NanoNextNL: Big in small things

With a total of 44 projects in ten different themes, TU Delft is a major participant in the NanoNextNL research programme, which was officially launched this summer. PhD students and postdocs are currently being recruited for research work due to last until 2016.

Jos Wassink

The NanoNextNL programme focuses on the development of nanotechnology in the broadest sense of the word: from nanomedicines and sensors, to energy applications and health risks. At TU Delft, projects have been submitted by the faculties of Applied Sciences (AS), Mechanical, Maritime and Materials Engineering (3mE), and Electrical Engineering, Mathematics and Computer Science (EEMCS), in particular, followed by the faculty of Technology, Policy and Management (TPM).

The research programme chaired by Dave Blank, a professor at the University of Twente, follows on from the previous BSik programmes MicroNed (approximately 56 million euros) and NanoNed (180 million euros).

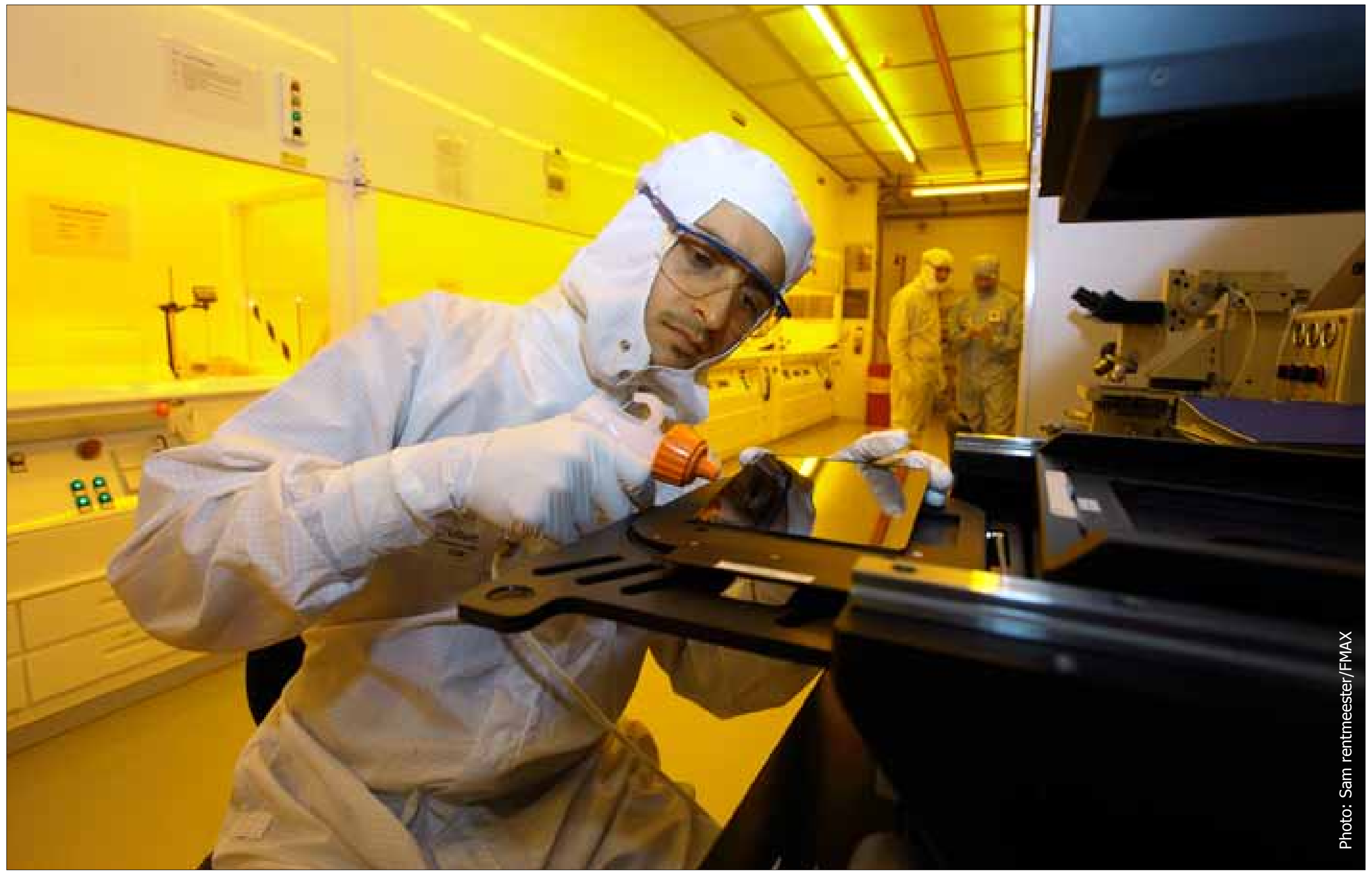
According to the nanonext.nl website, the objective of the new research programme, in which universities, knowledge institutes and companies collaborate, is to create "an open, dynamic and sustainable ecosystem for research and innovation, with which the Netherlands can continue to play its leading role in the world, and can extend this role further, in micro and nanotechnology".

The total budget for the programme is 250 million euros, of which half will be contributed by the universities, knowledge institutes and companies, primarily in the form of man hours and the use of facilities. The other half will be funded by the Ministry of Economic Affairs, Agriculture and Innovation, paid from the natural gas profits (Economic Structure Enhancing Fund (FES)).

