystem research – have, in time, initiated and developed long-lasting alliances with the other institutes of the NCSR, as well as with other research organisations in strategic areas such as nanobiotechnology and nanolithography.

In addition, research synergies have been developed within the institute for the same purpose.

Research at IMEL is carried out at EU level through its participation in European research projects, networks of excellence and technology platforms. EU projects cover a number of specific priorities of the EU research framework programme, including mainly information and communication technologies; nanotechnology, materials and production processes; and energy, health and the environment. IMEL's success in the above peer reviewed R&D funded programmes represents one of the strongest endorsements of IMEL's R&D competence and reflects the world-class standing of the institute. As a result of the numerous European and national projects that the IMEL has participated in, important research findings have been published in high-impact journals and related patents have been issued.

Some of IMEL's significant accomplishments over the past few years

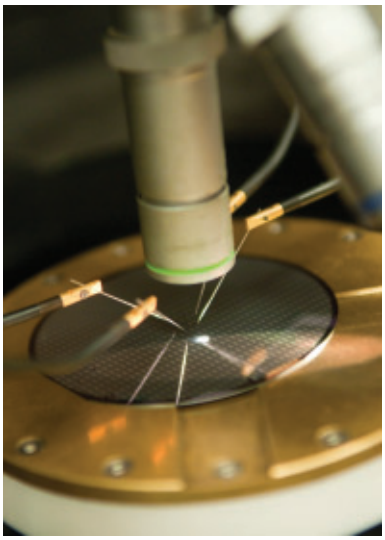
include the development of integrated optical or mechanical silicon transducers with integrated readout and microfluidics suitable for point-of-care testing, sensors able to recognise a variety of gases operating similarly to an electronic nose, and new concepts for the realisation of low-power electronic memories based on silicon or organic materials. These achievements will pave the way for future research activities at IMEL, such as the development of autonomous microsystems harvesting energy from different sources.

At European level, IMEL is a member of the European Academic and Scientific Association for Nanoelectronics, which aims to promote scientific collaborations with industry and provide skills and expertise for the execution of common projects and studies, as well as education and training in nanoelectronics. IMEL is also one of the 16 founding members of the European Institute of Nanoelectronics, named SINANO, which was established in 2007.

IMEL was recently awarded a three year EU funding grant from the REGPOT programme to become a Centre of Excellence in Micro and Nanosystems, with a key role in South Eastern Europe. This includes the purchase of a state-of-the-art e-beam nanolithography tool with lithographic capabilities down to 8nm (1nm = 1 billionth of a metre), recruitment of postdoctoral researchers and secondment of personnel to well-recognised research centres for the exchange of know-how. The project that started in late 2009 will enable the exploration of nanoscale devices, such as nanowires, as building blocks of future nanosystems.

The national role of IMEL

At the national level, the expertise and infrastructure of IMEL are unique in Greece, which reflects its central role in developing novel technologies, in transferring technology and know-how to the industry and in developing human potential.



IMEL aims to act as a national centre of excellence in micro and nanofabrication, nanoelectronics and MEMs, and to provide access to its facilities to research centres, universities and SMEs at national and European level. In this context, IMEL plays a significant role in educational and training activities for Master's and PhD degrees, in collaboration with Greek universities. It is worth noting that several former PhD students and postdoctoral researchers of IMEL are founders or key personnel of design houses currently operating in Greece, and some others have been recruited as technologists in the recently established photovoltaic industry in the country.

The Hellenic Semiconductor Industry Association, which gathers together a remarkable number of small but dynamic private companies – as well as new industries in the field of silicon solar cells offer new opportunities for industrial collaborations within the country for IMEL in the coming years. By the same token, spin-off companies from the institute are now seeking to exploit new fabrication and characterisation technologies and microsensors developed at IMEL.

For countries such as Greece, where there are no traditional mainstream semiconductor foundries, the advent of microsystems and nanotechnology opens up the opportunity to develop new small-to-medium facilities to produce microproducts for the replacement of traditional technological commodities without the need of exceedingly large capital investment. Smart ideas developed in the laboratory through micro/nanotechnology can materialise into products or components of a larger commercial entity, run by young researchers through micro/nanotechnology, with modest capital investments.

After 25 years of growth and following the recommendation of the external evaluation committee and the encouragement of its advisory board committee as well, IMEL has recently proposed to the General Secretariat of Research and Technology an outlook for the future, with the creation of a new, state-of-the-art facility. The likely acceptance of such an initiative is of critical importance for IMEL's continuing growth and interaction with European research organisations. This interaction will not only have an impact on IMEL's research activities but it will also influence higher education and the emerging industrial activities in the country.

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