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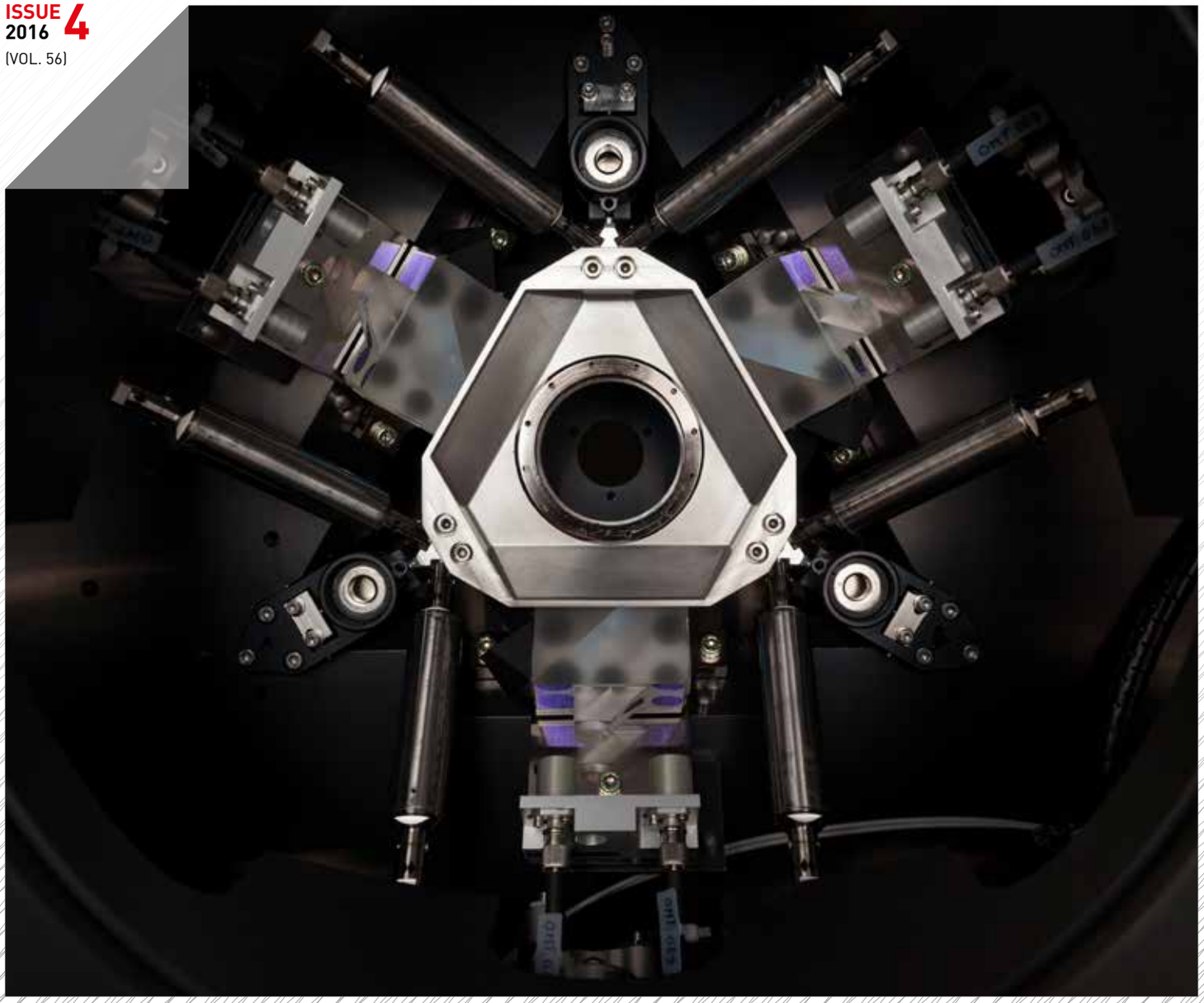
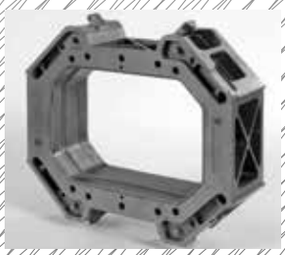
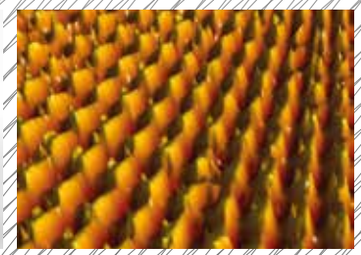


