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inno · Innovative Technologies - New Applications

Micro & Nanotechnology in the Netherlands

Henne van Heeren
Rens Vandeberg

Micro and nanotechnology (MNT) plays an important role in the Dutch innovation landscape. The Netherlands has invested heavily in these technologies over the last twenty years. Even at an early stage the Netherlands adopted a proactive stance by initiating various national programs. As a result, it has acquired a high level of knowledge and an excellent position in the international field of micro and nanoscience and micro and nanotechnology.

Despite the small size of the Netherlands, Dutch nanotechnology publications are very frequently cited, and the Netherlands takes seventh place globally in terms of filed patents on nanotechnology. The research activities rapidly gave rise to industrial interest and many Dutch companies subsequently entered this field. Important themes for these companies are bionanotechnology, nanofabrication/characterization and nanomaterial science. The most important application areas are life sciences, food & nutrition and water, linked to societal challenges such as the ageing population, climate change, food for a growing population and clean water. Take water for instance. Currently, over one billion people worldwide do not have access to reliable water sources. This has overwhelming consequences that demand technology-driven solutions. Nanotechnology will contribute to water-related challenges in roughly three areas: separation processes, catalytic processes, and sensoring. Another example is the significant number of research topics in the agro-food sector that depend on the understanding of material properties in terms of the ingredients, which become specific on the molecular (nano-) scale. Since the conditions that are relevant to food and nutrition vary from making, transporting, storing, consuming to digesting, the aforementioned understanding is required in terms of ingredient composition and concentration, energy input, temperature and time. The connecting link is the structure that exists between the macroscopic and nano-scale. Furthermore, micro and nanotechnology are contributing to the creation of more sensitive and faster measurement instruments helping to ensure the supply of safe and high-quality food products. As the Netherlands is the third largest exporter of agricultural products worldwide, this is a strong driver for R&D.

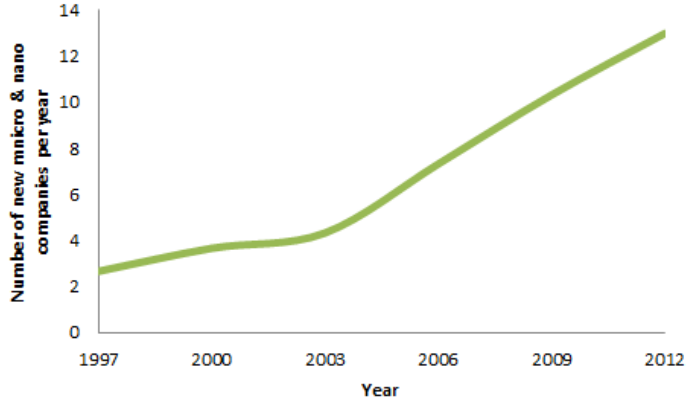
The societal relevance of nanomedicine and integrated microsystems for healthcare cannot be underestimated. The changing demography of the Dutch population, as a result of baby boomers starting to reach retirement age, causes a significant strain in the Dutch healthcare system. Micro or nanotechnology-based solutions enable prevention and early diagnosis of disease, more effective targeted treatment and are even making inroads into regenerative medicine. The focus on important diseases by the industry is strengthened by the active involvement of researchers of academic medical centers, adding both broadly applicable technology-driven projects and projects dedicated to important clinical questions in cancer, cardiovascular diseases, neurodegenerative diseases, inflammatory and infectious diseases.

This article will give a broad overview of the Dutch micro and nanotechnology landscape. This is a lively community characterized by large companies (Philips, ASML, etc.) working together with many smaller companies, technology/application specialists, and research groups from universities and institutes. The cement between all the activities and collaborations is formed by two organizations: NanoNextNL and MinacNed, supported by specialized organizations like NanoLabNL and NanoHouse.

NanoNextNL

NanoNextNL (www.nanonextnl.nl) is a broad innovation-oriented consortium of over a hundred companies and institutes which are innovating with micro and nanotechnology. It forms an open, dynamic and sustainable ecosystem to stimulate the Dutch high tech economy. The 28 individual research programs running in this consortium are divided into 10 themes, covering areas such as nanomaterials, energy, clean water, bionano and agriculture & food. Specific attention is being paid to the overarching theme Risk Analyses and Technology Assessment (RATA). Nanotechnology encompasses new possibilities and expectations. At the same time 'unknowns' about potential human, environmental and societal risk also have to be addressed in order to stimulate innovation. Thereby not only health and environmental risks related to nanoparticles are assessed, but for instance also ➲

Number of micro and nanotechnology start-ups per year in the Netherlands (courtesy enablingMNT)



| Focus: Micro and Nano Industry in the Netherlands|

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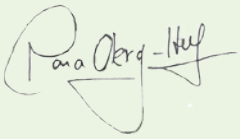
Editorial

Focus: Micro and Nano Industry in the Netherlands

Welcome to the first international issue of »inno«. From this year on, IVAM is going to publish one issue in English with a special focus on the international micro- and nanosystems industry each summer. The members of the IVAM Microtechnology Network come from all over the world and with our international activities we try to help our members cross barriers that may complicate their entry into global markets. At the moment, we are advancing in two directions: establishing or fostering partnerships, and identifying relevant trade shows and events. Many of these relevant events take place in direct neighbourhood to Germany – in the Netherlands, as for example the MicroNanoConference (www.micronanoconference.nl), the COMS (www.coms2013.com), the Precision Fair (www.precisiebeurs.nl) or the High-Tech Systems (www.hightechsystems.nl). Due to the facts that there is a lot going on in the Netherlands and that most of the non-German IVAM members are Dutch companies, the main focus of this issue in on high-tech industry in the Netherlands. I hope you enjoy reading these interesting contributions from IVAM members and partners.

Best regards

Mona Okroy-Hellweg



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societal issues related to new diagnostic methods that might change the point of care and the patient-doctor relationship. In order to investigate this multitude of issues 15 % of the total NanoNextNL budget is invested in the RATA theme. Through the RATA activity a Safe-by-Design concept is integrating nanoscience and technological development with RATA insights that can be encompassed in new products and services through which innovation is stimulated and accelerated.

SMEs are well represented within NanoNextNL, the rationale behind this is that they provide a dynamic element to the programs and also tend to be more innovative in emerging technologies like nanotechnology compared to larger companies. Although many micro and nanotechnology development activities in established companies are expected as an outcome of this program, the generation and initial support of spin-off companies is also one of the goals. During the running of the predecessor programs, MicroNed and NanoNed, over 60 spin-offs were generated, mostly microtechnology based. The timely arrival of the follow-up program NanoNextNL ensured the continuation of this process of start-up creation and support. It is expected that most of the NanoNextNL spin-offs will be nanotechnology-based companies.

NanoLabNL

NanoLabNL (www.nanolabnl.nl) is the Dutch national facility for nanotechnology research and provides a full-service and open-access infrastructure for R&D as e.g. conducted within NanoNextNL and by MinacNed members. Since 2004 NanoLabNL has been offering the use of its facilities and expertise to universities, research institutes, start-ups and industry on 4 locations in the Netherlands (Delft, Eindhoven, Groningen and Twente). Each of the NanoLabNL locations offers a range of basic and expert technologies. The basic technologies provide a general infrastructure suitable for common nanofabrication activities with a geographical barrier as low as possible. The expert technologies are unique facilities and/or expertise that aren't likely to be found anywhere else in the country. Through its facilities and expertise, NanoLabNL supports scientists in their research and businesses in improving or renewing their products and production processes and/or developing new products

MinacNed

MinacNed (www.minacned.nl) is the microsystem and nanotechnology association in the Netherlands, bringing together companies and research institutes. MinacNed counts approximately sixty members, such as Bronkhorst High-Tech, Philips Innovation Services, FEI Company, MESA+, Scienion AG and LURIS Leiden University. The objective of MinacNed is to create economic added value for the members by initiating joint activities among its members and with relevant stakeholders in the field of microsystems and nanotechnology. Among MinacNed's activities are: networking in the ecosystem, promoting collaboration in R&D and exchange of knowledge/experience in business development leading to the development of high-value business chains. Representation of the community and influencing public policy and public opinion on specific issues also belong to the tasks of MinacNed. Besides member meetings to reinforce networks and organizing workshops focusing on market development, MinacNed founded the annual MicroNanoConference. Initiating and organizing specific clusters within the association is another task. Three clusters initiated by MinacNed are the Business Cluster MicrofluidicsNL, the Surface & Deposition cluster and the Nanoinstrumentation cluster.