The Delft micro/nano community has submitted 44 projects with a total budget of nearly 24 million euros. The participation of the other Dutch universities is comparable: the University of Twente has submitted projects worth 27.6 million euros, and Eindhoven University of Technology projects worth 16.9 million.

"The universities of technology and Wageningen University are active on a wide scale," observes Dr Leon Gielgens, Programme Office Director of NanoNextNL at STW. Professor Fred Keulen (3mE), vice-chairman of NanoNextNL, agrees: "These universities contributed greatly to the MicroNed and NanoNed programmes and consequently played a significant role in designing the NanoNextNL programme. As a result, several hundred PhD students are being educated there, and they will be our future knowledge workers."

www.nanonextnl.nl

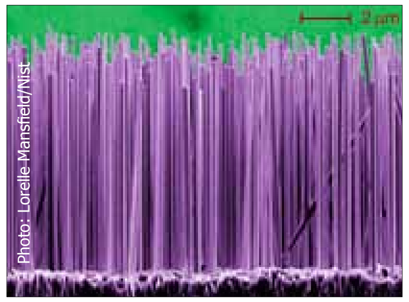


Hugo Perez Garza at work in the cleanroom of the Van Leeuwenhoek Laboratory.

More than Moore

The law of Moore (the number of circuits on a microchip doubles every two years) has applied since the 1970s. By the same law, semiconductors have become ever smaller, currently approaching molecular scale, which is when things become really interesting, writes theme coordinators, Reinout Woltjer (NXP) and Derk Reefman (Philips). This increasing miniaturisation has reached a point where researchers can bridge the gap between electronics and molecular processes using light, chemistry, magnetism and spin. This offers new perspectives, such as the detection of separate photons, interaction with living cells, and manipulation and reading of spin states. A few examples: Professor Herre van der Zant (Applied Sciences) and Dr Sven Rogge want to further develop nanowires in order to detect biological molecules. Molecule binding, for example, is measurable because the mass and hence the resonance frequency of the wire changes.

At 3mE, Professor Fred van Keulen and Dr Hans Goosen will work on making the gossamer thin sensors in nano electro-mechanical systems (NEMS) more stable and easier to calibrate. These are used to measure masses of 10-21 gram (50 carbon atoms) and displacements of 10-15 metre (one tenth of an atomic nucleus). Improved stability is a precondition for reliable and quantitative readings, the researchers claim. Finally, Dr Val Zwiller (Applied Sciences), will aim to use nanowires to produce lasers on a molecular scale. He will do this in collaboration with colleagues in Utrecht and at Harvard.

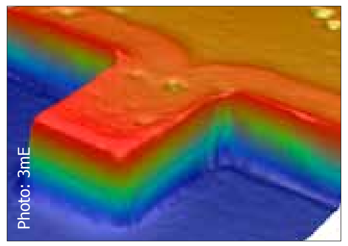


Nanowires of semiconductor material (gallium nitride) as a basis for nanolasers. Colour added to electron microscope image.

Nano manufacture

Nano-research is all very well, but before it can really be applied the gap between concept and economic activity must be bridged, explains Frank de Jong, of electron microscope manufacturer FEI. De Jong is the Nano manufacture theme coordinator, a position which entails overseeing the development of equipment, processes and technology that will make it easier to manufacture nanostructures for countless applications. On the one hand, this is by no means easy, as it concerns structures smaller than 100 nanometres and involves spatial atomic structures. On the other hand, such technology is very important to specialised companies like FEI, Philips, AMSL and Mapper, which are in the global vanguard.

The programme distinguishes between the inspection and the manufacture of nanostructures. Examples of inspection include the programme Professor Lis Nanver (EEMCS) and Dr Jacob Hoogenboom are working on in collaboration with FEI, seeking to enable the detection of (soft) biological molecules with an electron microscope. Hoogenboom also has several projects in which he aims to combine optic (fluorescent) microscopy with electron microscopy. Examples of the manufacture of nanostructures include the projects of Professor Pieter Kruit, supported by Marco Wieland (MSc) of Mapper, which aim to not only position the 13,000 electron rays of the appliance relatively, but also individually, to within 2 nanometres. Together with Dr Kees Hagen (Applied Sciences), Prof. Kruit is also developing a technology to write ultra-fine lines (in platinum and carbon) on silicon using the beam of an electron microscope.



Set of 40nm monocrystalline silicon cantilevers suitable as an ultra sensitive sensor.

Energy

Theme coordinator, Dirk Smit (Shell), believes the challenge for the 21st century is more energy, less CO_2. The research programme aims to focus on this in two ways: more efficient generation of renewable energy plus more efficient and cleaner use of fossil energy.

Starting with the first: nanotechnology can improve solar cells in several ways, according to Programme Director, Professor Wim Sinke (University of Utrecht). In the 'luminescent' solar cells, for example, phosphors and colours convert high-energy photons into more, low-energy photons. To enable as many of these photons as possible to be absorbed by the silicon, Professor Paul Urbach (AS), in collaboration with Philips, aims to develop thin nanostructures and filters to guide the light as optimally as possible to the light-sensitive layer.

Reducing energy consumption and CO_2 emission demands more efficient methods of converting fuels into usable forms of energy and removing unwanted components, explains chemist and Programme Director, Professor Freek Kapteijn (Applied Sciences). Nanotechnology may provide the solution by making materials which improve fuel conversion efficiency. The programme also includes the improvement of hydrogen storage and the capture and conversion of CO_2.

Concentrator gives extra light under the solar simulator.