- **DEBURRING**, THE FINISHING TOUCH
- **STRUCTURED AND FREEFORM** SURFACES
- FOCUS ON ROBOTIC **GRIPPERS**
- **DSPE CONFERENCE 2016** CATALOGUE





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DSPE

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Objective
Professional journal on precision engineering and the official organ of DSPE, the Dutch Society for Precision Engineering. Mikroniek provides current information about scientific, technical and business developments in the fields of precision engineering, mechatronics and optics.
The journal is read by researchers and professionals in charge of the development and realisation of advanced precision machinery.

60th anniversary DSPE YOUR PRECISION PORTAL

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The main cover photo (featuring a hexapod used in an AFM) is courtesy of TNO Technical Sciences. See the DSPE Conference programme on page 24 ff.

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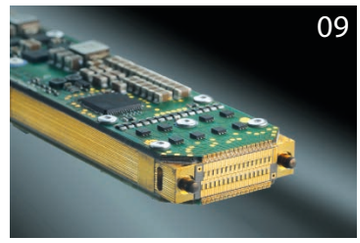


FEATURES

FARMING, PIONEERING AND INTERNATIONALISING

Next month, the third DSPE Conference on Precision Mechatronics will take place at the inspiring Ruwenberg location in Sint Michielsgestel, the Netherlands. We are looking forward to this very nice, content-rich social event. Practising precision engineering means networking. Many participants will be eager to present themselves and show their precision engineering designs. I am pleased that we have succeeded in becoming a 'warm' society of specialists who are willing to share knowledge with each other in an atmosphere of goodwill. We are sharing, we are creative, we are thinking outside the box. That is, from an international perspective, our added value when it comes to creating high-tech systems.

Let's go abroad and offer our capabilities to our international customers. This is exactly what the conference theme aims for: 'Farmers, Pioneers and Precision Engineers', inspired by the discussion about sustainable business and prosperity generated from precision engineering know-how and the role that (new) application areas play.

The community's success depends on maintaining and deepening existing knowledge (farming) and exploring new knowledge (pioneering). Therefore, it is essential to continue working in the current application areas, while also developing and investing in new ones. Maintaining the current success and simultaneously developing new knowledge and application areas is an exciting challenge for the Dutch precision engineering community.

A major aspect of creating high-tech systems is systems engineering, including tolerance budgeting. To create the best performing system, all tolerances and their interactions should be carefully treated. This is the way to obtain optimal results. DSPE will explore more activities in this area to make members aware of the value of systems engineering.

Areas we are currently working on in our society include semiconductor industry, precision instruments and medical, industrial, cryogenic, automotive, robotics and agricultural systems. Constant innovation keeps our work interesting and spreading our wings internationally will add an extra dimension. However, extra issues will also cross our path, such as cultural differences and intellectual property issues. We have to work on those if we want to let precision engineering grow as an important export product of the Netherlands. The DSPE Conference provides the showcase.

Keeping our discipline booming is an important goal for DSPE.

I want to thank all the people who are actively participating in DSPE and wish all the participants a very enriching and enjoyable DSPE Conference.

Hans Krikhaar
President of DSPE
hans.krikhaar@dspe.nl

DEBURRING, THE FINISHING TOUCH OF ACCURATE MACHINING

Burrs: manufacturers of precision machining equipment usually deny their existence. But even laser machining, wire erosion and precision punching cause burrs, however tiny they may be, making some form of deburring indispensable. Timesavers International in Goes, the Netherlands, is specialised in such deburring equipment, achieving rounding-off radii from nearly 0 to 2 mm. Another precision challenge addressed by Timesavers has been the design of a huge machine for calibrating metal sheets.

FRANS ZUURVEEN

The Timesavers 81 series sheet calibration machines can handle titanium, stainless steel, aluminium and other metal sheets up to 7,500 mm long and 2,100 mm wide (see Figure 1). By grinding the upper and lower surfaces three times in a row, and with the sheet upside-down during the second time, a thickness accuracy tolerance of 25 µm is attainable, making this calibration process real precision technology. The main application area of such calibrated sheets is the aircraft industry.