Source:
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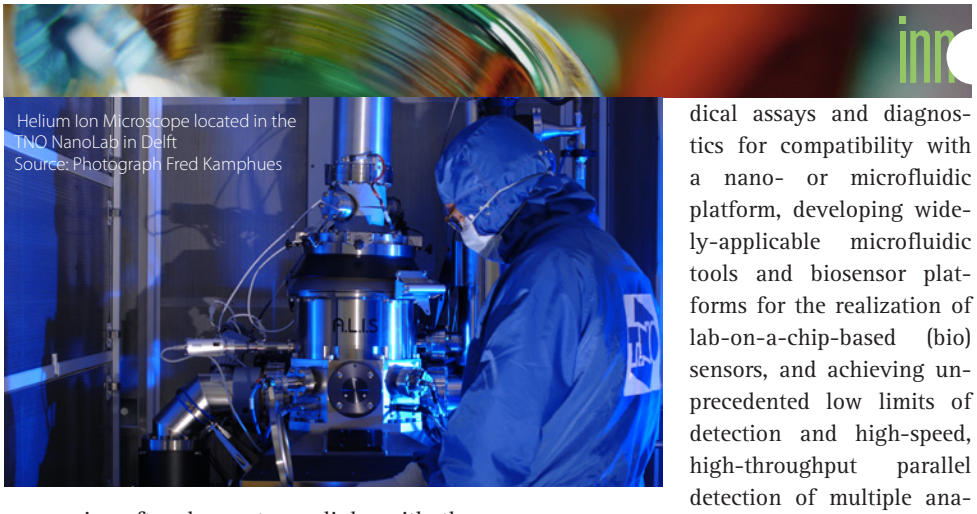
The business cluster MicrofluidicsNL brings together Dutch specialist organizations in the area of microfluidics (http://www.minacned.nl/microfluidics/microfluidicsnl-leden.html). Together, the partners cover the complete microfluidic business chain from components to complete systems. The Dutch microfluidic community is among the strongest in the world, together with the Boston (USA) and Cambridge (UK) area.

NanoHouse

NanoHouse is the Dutch knowledge broker in the field of nanotechnology. The ambition of NanoHouse is to promote nanotechnology and make businesses accept and apply it in order to contribute to a knowledge-intensive economy. NanoHouse acts as a catalyst and facilitator for the economy of knowledge between universities, R&D companies, national programs and SMEs. NanoHouse focuses on assisting start-ups and creating collaborations between ➲



knowledge institutes and businesses through open innovation, in which knowledge about opportunities and risks are shared. The activities fit in the economic agenda of Brainport and contribute to the existing regional advantage. The Brainport region is responsible for 35% of the Dutch export, 45% of private investment in R&D and 55% of patent requests. NanoHouse is located in the Brainport area (around Eindhoven), near one of the largest European chemical sites: Chemelot. Chemelot is the host of multinationals (DSM, Sabic, Akzo, Lanxess, OCI Nitrogen) and several SMEs (Chemtrix, Kriya Materials, Magnamedics, Nano4imaging). This area has strong relations to knowledge institutes and companies located in Belgium and Nordrhein-Westfalen (Germany).

The role of NanoHouse is to stimulate and facilitate innovation through open innovation with nanotechnology being the driving force. NanoHouse assists in identifying nano-opportunities, naming risks and bringing together the right parties able and willing to work in all aspects, an independent and expert party that inspires, promotes, facilitates and organizes successful open innovation prospects are needed.

Nanomedicine and Microfluidics

Over the previous decade nanotechnology and biology have become closely entangled. (Bio) chemical processes and mechanical structures from nature often inspire nanotechnologists to create new biotic systems and nanomaterials. But micro- and nanotechnology also provides new impetus to biomedical and medical research. Firstly, the lab-on-a-chip technology with its many new diagnostic opportunities, secondly for the controlled release of drugs in the body and thirdly, advanced methods to test in an early state the side effects of newly proposed medicines.

Many candidate and established drugs developed for the treatment of life-threatening and serious chronic diseases have inferior properties with consequently unfavorable therapeutic implications. Nanomedicines (i.e. advanced drug delivery systems) of a particulate or macromolecular nature are being designed to improve the therapeutic behavior of such drugs. Nanotechnology-inspired approaches to system design and formulation, an improved understanding of (patho)physiological processes and biological barriers to drug delivery, as well as the lack of new chemical entities in the 'pipeline' of large pharmaceutical companies, indicate that there is a bright future for nanomedicines as pharmaceuticals. An important Dutch player in this field is Philips, but there are also many smaller players active. Those companies often have strong links with the Dutch academic community, enabling them to bring new products to the market. Even more important for these companies is the interaction with the research community and their links with (Dutch) specialist suppliers.

Microfluidics is the art (which is slowly becoming the science and business) of using small amounts of liquids to process and/or analyze materials. Generally speaking, microfluidics refers to handling small volumes of liquid in microstructures having dimensions between a few nanometers (nanopores) and hundreds of micrometers (microchannels). There are many applications of microfluidics and several of them are being explored by the nearly 50 Dutch companies active in this segment.

The trend towards new, chip-based, technologies to allow point-of-care testing is demonstrated by several market analyses. Recent developments in micro/nanofluidics and their integration in lab-on-a-chip systems have great potential for medical diagnostics in general. On the one hand, they enable the realization of portable analytical instruments that can be used at the point of care, while on the other hand new micro/nanofluidics phenomena and techniques enable the analysis of all components in biofluids, ranging from various biomolecules to subcellular fragments and whole cells at extremely low concentrations.

The challenges here include tailoring biomedical assays and diagnostics for compatibility with a nano- or microfluidic platform, developing widely-applicable microfluidic tools and biosensor platforms for the realization of lab-on-a-chip-based (bio) sensors, and achieving unprecedented low limits of detection and high-speed, high-throughput parallel detection of multiple analyses, down to the single molecule level. Innovative solutions and rapid advances can be expected, not only in the (nano/micro) fluidics technologies but also in new ultrasensitive sensing principles and detection modalities, and the ancillary processing steps, such as surface-oriented chemical biology for the immobilization and capture of analytes.

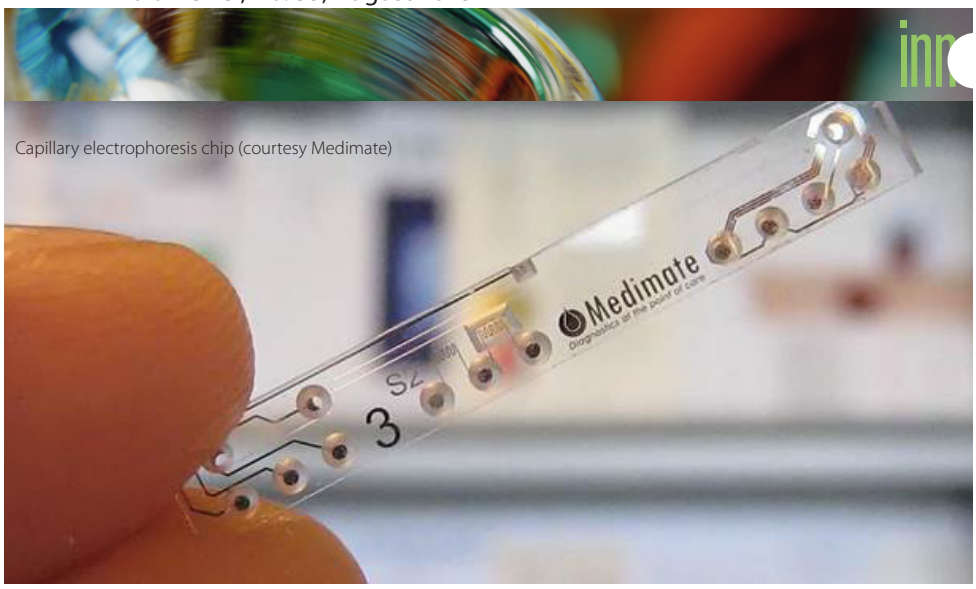

Plug and play microfluidic chip holder
(courtesy Micronit)

Microdroplets

A driving force for microfluidics is also the interest in better control of liquid droplets. With the emergence of microfluidics it became possible to manipulate individual droplets and have more precise control of their properties. Firstly by using jetting technologies; MA3 Solutions is one of the companies supplying equipment to do this. Their core expertise is inkjetting with picoliter precision.

