Micro and Nano Technology in Ireland

Cian Ó Mathúna and Michael Grufferty

Building on Ireland's recent 'Celtic Tiger' economic growth, the Irish Government, through the National Development Plan 2000-2006 (NDP), has committed to spend €2.48bn for research, technological development and innovation, as part of its policy to ensure that Ireland will be one of the foremost knowledge-based economies in the world. It is achieving this objective through large-scale, collaborative and strategic investments by various funding agencies.

The Investment Development Agency is targeting foreign direct investment in R&D from major multinational companies (www.ida.ie). Enterprise Ireland's strategy is to transform Irish indigenous companies into market-focused and innovation-driven businesses, capable of maximising exports through the utilisation of applied research and technology (www.enterprise-ireland.com).

Science Foundation Ireland (SFI) was established, with a budget of over €700M, to target long-term research investment into two strategic areas: ICT and biotechnology (www.sfi.ie). SFI and the Higher Education Authority (www.hea.ie), have invested more than €300M in third-level MNT research, resulting in the establishment of world-leading centres of excellence with up to 1000 researchers working in the areas of microelectronics, sensors, ambient intelligence, nanoelectronics, photonics and bio-medical diagnostics.

Funded as part of the NDP investment strategy, the **Tyndall National Institute** (www.tyndall.ie) is Ireland's largest ICT research centre. Incorporating research activities from the former NMRC, University College Cork and Cork Institute of Technology, Tyndall brings together over 300 researchers on a single site with extensive research and MNT fabrication facilities for the benefit of Irish industry and academia. A significant player in EU FP6 programmes, Tyndall has major research activities in electronics, photonics, nanotechnology and ICT for life sciences. Recent highlights of MNT research activities include:

- In ambient intelligence, Tyndall is developing miniaturised 3D (25mm and 10mm cubes), autonomous, wireless sensor modules that offer a unique level of modularity, design flexibility and robustness for applications in e-health and sustainable development.
- Photonic devices developed at Tyndall, currently in commercial production, include vertical-cavity surface emitting lasers (VCSELs) and resonant-cavity light-emitting diodes (RCLED).
- Nanotechnology researchers have developed novel ultra compact devices based on functional nanomaterials such as single nanowire sensors,waveguides, lasers and photodetectors.
- In the area of medical devices, microneedles, fabricated using silicon and polymer technology, have been used to study electrotherapy of cancer tumours and for painless delivery of DNA vaccines to human skin tissue.

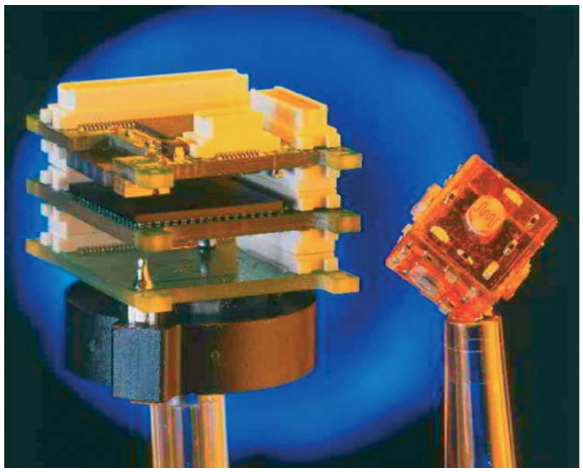

Figure 1: Tyndall 25mm and 10mm 3D wireless sensor modules.

Information and Communications Technologies (ICT):
Ireland hosts leading multinational ICT companies including Analog Devices, HP, IBM, Intel and Xilinx. Intel is currently in start-up mode for its 65nm, 300mm wafer fabrication facility. Intel is also an industrial partner in the SFI-funded Centre for Research on Adaptive Nanostructures and Nanodevices. Xilinx, Inc., a world leader of programmable logic solutions, has recently established Xilinx Research Labs at its European Headquarters in Dublin.