1 *A Timesavers 8100 belt grinding machine for the accurate calibration of sheet metal up to 7,500 mm long.*

AUTHOR'S NOTE

Frans Zuurveen is a freelance text writer who lives in Vlissingen, the Netherlands.

Belt grinding versus stone grinding

The 81 series sheet calibration machines, which will be dealt with further on in this article, may be regarded as a successful spin-off of Timesaver's deburring expertise with grinding belts. In the precision engineering world, stone grinding is mostly preferred to belt grinding because stone grinding has the ability to machine 3D-curved surfaces. On the other hand, belt grinding is limited to the machining of flat surfaces, although cylindrical forms can be handled too.

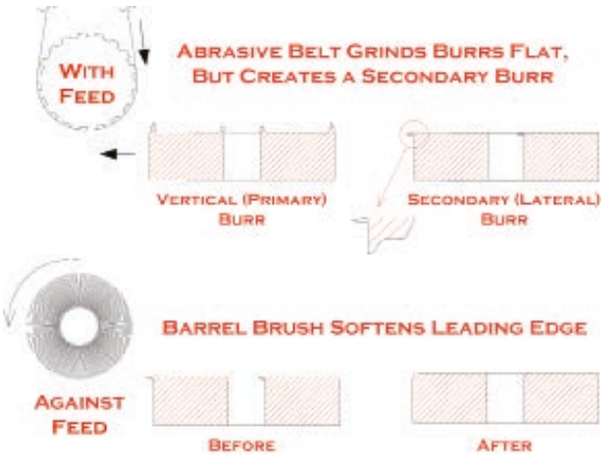
Hermes Abrasives in Hamburg, Germany, is an important supplier of grinding and sanding materials. They claim some important advantages for the application of their belts: long lifetime, high cutting rates and dry as well as wet application. Base materials for grinding belts are paper, cloth or webrax, a non-woven cloth with a polyester web. A surprising property is the regular arrangement of abrasive grains – aluminium oxide, zirconium oxide, silicon carbide or special ceramic – on the base material. Because of the identical orientation of each abrasive grain, Hermes states that their grinding particles nearly always show the same cutting and clearance angles. This is contrary to the stochastic orientation of grains in stone grinding discs. And Timesavers claims that changing a grinding belt requires much less time than changing and adjusting a stone grinding disc.

Deburring technology

Timesavers has more than seventy years of experience in the field of deburring technology, with its roots in the development and sales of wood machining equipment. Gradually, its expertise evolved from the rather rough removal of unwanted machining remnants to a sophisticated technology for applying the finishing touch to precision parts from sheet metal. This evolution originated from the understanding of primary and secondary burr formation.

Figure 2 shows how a so-called primary burr can be removed by making a grinding belt move in 'with feed' mode. The primary burr disappears, but a secondary burr

occurs inside the hole due to plastic deformation of the primary burr. [If the belt was moving in 'against feed' mode, a secondary burr would occur at the other side of the hole.]



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The lower part of Figure 2 shows the solution to this problem: using a barrel brush. This is a rotating brush with slabs of grinding cloth, which tend to protrude outwards thanks to centrifugal forces. Those slabs penetrate into holes and remove the secondary burrs. Depending on parameters such as rotational speed, slab stiffness, type of abrasive, product material, etc., the edge of the hole is rounded off with a radius between nearly 0 and about 2 mm.

Grinding tool configurations

Deburring is very often an indispensable operation, but the customer-specified rounding-off radius is subject to variation. Electronic workpieces need a rather large radius because of the risk of damaging wires at sharp edges. Rounded-off workpieces are also preferred in the food industry and for parts that have to be powder-coated. Products for the aircraft industry need some rounding-off as well, because sharp edges may damage the rubber cushions applied in large presses for aluminium sheet parts. On the other hand, high-precision parts must often have well-defined sharp edges. Needless to say, the deburring process for precision sheet parts should reduce the product thickness as little as possible. These varying customer wishes require a thorough knowledge of deburring processes.