Emulsions, droplets of one liquid dispersed in another, aerosols, etc., have attracted scientific interest since the 19th century. As the properties are very much determined by droplet size, control of size distribution is essential, especially when it concerns medical products; in this respect the long term stability of monodisperse droplets is a key asset. In addition to the production of medicine, microdroplet and microbubble technology also offer opportunities for cosmetics and the manufacture of food ingredients.

There are several ways to make small droplets with a narrow size distribution; for instance, by using a microfluidic channel construction forming a Y. One port will bring in an oily substance, the other a water-based flow. Droplets are formed at the juncture; their size depending on the material properties, the dimensions of the channels and the angle between the channels. Another way, as the drug delivery company Nanomi proposes, is to force a liquid into another liquid through a membrane with accurately structured holes. This last technology might be a more likely candidate for scaling up. Both processes feature reduced product waste as no post process sieving is required to fractionate the microsphere product to within ➲



Capillary electrophoresis chip (courtesy Medimate)

the desired range. Medspray designs and develops aerosol and spray devices to be used as inhalers based on perforated membranes. The precise control of the holes in the membrane guarantees a very narrow droplet distribution, leading to higher efficient medical usage.

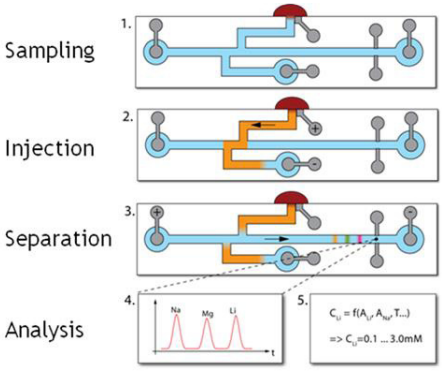
Another company worth mentioning is EmulTech, a formulation development and technology company dedicated to the innovative formulation of drug delivery systems for (bio)molecules that expand the delivery, bioavailability, and efficacy of (bio)pharmaceuticals.

Such technologies are perfectly suitable for the formulation of fragile and poorly soluble compounds with a narrow therapeutic window, but also as a contrast agent for imaging diagnostics as proposed by Tide microfluidics. Ultrasound contrast agents are minuscule microbubbles, smaller than a red blood cell, which can be safely injected into the patient's bloodstream to enhance the contrast in ultrasound images. The key to this enhancement are microbubbles that are made to resonate by the high frequency sound wave of the ultrasound equipment. The size of each microbubble plays a crucial role since resonance is only accomplished when the size precisely matches the operating frequency of the ultrasound equipment. This observation triggered Wim van Hoeve of Tide Microfluidics to use microfluidics (technology supplied by Micronit) for better control of bubble size. One of the scientific advisers of Tide Microfluidics, Dr. Michel Versluis, University of Twente, discussed this with Gert Veldhuis of Nanomi, and carried the idea one step further. Nanomi and the University of Twente, together with Erasmus University Medical Center and the technology provider LioniX are now cooperating to make such bubbles more specific by adding an active layer. This will cause the bubble to adhere to, for instance, tumor cells, creating a very specific and sensitive diagnostic methodology with a broad range of potential applications.

Other ongoing R&D work aims at better controlled release of drugs, with the medicine encapsulated in a slowly dissolving material. The timing and amount of medicine to be released is then determinated by the dimensions of the package; again pointing to the importance of size control.

Microfluidics-based medical diagnostics

The most vibrant part of the microfluidic world is the area of medical diagnostics. The diversity is huge and many niche, but still substantial, market segments are to be addressed by this technology. One example being Medimate; this company developed an instrument based on a capillary electrophoresis chip. Such a chip pulls the different electrolytes apart during the transport through a long microchannel. Each type of electrolyte reaches the electrodes at a certain time. The figure below shows its working:



Working principle of capillary an electrophoresis device (courtesy Medimate)

One drop of blood is placed on the sample reservoir at the end of the sample channel. An electric field over the short sample channel causes the positive particles in the blood to migrate to the other end of the sample channel. An electric field over the long separation channel causes the positive ions at the intersection of the two channels to migrate to the end of the separation channel. In the long channel, the ions are completely separated by the different speeds of migration. Such devices can be created by etching a glass wafer and structuring metal electrodes using lithographic methods. (See figure at the top.)

This enables for instance the electrical measurement of lithium in blood for patients suffering from bipolar disorder. The dosing of the lithium salt is critical, not enough and it doesn't work, too much and the patient will be poisoned. Veterinary applications are being developed by Medimate's sister company Blue4green.

Organ-on-a-chip

The biggest challenge in drug development is the negative side effects discovered only late in the development process, for instance during clinical trials, leading to heavy financial losses. Mimetas is one of the companies working on so called 'organs-on-a-chip'. Using such instruments new drugs can be tested before the costly clinical trials start. But there is more - medicines are still of the kind of 'one size fits all'. On a longer time scale, we see the opportunities offered by a more personalized approach to medicine and health: 'personalized medicine,' sometimes defined as 'therapy tailored to an individual's genetic makeup'. This is also known as 'pharmacogenomics' and is undergoing fast growth as the cost of testing is decreasing and the understanding of gene-disease associations is increasing.

Organs-on-a-chip are regarded as a stepping stone towards more complex medicine approaches, including precision medicine, combinatorial therapies and ultimately personalized medicine.

Other microfluidic activities

Although the medical field is the area getting most attention, the opportunities for microfluidics in the processing industry shouldn't be underestimated. At first sight this seems strange: an industry focused on high volumes working with small channels? The rationale behind this is the better control of process conditions, leading to less energy usage and more efficient use of chemicals. Dutch companies in this field are ChemtriX, Future Chemistry and Flowid.

Specialist companies such as Medimate, Tide Microfluidics, Nanomi, etc. don't operate in a vacuum. Behind them there are a number of R&D and production subcontractors. For instance: Micronit, the leading company for microfluidic component development and manufacturing; LioniX, expert in optofluidics, ➲

PhoeniX the Design and Modelling software specialist and processing expert Cytocentrics, a company that uses the well-known Philips Innovation Services (an associated partner of NanoLabNL) facilities in Eindhoven.

Nanofabrication and characterization Semiconductor industry

The Netherlands also has a strong position in the semiconductor equipment market. It is also home to companies like ASML and FEI. There are however many more semiconductor and nanotechnology equipment suppliers in the Netherlands. In total the Dutch semiconductor cluster, with its 15,000 employees, has a turnover in the Netherlands of over 10 B$ and spends 9% of this on R&D. Through its network of subcontractors it is the mainstay of micro/nano technology in the Netherlands. The interest from this sector in micro- and nanotechnologies is high while micro- and nanotechnologies are playing an ever increasing important role in products serving a wide variety of markets and applications. Nanofabrication is an essential part of the innovation chain from 'concept' to 'economic activity'. Especially in nanotechnology is it almost impossible to design a product or process without taking nanofabrication, patterning, inspection and characterization into account. Nanofabrication is one of the few thematic areas which is really strongly coupled to the flourishing high-tech equipment industry in the Netherlands. This sector of the Dutch economy has exhibited strong growth in recent years and has a strong ambition to grow even further. The strength of the high-tech equipment industry in the Netherlands is based on a combination of outstanding scientific excellence of a number of academic groups, several (large) corporate players who are market leader in their field, and a group of smaller (start-up or spin-out) companies.

Technical challenges in the field of nanofabrication are large and numerous. Making and characterizing structures with sub-100nm dimensions, the scale on which fabrication and inspection has to be controlled, is nearing 3D atomic dimensions. The development and use of the equipment requires more and more scientific understanding at the atomic scale as well. The main technology challenge can be formulated as follows: How can we understand and control the physics and chemistry of fabrication and inspection with equipment at atomic dimensions. Two general research topics can be distinguished: Modeling of beam/material interactions for both patterning (electron or photon-induced) and inspection. 2) Using nano-technologies to make critical equipment parts such as (nanostructured) multi-layer UV mirrors for use in future highly advanced X-ray spectrometers, multi-beam electron lenses or SPM tips.

For the semiconductor industry it is important that the new nano-inspection methods have a throughput fitting to a high volume production line. This challenge in itself yields interesting scientific questions. Beyond the drivers in this field coming from the semiconductor industry, there is great scientific interest to find new methods for making individual nanostructures, or small series: 'nanoprototyping'. There are both process challenges (the use of He and electron beams, dip-pen technologies, imprint, etc.) and equipment challenges.

