

## Moving nano from lab to app

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# MOVING NANO FROM LAB TO APP

Nanotechnology has been and still is a 'hot' research topic, and the Netherlands have a forefront position in the scientific field. The expectation is that nano will be fuelling new applications and functionalities. Time has come to exploit the potential and create real impact in industry and society. To this end, TU Delft has initiated the Nano Engineering Research Initiative (NERI), a collaborative research programme aimed at moving nano from lab to app. On 25 October 2017, NERI went public officially. An inspiration event was organised to mark the occasion.

MARCEL TICHEM AND GABY OFFERMANS

## Opportunities and big challenges

In semiconductor manufacturing, working at nanometer scale is common practice. Ever smaller line-widths can be written in a lithography-based process. However, 'nano' as it is explored in fundamental science has more potential than semiconductor technology offers. New nanomaterials are investigated, including nanoparticles, carbon nanotubes or 2D nanomaterials like graphene. Surface structuring and functionalisation on the very small length scale affects properties like wettability or fouling, or can be used to create surface-integrated sensors. Also, multi-material 3D structuring of materials from nano to micro to macro is expected to result in entirely new classes of materials with new behaviour.

The big challenge is to open up this potential for the design and manufacturing of materials, components and devices that will enter real markets, and thus impact our daily life. Although selected examples are entering markets already, e.g. in point-of-care medical diagnostics, the general observation is that a lot of potential of the field has still to be tapped into.

## NERI

The Nano Engineering Research Initiative attempts to address precisely this challenge. What industry-compatible manufacturing methods are needed to produce nano-enabled materials and components? What functionalities,

1 Impression of the nano engineering inspiration event in Delft.

### AUTHOR'S NOTE

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with the same values ‘Passion’, ‘Professionalism’, ‘Perseverance’ and ‘Performance’ as our own company Nexperia”, Marcel Vugts, general manager of Nexperia-ITEC, added.

In one of the sections the opportunities of engineered smart materials were explained (Figure 2). 3D structuring of materials across length scales leads to properties that are uncommon to the material’s bulk form. Even more interesting is the question how such materials may be designed in order to have a certain, prescribed and unique property. Industrial partners Nexperia and Krohne Altometer collaborate with PME researchers on the development of such smart materials for advanced sensing applications.

Polymers can be structured and functionalised in many ways. The combination with topology optimisation, a computer-based design method to find topographies, provides new opportunities to make smart micro-fluidic functions. Volume-compatible manufacturing is needed to bring applications to markets. NERI collaborates with the Technical University of Trondheim (NTNU), Norway, and the Norwegian company Conpart to explore the use of micro- and nanoparticles for new functionalities in flexible and wearable electronics.

Nanostructures fabricated by CVD diamond topographies, graphene, and nanocantilevers were displayed to show that entirely new ranges of sensors may be obtained. The integration of an AFM with a standard industrial robot showed that nanoscale metrology in a real-life production environment is possible (Figure 3). Together with the Dutch Metrology Institute, VSL, new activities will be started on 3D AFM.

PME staff members demonstrated NERI research topics at the inspiration event (Figures 2 and 3). ■

2 On the right Just Herder, professor of Mechatronic System Design, explaining the concept of engineered material structures to Cor Heijwegen, CEO of Hittech Group.

3 On the right Jo Spronck, associate professor of Mechatronic System Design, demonstrating an in-line nanometrology set-up to Gijs van der Veen, senior dynamics and control developer at Nexperia. This set-up is a result of the aim4np (Automated in-line Metrology for Nanoscale Production) EU project.

robust against real-life use scenarios can be proposed? How can this knowledge be made available to designers?

The initiative was started from the Department of Precision and Microsystems Engineering (PME), which focuses on functions that derive performance from the small scale, ‘nano-enabled’, and on the machines and instruments that allow operating at the small scale, ‘enabling nano’. NERI is a collaborative research programme, where research institutions and industrial partners engage with each other to address the relevant challenges, and set out to work towards breakthrough innovations based on ‘nano’. Moving nano from lab to app requires alignment and cooperation with potential industrial end-users. They learn what the impact of the small scale might be for their products. The ambition for NERI is to grow into an international initiative; the first steps in these directions have already been taken.

### Inspiration event

To celebrate the official start of NERI, a nano engineering inspiration event was organised on 25 October 2017 (Figure 1). In an afternoon programme, research was put on display in an exhibition-like setting to illustrate the overall NERI vision and to inspire the attendants. Around sixty company representatives joined the event, mostly R&D project leaders and decision makers. The event was organised in collaboration with Holland Instrumentation, the high-tech platform for the Western parts of the Netherlands.

In an interview with NERI partners Krohne Altometer and Nexperia it became clear why they team up in NERI: “The fundamental knowledge we gain from the projects can be further developed within our own field of application”, Andre Boer, general manager of Krohne Altometer, said. “We find in PME a multidisciplinary team that operates