Some decades ago, Timesavers' deburring processes comprised the simple application of Scotch-Brite rotational discs. Such discs consist of non-woven polyamide mesh containing glue to which the abrasive grains are applied. These simple deburring processes sufficed to remove primary burrs.

Over time, customers and Timesavers specialists became aware of the existence of secondary burrs and the necessity to remove them. Figure 2 illustrates that barrel brushes, shown in Figure 3, are able to accomplish this. The only disadvantage is that secondary burrs with about the same direction as the circumferential brush motion do not vanish. This insight inspired Timesavers to invent several configurations of grinding belts and barrel brushes in gradually advancing deburring machinery, with the main objective of confronting every part of the product with a correct direction and speed of the brush and belt. Figure 4 is an example of this evolution and Figure 5 shows the configuration in practice.

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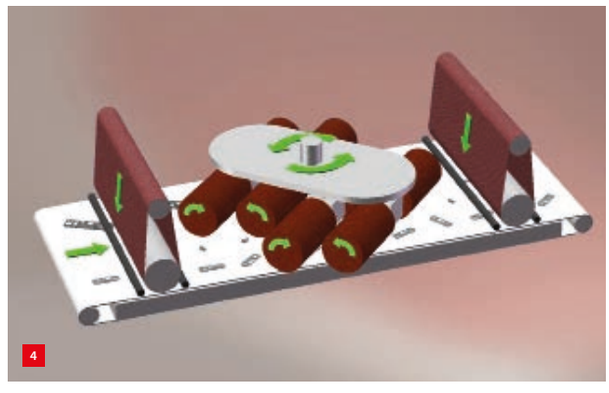

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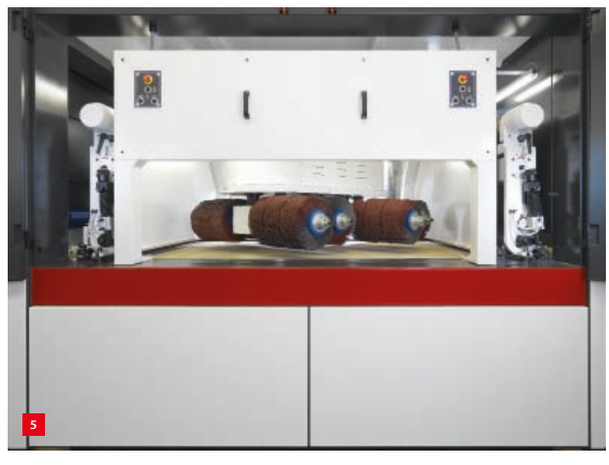

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2 *Upper part: removing a primary burr with a grinding belt, with the unwanted creation of a secondary burr inside a hole. Lower part: removing a secondary burr with a barrel brush. (Published in The Fabricator magazine, www.thefabricator.com, May 2012)*

3 *An arrangement of four barrel brushes, the two left ones as well as the two right ones mutually rotating in opposite direction.*

4 *An advanced configuration of two grinding belts and four barrel brushes, resulting in the removal of primary as well as secondary burrs.*

5 *The arrangement of Figure 4 in a Timesavers 42 series deburring machine.*

"Farmers, Pioneers and Precision Engineers"

The third edition of the DSPE Conference on Precision Mechatronics will be held in conference hotel De Ruwenberg in Sint Michielsgestel, the Netherlands, on 4-5 October 2016. This year's theme is "Farmers, Pioneers and Precision Engineers", inspired by the discussion about sustainable business and prosperity generated from precision engineering know-how and the role that (new) application areas play.

1 *Once again, the DSPE Conference will be held at the inspiring location of conference hotel De Ruwenberg in Sint Michielsgestel.*

The Dutch precision engineering community's success depends on maintaining and deepening existing knowledge (farming) and exploring new knowledge (pioneering). Therefore, it is essential to continue working in the current application areas, while also developing and investing in new ones. Maintaining the current success and simultaneously developing new knowledge and application areas is an exciting challenge for the community.

Here, cooperation and communication play a crucial role. To continue sharing the available expertise and experience in the field of precision and control engineering, DSPE decided after the first two successful editions, in 2012 and 2014, to organise a third DSPE Conference on Precision Mechatronics. The target group includes technologists, designers and architects in precision mechatronics, who, through their respective organisations, are connected to DSPE, the mechatronics contact groups MCG and MSKE, or selected companies and research/educational institutes.