The Netherlands has two companies in the top 10 semiconductor equipment companies: ASML, leader in lithography, and ASM, production equipment for wafer processing and assembly & packaging. ASML alone has 1,500 researchers in the Netherlands and bases its production (and part of its R&D!) on a large number of specialist subcontractors. Recently is was announced that NanoNextNL's partner ASML will work together with the Foundation for Fundamental Research on Matter (FOM-AMOLF), the two Amsterdam Universities and the Netherlands Organization for Scientific Research (NWO) in a new institute for Nanolithography to be established in Amsterdam.

The third large semiconductor company is BESI, an electronic assembly equipment supplier.

Nano-inspection

Among the large companies, the test & measurement segment is represented by companies like FEI and PANalytical. FEI produces electron/ion-beam microscopes and other instruments for nanoscale applications across many industries: industrial and academic materials research, life sciences, semiconductors, data storage, natural resources. PANalytical is one of the top two suppliers for analytical X-ray instrumentation in the world. One of their technologies is small-angle X-ray scattering (SAXS), a technique that is used for the structural characterization of solid and fluid materials in the nanometer (nm) range. This probes inhomogeneity of the electron density on a length scale of typically 1-100 nm, thus yielding complementary structural information to XRD (WAXS - wide angle X-ray scattering) data. It is applicable to crystalline and amorphous materials alike. Some typical applications comprise the determination of nanoparticle and pore-size distributions of specific surface areas and the structure analysis in inhomogeneous (e.g. core-shell) particles. The technique may also yield information with respect to the aggregation behavior of nanoparticles.

The major challenge is not only to probe at atomic resolution (which can be done by electron microscopy or scanning-probe microscopy tools), but to achieve that in realistic conditions. This will mean adding capabilities for e.g. very fast or near real-time imaging, 3D structure determination, adding property-measurement to mere structure and composition, and probing under conditions relevant to the user, for instance in liquid or atmospheric pressure rather than in vacuum.

DELMIC focuses on systems that can be integrated with scanning electron microscopes, for instance fluorescence microscopy. This platform allows the user to obtain functional color information through fluorescence microscopy and structural information by using the scanning electron microscope. Applications of the platform are primarily found in the life sciences.

Nanopatterning

In addition to the big 5 (ASML, ASM, BESI, FEI and PANalytical), there are many more Dutch companies oriented to the semiconductor market, some established specialists, others new players. Two of the most ambitious new players in the field of nanopatterning are Mapper and SolMateS. Mapper aims to find a place on the market for high end lithography equipment by using multiple electron beams. SolMateS' piezoelectric layers are to be used in all kind of miniature systems. Currently those layers are deposited by notoriously unreliable and costly wet processing. SolMateS offers an alternative based on a technology developed at the University of Twente, and is the most advanced manufacturing solution currently available to deposit piezoelectric thin films. It will be used to create components for the next-generation mobile electronics, thin film actuators and medical devices. In addition to the aforementioned ASM, there are two other companies active in ALD in the Netherlands: Levitec and SolayTec. Both companies have systems in evaluation at customer's sites.

Not a company - but important enough to mention - is Holst Centre, the TNO / IMEC cooperation. It is working on roll-to-roll technology for high volume/low cost electronics. Holst Centre managed to initiate an impressive number of development projects with leading electronic companies.Main drivers continue to be the fabrication of ever smaller structures at an ever increasing speed. ➲


Discussions during the MicroNanoConference 2012
Source: MicroNanoConference

'Smaller' now means sub-20 nm with precision and accuracy down to 0.5 nm. In addition, the need has arisen for much more flexibility as many more types of substrates, materials and processes are being explored in very different nanotechnology domains. This means that besides extreme UV lithography-based processes, also direct-write technologies will play a greater role. Beam/matter interactions have to be modeled extensively to anticipate the desired resulting structure.

An example of such a company is Smarttip, supplying magnetic force probes for high-resolution magnetic imaging. Smarttip recently extended its product range with probes with a fluidic microchannel directly incorporated into an AFM-type cantilever to allow controllable, local dispensing and aspiration of liquid through a submicron aperture at the probe tip. Applications range from nanopatterning, ion conductance microscopy, patch clamp measurements, direct cell injection, cell staining and cell adhesion.

MicroNanoConference

The Dutch micro/nanocommunity is united in the business association MinacNed and the large innovation program NanoNextNL. NanoNextNL and MinacNed jointly organize the annual international MicroNanoConference (www.micronanoconference.org). This year on December 11-12 is the ninth edition of the successful MicroNanoConference. The slogan for this year is 'Meet the Micro & Nano experts @ Ede'. Thanks to the growing reputation of the conference the list of the 24 keynote and invited speakers is quite impressive. Testimonials from earlier speakers and participants convinced the candidates on our shortlist that this conference is the event to attend. As a result, this event has grown into a major international conference on micro/nano science and technology. It will give special attention to bridging the gap between players in micro/nano technology. The exhibition itself and the conference dinner are great opportunities to meet keynote and other speakers, exhibitors and other attendees to discuss with them the latest news and developments. The organizers expect over 500 attendees and about 30 booths.

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New technologies in microfluidics and MEMS applications

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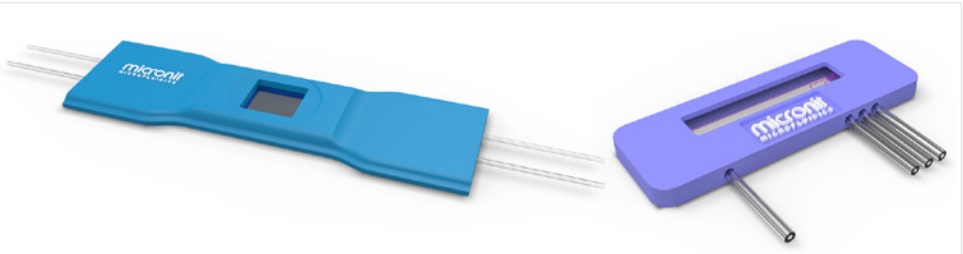
A rapidly growing interest in lab-on-chip microfluidic devices and MEMS packaging applications has led to a number of new technological developments in this area. Beside microstructuring and machining of glass wafers, the development of passive flow control tools, microfluidic interfacing solutions and innovative MEMS processing technologies have been key for the Research & Development team at Micronit.

Passive flow control in microfluidic devices

Passive capillary stop valves are an elegant way for a flowing liquid, within a microfluidic device, to be completely stopped without any external interference. This is controlled through the interaction of liquid with the device's geometry and its material properties. Surface alteration or channel geometry design are commonly used to stop fluid flow. A device's surface can be altered to repel a liquid and retard its flow. An example of this is using hydrophobic regions within a hydrophilic system to stop water flowing. Using specially designed channel geometries removes the need for surface treatments to a device in order to stop the liquid, meaning designs are simplified and manufacturing steps reduced, resulting in lower production costs.. These valves can be used for better control over volumes in microfluidic metering systems, meaning far smaller volumes can be accurately sampled than by standard pipetting techniques.

To restart the flow several options exist, one of which is electrostatic triggering. This trigger uses electrodes positioned on either side of the stop valve. The electrostatic attraction, induced by the voltage acting directly across the liquid-air interface at the location of the valve, will pull the fluid through the valve and restart the flow. Ultimately, electrostatic triggering offers all the advantages of a capillary stop valve with only a small instantaneous electric charge needed to restart the flow, thus removing the necessity for complicated physical valves and expensive peripheral equipment. Use of this technique enables the implementation of more complex laboratory workflows,requiring multiple flow sequences without the need for mechanical valves or active pumping.

Wafer scale through substrate vias (TSVs) in glass. Source: Micronit Microfluidics


Examples of SideConnect 2D cartridge designs; microscope slide configuration (left) and capillary electrophoresis configuration (right). Source: Micronit Microfluidics

Microfluidics: interfacing with SideConnect technology

A new type of fluidic connection has been developed in addition to currently standardized microfluidic chip holders like Fluidic Connect Pro. The patent pending SideConnect technology simplifies the microfluidic chip/cartridge design and thereby reducing production costs. Microfluidic access is provided on the edge of the chip at the bonding interface between top and bottom wafer (side connection), thus avoiding additional processing like hole drilling or powder blasting of the top layer. Moreover, the functional area of a chip can be significantly reduced due to the smaller footprint of the design (only channels). The microfluidic chip can be side connected to a plastic cartridge either in a 2D (in-plane) or a 3D (out-of-plane) configuration. The 2D version results in a slim assembly, which is easily accessible for optical applications. The 3D version contains top reservoirs that can be easily integrated into a surrounding cartridge and accessed for pipetting a defined volume of sample, buffer or reagent. This SideConnect technology has already proven to be compatible with applications like capillary electrophoresis, but the chip-cartridge design can basically be customized to any specific application. Currently, new SideConnect disposable lab-on-chip products are being developed for use in several point-of-care applications.