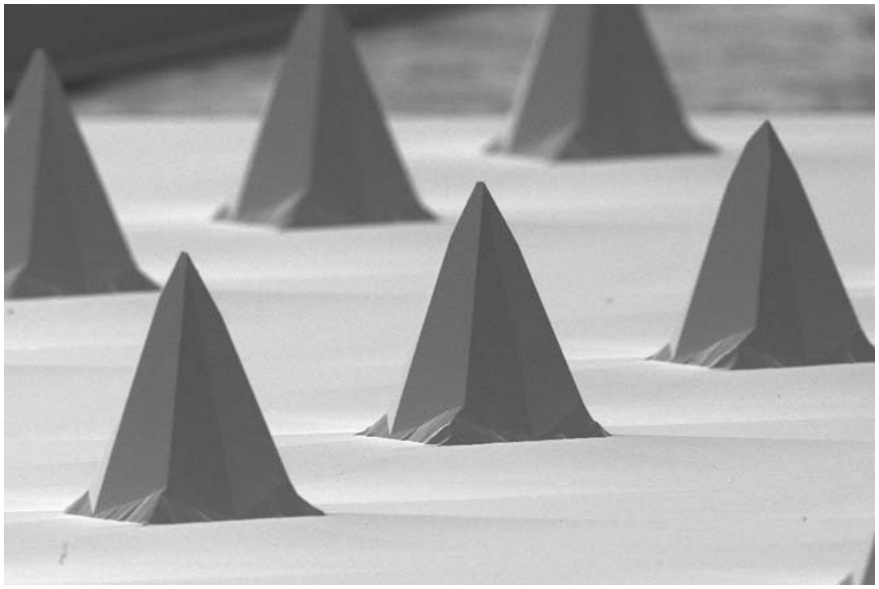

Figure 2: Wet-etched silicon microneedles, fabricated at Tyndall, for use in electrotherapy of cancer tumours and painless delivery of DNA vaccines to human skin tissue.

The SFI-funded **Centre for Telecommunications Value-Chain Research** (CTVR - www.ctvr.ie) is focused on applying a multidisciplinary, value-chain perspective to research aimed at realizing the next generation of telecommunications networks. Research is being undertaken on advances in radio, optical and network control technologies, but also, most critically, on the ability to manufacture and construct these networks at affordable cost. Lead by Trinity College Dublin, the Centre brings together researchers from 5 Irish Universities. The key industrial partner, Bell Labs Ireland, works closely with researchers in New Jersey and other Lucent research facilities around the world.

Ambient Intelligence and Wireless Sensor Networks:
With core competencies in photonics, life sciences & health and nanotechnology & microsystems, the **National Centre for Sensor Research** (NCSR - www.dcu.ie/~ncsr) at Dublin City University (DCU) has identified networked sensors and point-of-care diagnostics as key strategic areas for the future development of sensor technology. NCSR, along with research teams from DCU and University College Dublin (UCD), is leading an SFI-funded programme, within the €6.5m **Adaptive Information Cluster** (AIC), a multi-disciplinary research cluster with a mission to integrate research on adaptive sensor networks, content extraction and adaptive utilization for applications in health management, traffic management, environmental monitoring and personalized retailing.

Optoelectronics and Photonics:
With significant investment in optoelectronics R&D since the early 1990's, Ireland has established a base of indigenous SMEs including: Eblana Photonics, Firecomms, In-Tune Technologies, Optical Metrology Innovations (OMI), Ntera, NuaLight, Plasma Ireland, PxiT, SensL and XSiL. Product applications include communications, displays, consumer electronics, automotive, biomedical diagnostics, instrumentation, optical device manufacturing systems and semiconductor processing and characterisation.

Nanoelectronics:
Intel is the key industrial partner in the ambitious €22 million nanoscience programme at the SFI-funded **Centre for Research on Adaptive Nanostructures and Nanodevices** (CRANN, www.crann.tcd.ie) which combines world-leading scientists from Trinity College Dublin, University College Dublin and University College Cork. CRANN has four key research areas: (1) nanoscale contacts and transport (2) self-assembled nanomaterials for pattern formation in chip technology (3) spin electronics that will allow the development of entirely new kinds of computers and (4) molecular interaction at cellular membrane and fluid interfaces that will ultimately be useful for new drug delivery technology.

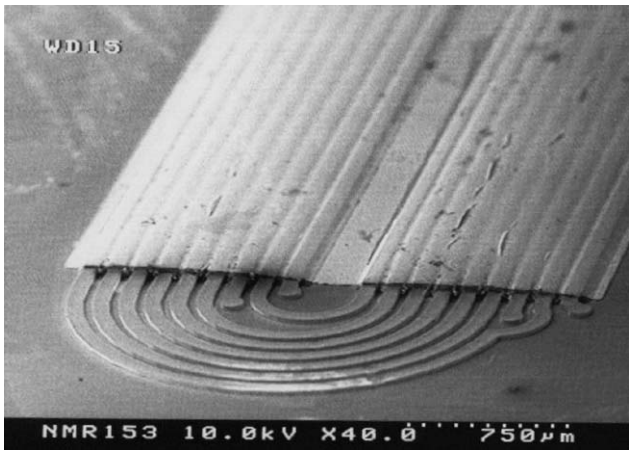

Figure 3: Thin film micromagnetic transformer on silicon for use in future power supply on chip (PSOC) applications.