MEMS: Metallized vias and room temperature bonding

The latest developments in MEMS packaging and electrical interconnections have been the main motivation for founding a MEMS company division. This division aims at providing the MEMS industry with structured glass wafers which can be an excellent packaging material for MEMS sensors and actuators.

To this end, manufacturing capabilities have been expanded in various directions, now including a 200 mm processing line for lithography, wet etching, powder blasting and (aligned) direct bonding. Furthermore a nanoimprint tool is available, allowing structuring of sub-100 nm features on wafer scale (up to 6" square). A core technology, which is being developed as part of the MEMS roadmap, is a novel method for creating metallized vias in glass substrates. The process provides a quick and elegant way of creating wafer-scale through-substrate vias (TSVs) in glass wafers, which can then be easily combined with already finished delicate device wafers such as MEMS sensors or actuators, without the need for post-metallization polishing steps, as is usually necessary in current state-of-the-art technologies.

Furthermore, to enable the packaging of e.g. sensitive (bio-)devices, a room temperature bonding technology for bonding glass to glass or silicon wafers has been developed. This laser-assisted bonding method is based on cleaning and pre-bonding the two wafers into a stack, followed by laser welding thereby forming a thin weld line. The silicon wafer functions as an absorber, making it easy to position the weld exactly on the interface between the two wafers. For an all-glass stack, a very thin, optionally biocompatible, metal/metal-oxide layer is deposited on one of the wafers prior to pre-bonding. This bonding procedure allows the hermetic bonding of two substrates at room temperature without the need of heating the whole stack of substrates as is currently common.

Micronit Microfluidics BV, Enschede, NL
http://www.micronit.com
Micronit MEMS, Enschede, NL
http://www.micronitmems.com

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IVAM.
www.ivam.eu

3D shape measurement – micrometer precision in industrial environments

Dr. Gerard van den Eijkel

Increasing quality demands and design specifications regarding precision have created new challenges for manufacturers with respect to quality control and product qualification. Off-line random surveys are increasingly replaced by 100% 3D shape inspections. This calls for in-line high-speed, high-precision measurements. Various optical methods cover the resolution range from tens to tenths of micrometers.

Conventional 3D product inspection using a coordinate measuring machine is time-consuming and hence not suited for in-line inspection. Optical solutions enable fast data collection (into the megapixel range) and various methods are available, depending on the type of surface, its optical properties, and the required accuracy and resolution (smallest details that need to be studied).

Stereo laser triangulation

Surface structure can be determined using scanning laser optics (laser profilometry): a height (or contour) map is calculated from the phase differences between light rays entering the camera after reflection by the various surface points. However, occlusion is a problem (see Figure 1). When one laser and one camera in fixed positions are used, holes with steep walls in the surface may not be scanned completely (laser occlusion), or will be partially invisible to the camera (camera occlusion), resulting in locally incorrect interpolation results. A straightforward solution is using two lasers in a stereo triangulation set-up using a telecentric lens (see Figure 1). Two-dimensional scanning can resolve occlusions in two directions.

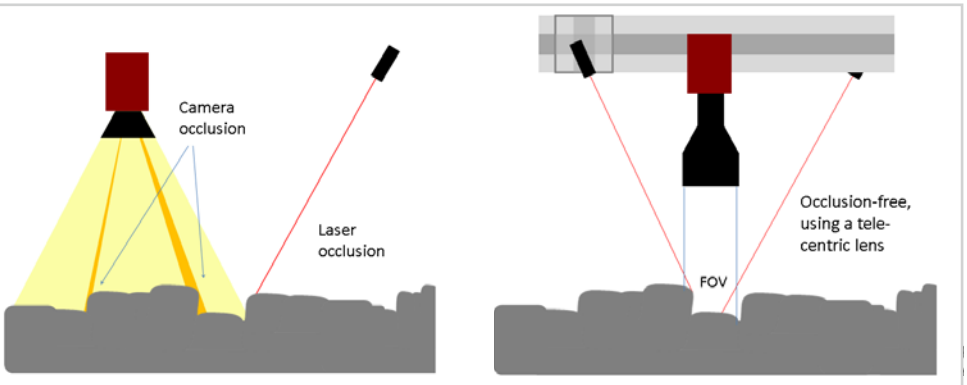


Figure 1: The occlusion problem (left) can be resolved with stereo laser triangulation.
Source: Focal Vision & Optics

Accuracy and resolution are in the order of tens of micrometers within the x-y plane of the surface as well as in the z-direction (height). A practical application is asphalt porosity measurement for assessing road-surface quality (texture) (see Figure 2). Stereo laser triangulation is typically suited for optically diffuse surfaces such as asphalt. With shiny (metal) surfaces, distinct reflections (and non-reflections) occur, the so-called speckle effect, which has an adverse effect on resolution.

Structured light method

Even better resolution can be achieved, in relatively short measuring times, with the structured light method. Using an incoherent light source, such as an LED or halogen lamp, a pattern of lines (or dots) is projected onto a small surface area, typically 4 x 4 mm^2. The reflection is recorded by a camera and the local curvature of the surface can be determined from the pattern deformation (the phase shifts between adjacent elements). No scanning is performed; all elements involved (light source, camera and surface) have to be fixed to a precise standstill – in industrial environments this can be realised by using a sufficiently short light flash. Colour coding further helps overcome the problem of "jumps" in the reflected pattern due to discontinuities in the surface.

As a rule of thumb, in the above geometrical optical inspection methods, the ratio between achievable resolution and working area dimension is in the order of 1:1,000. Hence, the absolute resolution in practice is limited to a few microns, provided the dimension (line width) of the individual pattern elements is of the same magnitude. In order to beat the 1:1000 ratio, sub-pixeling methods can be applied accompanied by 3D stitching of consecutive measurements into one large contour map. In this way, even with conventional geometrical optics sub-micron precision can sometimes be achieved.

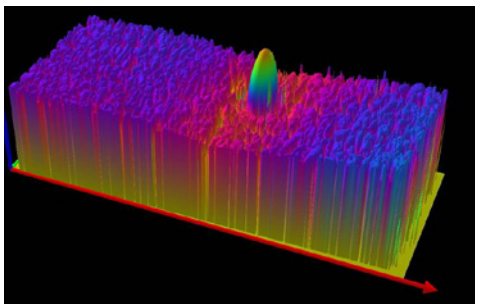


Figure 2: Result of a stereo laser triangulation surface scan (asphalt with an anomalous object).
Source: Focal Vision & Optics

White light interferometry

Usually, sub-micron resolution requires interferometry (see Figure 3). A light beam is split into a reference beam (travelling a path of known distance) and a measurement beam. Both beams are reflected, by a reference mirror and the object to be inspected, respectively. By tuning the length of the reference path, constructive interference of the two beams can be achieved, which pinpoints the measurement distance. For fast scanning, the reference mirror is put into vibration at an amplitude in the order of 10 microns. Within this 10 micron working range, interference is obtained for each surface point at a specific mirror position corresponding to the height of that point, allowing the generation of a height map. Following the 1:1,000 rule, resolution may be as low as 10 nanometers. To improve the signal-to-noise ratio, the light beam can be chopped. The measurement signal is then locked in with the modulation frequency, while noise is not. By prolonging measuring times (averaging), even nanometer resolution comes within reach.

Applications of white light interferometry can be found in the inspection of semicon or optical structures, for example surface defects, such as pitting, or coating thickness. Industrial applications require that the objects to be studied have "neatly" reflecting surfaces, and that ambient vibrations (air!) do not interfere with mirror vibrations. Conditioning the ambient, however, ususally is not an industrial option. Therefore, this demands the utmost from the opto-mechatronic design of the interferometry set-up. ➲

Opto-mechatronics

Industrial vision applications are driven by the ever-increasing availability of low-cost computing power and CCD/CMOS-enabled cameras. Combining optical measurement techniques and mechatronic design principles allows the development and construction of opto-mechatronic systems for precision product inspection (camera in the control loop). Design issues include the alignment of optical components, their position control, the dynamics of the objects inspected, vibration isolation, and image processing (software).

As an expert in image recognition and technical optics, Focal Vision & Optics is part of the Demcon cluster. Demcon, with headquarters in Enschede, the Netherlands, is a high-end technology supplier of complex mechatronic systems

Focal Vision & Optics, Oldenzaal, NL
http://nl.focal-machine-vision.eu

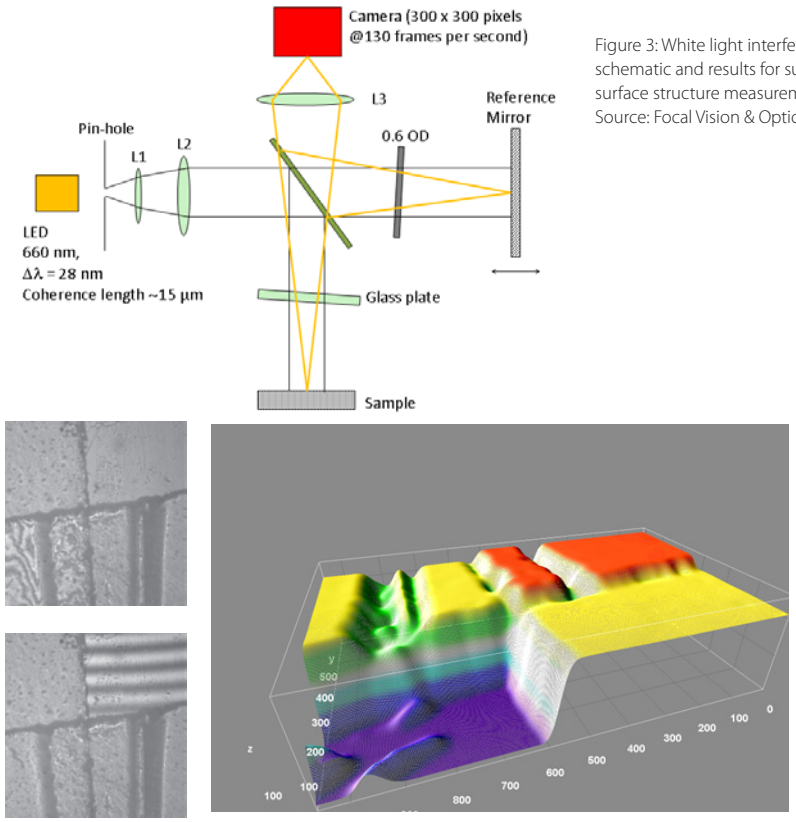


Figure 3: White light interferometry, schematic and results for sub-micron surface structure measurement. Source: Focal Vision & Optics

Facing the miniaturization challenge

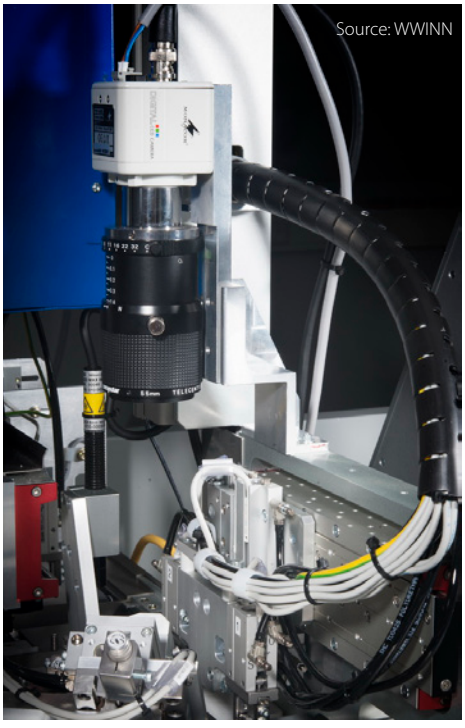
Martin Langkamp

In the modern world of consumer electronics, miniaturization of components is a continuous trend. In parallel, the intelligence and complexity increase. For manufacturing companies, this means very high accuracy and quality requirements in their production processes. Currently used production systems can no longer guarantee these requirements.

WWINN Group member IMS is a tried and tested specialist in developing and realizing assembly platforms for the consumer electronics, medical and automotive industries. These assembly platforms are especially suitable for high volume assembly of small, complex composed components. IMS recently launched the ProMu assembly platform as solution for increasing accuracy and quality requirements. The ProMu is a modular platform capable of highly accurate, fully automated assembly of small-sized products in a clean room environment. The platform assembles with an accuracy of 10µ and less, making it very suitable for small-sized optical components used in mobile phones and implantable medical devices. ProMu facilitates integration of standard and customized units which are responsible for the assembly process, onto one platform. This results in more efficient and cost-effective production.

Modularity

The ProMu consists of pluggable processing units. This modular build-up makes it possible to use these units both on the fully automated ProMu and other platforms in the IMS portfolio, such as the semi-automatic ProMicro. Therefore the production volume is easily scaled up from medium to high production volumes.


Source: WWINN

The processes do not change because of the scale-up; at most, more units have to be added to implement more processes. The platform is basically capable of positioning with an accuracy of 10µ. Optionally, with the use of standard modules, an accuracy of 500 nm can be reached in the XY field. This can be reached by using dynamic positioning determination with the use of camera systems. The accuracy of the Z-axis starts from 1µ. IMS has chosen the company Beckhoff as supplier for the standard PLC for the controls. The form factor of its I/O and modular approach using Ethercat enables IMS to keep the I/O locally at the units. Therefore the units are exchangeable without rewiring. Furthermore the PLC range that Beckhoff offers gives IMS a cost effective solution for each situation, from high end to small without the need to change the software. Another advantage of these separate units is the ability to test the units off-line on a semi-automatic platform. This makes it possible to test and validate before implementing the unit on the equipment. And it also creates an easy maintenance situation. Last but not least, the modular build-up makes it easy to convert the platform for production of other product types.


ProMu assembly platform
Source: WWINN

High accuracy, high speed

The processes performed with ProMu are not only very accurate but are also very fast. The module can assemble at very high speeds, perfect for small components used in mass markets. The ProMu has an index time of only 0.28 seconds over a stitch of 60 mm. This leads to a cycle time of 1,5–5 seconds per product.

Integration

Several 'standard' processing units can be mounted on the ProMu to create an integrated production process. Because of the small stitch, there is room for 16 units in one ProMu module. The units can apply processes coming from the top of the product as well as from the bottom, to increase the range of possible processes performed. This is done in a limited floor space of 960 by 960 mm. Examples of manufacturing processes which can be integrated on to the ProMu, and where IMS is familiar with are: pick-and-place operations, visual inspection with use of (multiple) camera systems, glue dispensing, curing laser welding, micro welding, thermo compression and automatic feeding of material. Of course many other customized processes are possible. The products are transported along the processing units with a synchronized linear motor system. The system can be configured for an index stitch of 60 mm or 120 mm. It is also equipped with an internal data tracking system to provide the processing units with status information. Optionally this data can be exported and saved in an external database as process log. Furthermore all events can be saved in the database. This makes it possible to view Pareto's and couple the machine to an OEE toolkit.

Clean assembly

Optionally, the ProMu is suitable for clean room class 5 production, by use of HEPA filters. Besides the ProMu has a small footprint and it also has a smart design which enables weight reduction. As a result, expensive clean room space is economically used. The accuracy, high quality, high speed and optional clean room environment make the ProMu very suitable to produce components for industries such as consumer electronics, optical, automotive and medical industry. ProMu can meet the challenge of miniaturization.

WWINN, Almelo, NL
http://www.wwinn-group.com

Company and product news

Highest precision for measuring liquid flow in the range of 0-120ml/min

The newest liquid flow sensor from Swiss sensor manufacturer Sensirion excels thanks to its ultra-pure materials and outstanding precision. The small SLQ-QT500 sensor is designed for the needs of the semiconductor industry: "The SLQ-QT500 is perfect for the high purity requirements of the semiconductor industry. It can be used to monitor coating processes with a variety of liquids and enables optimal process safety," says Dr. Andres Laib, Director of Sales Liquid Flow Products.