Medical Devices and Diagnostics:
Ireland currently hosts manufacturing facilities for 13 of the top 25 medical device and diagnostics companies in the world. In recent years, companies such as Medtronic and Boston Scientific have established R&D teams in Ireland. In September 2005, SFI funded a **Biomedical Diagnostics Institute** at Dublin City University. With initial funding of €16.5m, including collaboration with Irish-based and foreign SMEs and MNCs, the Institute's goal is to position Ireland to make a major breakthrough in the €20Bn global diagnostics market through the development of revolutionary, miniaturised, self-diagnostic devices and sensors to provide early warning of deadly and debilitating illnesses like cancer, diabetes and heart disease.

Technology Clusters:
In a drive to develop and sustain strategic industry sectors, Enterprise Ireland has lead an initiative to establish industry networks of indigenous SMEs, multinationals and academic research groups in areas such as IC design, power electronics, wireless sensor networks, photonics, nanotechnology, medical devices and biotechnology for diagnostics and process monitoring (www.midas.ie), (www.peig.ie), (www.wisen.ie), (www.photonicsireland.com), (www.nanotechireland.com), (www.ibec.ie/Sectors/IMDA). Recently, a 3-year, €3.3 M, industry-lead research programme was launched to develop next generation power management systems based on magnetics-on-silicon for power supply-on-chip; digital control, 3D packaging and advanced thermal management (www.peig.ie).

Conclusion:
Ireland is positioning itself as a knowledge economy based on advanced education, innovation and high technology investment. Investment in R&D in MNT, in indigenous SMEs, multinationals and academia, is a strategic element of this vision with large-scale, coordinated programmes being targeted in microelectronics, sensors, ambient intelligence, nanoelectronics, photonics and bio-medical diagnostics and therapeutics.

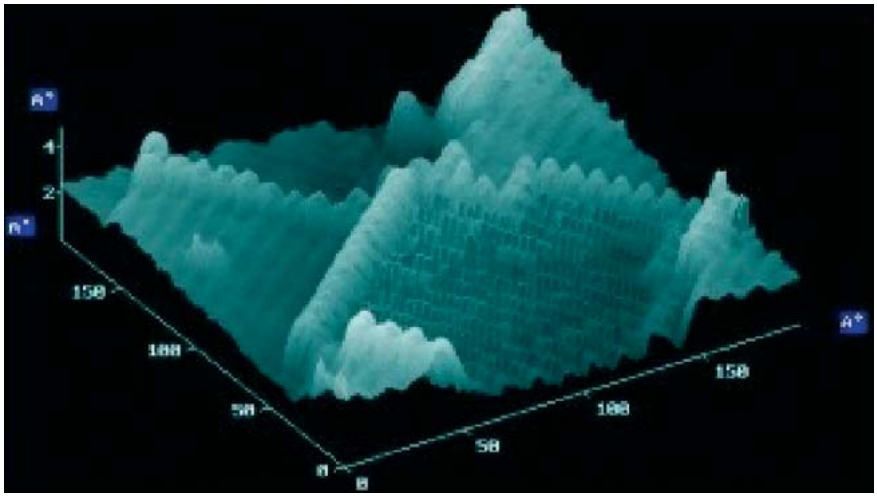

Figure 4: Nanometre scale detail on the surface of tungsten observed at CRANN.

Figure 5: An expressive evening gown, developed by Lucy Dunne at AIC, which displays physiological signals, such as laughter, pulse, alertness and the startle reflex, through lights embedded in the garment.

Looking into the future, the Irish government has initiated a Technology Assessment exercise to identify investment options for the successful development and application of nanotechnology in Ireland.

NanoIreland, with three panels established in the areas of Nanobio, Nanomaterials and Nanoelectronics, has initiated a consultation process that will engage with industry, academia, society and government to participate in the national decision-making process to assess future national investment options (www.nanoireland.ie).

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Contact:
Dr. Cian Ó Mathúna
Tyndall National Institute, Cork, Ireland.
Phone: +353 21 4904350
E-Mail: omathuna@tyndall.ie