The SLQ-QT500 covers flow rates from 0 - 120ml/min. As with all Sensirion liquid flow sensors, its flow channel is absolutely straight and has no moving parts. The sensor is based on the patented CMOSens Technology. The microthermal flow measurement is performed through the flow channel wall, which separates the chip from the measured liquids. Therefore, only the PFA tubing and the quartz flow channel are in direct contact with the liquid. This guarantees that the sensor has a superb chemical resistance. Thanks to these features as well as the RS485 digital interface, the sensor is able to achieve an exceptionally reliable measurement with a sample rate of up to 1 ms.

With this unique technology even liquids with a very high viscosity (100,000 cP and more) are not a problem. Andres Laib says: "The sensor is suitable for measuring hydrocarbon-based solvents such as photoresists, as well as water-based liquids such as TARC and H_2O_2. With the SLQ-QT500, liquids with virtually any viscosity as well as liquids which contain particles can be measured. This makes the sensor unique in the liquid flow sensor industry."

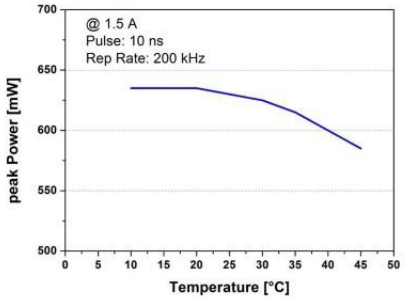
Liquid flow sensor SLQ-QT500
Source: Sensirion AG

SENSIRION – the sensor company, Email: info@sensirion.com, www.sensirion.com

Pulsed seeder now at 1030 nm

eagleyard Photonics expands its high-quality pulsed laser family by its new DFB 1030 nm seed laser. This additional laser complements the already worldwide successfully established DFB 1064. This type of laser diode is the convenient product for pulsed seeding of Yb-dopted fibers. The pulse peak performance of more than 600 mW combined with its excellent spectral features gives this laser the ideal characteristics for this kind of application. "The overall positive feedback from selected customers at Laser World of Photonics in Munich to whom we presented the test data of the DFB 1030 was very encouraging for us." says Michael Kneier, VP Sales and Marketing at eagleyard Photonics. "Even more, we are excited to pronounce the product release on the occasion of the 10th Conference on Lasers and Electro-Optics Pacific Rim in Kyoto (CLEO-PR), Japan."

Because of its high efficiency in conjunction with the compact housing and robust design this DFB-1030 laser diode is perfectly suited for the use in fiber lasers for high precision material processing, also available in a 14-Pin-Butterfly package. "All seed applications that need frequency converting will benefit from the outstanding Side-Mode-Supression-Ratio (SMSR) of 30 dB under pulse-mode.", explains Kneier.



Pulse peak power depending on temperature
Source: eagleyard Photonics

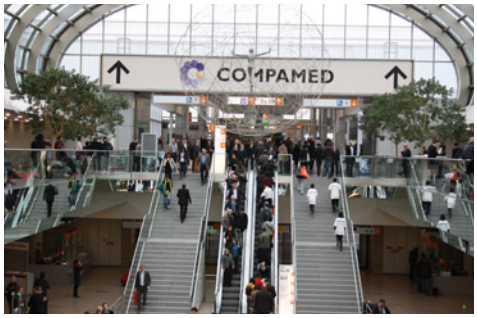
eagleyard Photonics, Sandra Chudek, Email: sandra.chudek@eagleyard.com, www.eagleyard.com

High-tech for Medical Devices at COMPAMED

The supplier fair COMPAMED will again take place co-located with the world's biggest trade show for medical technology MEDICA in Dusseldorf from November 20-22, 2013. The trade fair is well known as the international leading market place for the suppliers' market of medical manufacturing. The IVAM Microtechnology Network will present the Product Market "High-tech for Medical Devices" as well as the "COMPAMED HIGH-TECH FORUM". At the joint pavilion "High-tech for Medical Devices" more than 40 international exhibitors from eight nations will showcase their products and technologies on an area of 600m². The COMPAMED has constantly grown in popularity during the last years, which is why the IVAM joint pavilion was, as in the year before, sold out at the beginning of the year. Moreover, a lot of companies are still on a "waiting list" for a booth in 2013. The main topics at the IVAM area are precision technologies, micro components, optical technologies and R&D-services.

The related "COMPAMED HIGH-TECH FORUM" offers the opportunity for exhibitors and invited specialists to present their innovations to an international audience. Within the last few years, the forum was established as an important international platform for high-tech solutions from the medical suppliers' industries. Experts, scientists and industry representatives hold presentations and discussions on the trend issues medical technology as well as health care management and present the latest developments.

With about 40 presentations during three days, the forum gives comprehensive insights into the medical suppliers' market. The focus of the forum 2013 is on "Laser and Photonic Applications", "Microprecision, Manufacturing and Processing" and "Printed Intelligence". Additionally, IVAM is planning a Singapore session and sessions in cooperation with partners like Microfluidic ChipShop and the Fraunhofer Institute for Reliability and Microintegration IZM.



More than 16.000 people from all over the world visited the COMPAMED 2012
Source: IVAM

IVAM, Orkide Karasu, Email: ok@ivam.de, www.ivam.eu

Company and product news

COMS: international conference on commercialization of micro- and nanosystems

From August 25-28, 2013 the 18th edition of COMS, the annual international conference on commercializing micro- and nanotechnology, will be held in Enschede, the Netherlands. This edition is all about connecting different worlds, realizing creative systems.

The conference focuses primarily on entrepreneurship and marketable solutions, not just science and technology. It is a hands-on, practical meeting to assist participants in bringing their products to market, finding new customers, or the perfect development partner. COMS will provide the latest information on technology transfer, manufacturing processes, facilities, infrastructure, investment, applications and markets, as well as covering regulatory issues, social implications, education and workforce development. Decision makers & qualified buyers from every sector meet in an atmosphere designed for business development. More information and registration under: www.coms2013.com

Source: Kennispark Twente

University of Twente MESA+ Institute for NanoTechnology, Miriam Luizink,
Email: info@mesaplus.utwente.nl, www.coms2013.com

Micro and nanotechnology are still highly dynamic themes for Japanese industrial sectors

The 6th German-Japanese Micro/Nano Business Forum at the Nano Micro Biz on July 4, 2013 in Tokyo attracted more than 450 Japanese industry representatives.

With his keynote presentations Prof. Gessner from the Fraunhofer Research Institution for Electronic Nano Systems ENAS provided an excellent overview about "3D-Integration for Smart Systems". Prof. Dr. Kentaro Totsu from Tohoku University gave a lecture about "Open-access Facility for MEMS R&D and Production". Particularly the presentation from Dr. Hiroyuki Yagyu from Panasonic Corporation about "Energy Harvesting Devices with Micro-machining Structures" attracted a large number of visitors. While Benjamin Hefler from Taisei Kogyo introduced "Research and Development of Micro Metal Injection Molding", Bernhard Klimt from Coherent Kaiserslautern talked about "High Quality Micro-machining with ps-lasers: The Process, Examples and Cost of Ownership". Finally Prof. Dr. Susumu Sugiyama from Ritsumeikan University showcased "Development of Polymer MEMS Process Technology and Its Application" while Morihito Hagura from Polytec Japan presented "A new Optical Measurement Method for 3-D Vibration and Motion Measurement of MEMS/Micromachines".

The forum was organized by the IVAM Microtechnology Network, with support of the Ministry of Economic Affairs, Energy and Industry of the State of North Rhine-Westphalia, the Micromachine Center in Tokyo and the Mesago Messe Frankfurt Corporation. A continuation of the forum in 2014 is planned. It will again take place within the Nano Micro Biz/ROBOTECH exhibition, which will move to Yokohama next year. For further information, please contact Orkide Karasu, ok@ivam.de.

Source: Mesago Messe Frankfurt

IVAM, Orkide Karasu, Email: ok@ivam.de, www.ivam.eu

Extension of the magnetic hermetic series of micro annular gear pumps

The magnetic driven, hermetic series of micro annular gear pumps has been extended with regard to size and drive options.

These pumps are suitable for handling crystallizing, air or moisture-sensitive liquids because the pump has no shaft seal. This feature is made possible thanks to a liquid-separating cup surrounding the magnetic drive. Long service life, leak-free operation, low energy consumption and an integrated speed controller characterize this pump series of the German HNP Mikrosysteme GmbH just like the compact measurements of the pump with a minimum diameter of 22 mm and a minimum length of 69 mm.

Besides the already well-proven mzr–4661, which was introduced two years ago as the first pump of the magnetic hermetic series, with the mzr–2961 and the mzr–7261 two additional sizes are available. Thereby precise and pulseless volume flows from 1.2 ml/min to 288 ml/min as well as system pressures up to 15 bar are possible. Further drive options to ensure a precise dosing are currently tested.

Magnetic hermetic micro annular gear pumps are now available in three sizes

Source: HNPM

HNP Mikrosysteme GmbH, Dörte Hoffmann, Email: doerte.hoffmann@hnp-mikrosysteme.de, www.hnp-mikrosysteme.de

Interview

Open innovation is in the genes of the Dutch.

Techwatch BV promotes the exchange of information and knowledge for professionals in highly specialized industries in the Netherlands and is publisher of the magazines and web presence of Bits&Chips and Mechatronica&Machinebouw, both specially targeted channels towards the high-tech industry. Additionally Techwatch organizes events, training and recruitment around technology, development and research in the high-tech sector. »inno« talked with Joost Backus and Rene Raaijmakers from Techwatch about the situation of the Dutch high-tech industry.

Joost Backus
Techwatch BV

Rene Raaijmakers
Techwatch BV

How does the government support the development of high-tech clusters in the Netherlands? Are there special funding programs? Can you give an example of a successful high-tech cluster and describe its characteristics

The Dutch government supports clustering in a novel way for the Netherlands. Nine top 'sectors' have been identified and 'innovation agreements' have been set up with partners in these 'sectors' to stimulate cooperation between businesses, academia, research, regional development and government. Realizing clusters by mere policy making is however difficult, one needs: a common theme, the right partners, appropriate timing, a sense of urgency and a bit of luck. Certainly the most successful tech cluster in the Netherlands is the Brainport region around Eindhoven with the High-Tech Campus (HTC), formerly Philips Research. In 1998 Philips concentrated all it's research in Eindhoven to foster 'exchange & cooperation'. This led to an open Philips campus in 2003, and literally the guards left and fences of the research facilities where taken down. Also non-philips companies could establish themselves at the HTC. This coincided with the fact that many Philips spin-offs, now on their own, began to thrive and the area got a real boost. These spin-offs, on campus or off campus, worked often with specialist high-tech partners in the region, thus boosting a whole new high-tech ecosystem around Eindhoven.

120 high-tech companies are now present on the Campus and many more are scattered throughout the region. The area has grown into one of the most innovative areas in the world. Just as an example, one of the most famous spin-offs of Philips is the lithography machinery giant ASML which has also added greatly to the dynamics in the Brainport area, and (as a former Philips spin-off), now in stock value sometimes overtakes Philips.

There seems to be a well-established culture of „open innovation" in the Netherlands. Why does it work so well - or better than in other European countries? How well do research and industry work together?

The short answer: it is in the genes of the Dutch. The Netherlands is quite small, historically there is an issue with locks, dams, levies and rivers, so one had to cooperate closely to fight floods and disaster. There is and was always a tendency to be open, pragmatic and cooperative in the Dutch society.

It also seems that the Dutch high-tech suppliers' industry mainly concentrates on the domestic market. Is that right? What is the structure of the user industries in the NL? Who are the major customers of the national precision engineering industry?

High-Tech Campus (HTC) Eindhoven
Source: HTCE Site Management B.V

The Dutch high-tech suppliers are strongly international. Many of them supply more than half of their production for export. Through open innovation experiences many partnerships have arisen between Dutch and German businesses. By far the most famous case is ASML around semiconductor lithography machinery. ASML has entered into a deep partnership with Zeiss. This is even called two companies, one product. But similar things hold for Philips-Süss Microtec or even truck maker Daf. In the Dutch ecosystems many mechatronics and high precision specialists have sprung up before and since 1998, among others: VDL-ETG, KMWE, Frencken, MTA, NTS Group and many, many others.

Is there a lack of specialized workforce in the Netherlands? Are there any initiatives for the next generation?

The lack of a skilled workforce is also a problem in the Netherlands. Education, academia and industry work together on this issue. But there is no 'quick fix'. It takes years before next generation skills will be available with sufficient experience and background.

You are also organizing the „High-Tech Systems". What is the aim of this event?

The main thread throughout the development of this spectacular tech ecosystem in the Netherlands is certainly characterized by borderless 'open innovation', cooperation and partnerships to bring world class products to the market. This holds also opportunities for those who seek to do business in the Netherland. The Dutch high-tech industry is expected to double from 2012 until 2020. At the network event High-Tech Systems 2014 there is ample opportunity to look into cooperation and business models for the high-tech industry. High-Tech Systems consists of a fair, a high quality lecture program, guided tours and a tech business matchmaking program as well as a networking dinner - all are ideal to get a quick feel for the area. High-Tech Systems is an excellent opportunity to enter the Duch high-tech market. Let yourself be inspired by Dutch open innovation and seek cooperation or partnerships. Partnerships start with a crucial first step: 'getting to know each other', and in these days of international travel it seems that interesting opportunities on the doorstep of Germany are sometimes overlooked.

Techwatch BV, Nijmegen, NL
http://www.bits-chips.nl
http://www.hightechsystems.nl

IVAM trade shows and events

IVAM RoundTable
September 19, 2013, Dresden, DE
at Feinmess Dresden GmbH
www.ivam.de/members/roundtables

COMPAMED
November 20-22, 2013, Dusseldorf, DE
International leading trade fair for suppliers of medical manufacturing. IVAM will present the Product Market "High-tech for Medical Devices" as well as the "COMPAMED HIGH-TECH FORUM".
www.ivam.eu

LaserForum 2013
November 28, 2013, Aachen, DE
Digital Photonic Production for Micro Parts
www.ivam.eu

HANNOVER MESSE
April 7-11, 2014, Hanover, DE
The world's largest industrial fair - IVAM will again present the Product Market "Micro, Nano & Materials".
www.ivam.de

MD&M West
February 11-13, 2014, Anaheim CA, USA
IVAM plans to organize a joint pavillion at the medical show MD&M. If you are interested in participation, please contact b2b@ivam.de
www.ivam.de

nanomicro biz
April 23-25, 2014, Yokohama, JP
IVAM will organize the 7th Japanese-German Micro/Nano Business Forum.
www.ivam.de

On our own behalf

Become a part of the IVAM Microtechnology Network and benefit from several advantages!

IVAM sees itself as the communicative bridge between suppliers and users of microtechnology, nanotechnology and advanced materials. Our major task is to create synergies and to support our members in exchanging knowledge, in collaborative projects and in establishing contacts with each other and with potential customers. With our networking events, cooperation workshops and the members' magazine IVAM InSide we offer our members a variety of platforms for networking and initiating cooperation. Through business platforms at trade fairs, technical presentation forums and extensive public relations we create visibility and get our members in touch with partners and customers.

If you are a member of IVAM, you are found easily and quickly in the IVAM directory. And what's more: you may portray yourself in a detailed and informative profile as a company on the IVAM website. The IVAM directory online allows potential customers to search for technologies, markets as well as keywords and nations. The IVAM website generates over 100.000 clicks per month (without bots).

Another way to win new customers is through IVAM's publications. The high-tech magazine »inno« provides a platform for technical articles, and you can place product news in the e-mail newsletters MikroMedia and NeMa-News as well as in the members' journal IVAM InSide. They will get you in touch with potential customers – more than 16,000 of them subscribe to these publications.

Trade fair participations without preparation and follow-up action are a waste of money. Apart from fulfilling all the organizing tasks before the trade fair, IVAM also advertises your products with concerted marketing measures before, during and after the fair. This draws the professionals to your booth, while you are able to concentrate on your business dealings. Members participate at reduced rates.

Take part and join IVAM! Companies, institutes, corporations, associations and individual persons that are involved in micro- and nanotechnologies or advanced materials can become a member of IVAM. IVAM brings you customers and facilitates your work. We are happy to explain the advantages of IVAM to you in person, too.

Readers of this »inno« issue can benefit from a special offer: companies or institutes who decide to become a member until November 2013, will save the registration fee. For further information, please contact membership@ivam.de.

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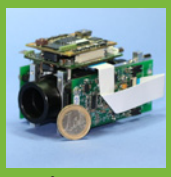
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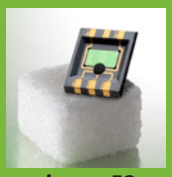
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