In addition to paper and poster presentations and demos, the conference will provide the ideal setting for networking, technical discussion and sharing the enthusiasm of working in this challenging field. The programme is outlined on the next page and the following pages feature the abstracts of the papers and an overview of the posters and demos.

2 *Participants of the successful 2014 conference.*

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Tuesday 4 October 2016

Invited speakers

Exponential technologies to solve humanities great challenges
Maarten den Braber (Singularity University Netherlands)

How to measure a gravitational wave from a binary black hole merger
Prof. dr Jo van den Brand (National Institute for subatomic Physics, Nikhef)

SESSION 1: SYSTEM DESIGN 1

System design of the next generation wafer tables for the die-sorter machine of NXP
Thijs Kniknie, et al. (NXP Semiconductors)

Large dynamic range atomic force microscope development
Stefan Kuiper, et al. (TNO Technical Sciences)

Wafer feeder capability in iX Hybrid
Rik van der Burg, et al. (Kulicke & Soffa Eindhoven, Sioux CCM)

SESSION 2: BIG SCIENCE

Cryogenic mechanisms for infrared astronomical instrumentation
Gabby Aitink-Kroes, et al. (NOVA Optical Infrared Instrumentation Group)

Development of automated assembly machines for the particle tracking system of the ALICE detector upgrade at CERN
Ivo Widdershoven, et al. (IBS Precision Engineering)

Actuator concept to align 4,000 quadrupole magnets in the Compact Linear Collider
David Tshilumba, et al. (CERN, TU Delft)

SESSION 3: ADVANCED APPLICATIONS

High-Density Optical Fibre-to-Chip Interface
Roy Derks, et al. (MA3 Solutions)

XY360 – Planar Positioning Stage with a PSD sensor and ferrofluid bearings
Stefan Lampaert, et al. (TU Delft)

Multibody-based topology synthesis method for large-stroke flexure hinges
Mark Naves, et al. (University of Twente)

Wednesday 5 October 2016

Invited speaker

Sanjeev Pandya (Executive Vice President for Global Business Development of Advanced Oncotherapy)

SESSION 4: PIONEERING NEW APPLICATIONS

High-volume harvesting machine for white asparagus
Ad Vermeer (Cerescon)

Precision engineering in a seismic environment: the design of an electro-magnetic vibrator
Björn Bukkems, et al. (MI-Partners, Seismic Mechatronics, Magnetic Innovations)

Transformation of a planar Maglev system to new application areas
René Boerhof (Philips Innovation Services)

SESSION 5: SPECIAL TOPICS

Advanced Feedforward and Learning Control for Mechatronic Systems
Lennart Blanken, et al. (TU/e, Océ-Technologies)

Reliable nanoscale measurements in the production line
Richard Koops, et al. (VSL Dutch Metrology Institute)

Large signal non-linear analysis and validation of the suspension of a transport tool
Araz Abbasi, et al. (NTS Systems Development)

SESSION 6: VIBRATION CONTROL

Vibration Damping for 2D Image Quality
Rob Gielen, et al. (Philips Healthcare - Image Guided Therapy Systems)

Vibration Isolation applied to Coriolis Mass-Flow Meters
Bert van de Ridder, et al. (Demcon advanced mechatronics, UT)

Enabling overlay/focus improvement via passive damping in ASML motion stages
Stan van der Meulen, et al. (ASML Research Mechatronics & Control)

SESSION 7: SYSTEM DESIGN 2

Mechatronics of a sub-milliNewton tribometer
Sander Paalvast, et al. (Janssen Precision Engineering)

Slicer module for large-volume reconstruction workflow
Ron van den Boogaard, et al. (FEI)

Large flat surfaces in a high-temperature and low-pressure environment
Rob Boereboom, et al. (VDL ETG - T&D)

Both days

POSTER SESSIONS AND DEMONSTRATIONS

SESSION 1: SYSTEM DESIGN 1 - 1

System design of the next generation wafer tables for the die-sorter machine of NXP

Thijs Kniknie, Luc van den Broek,
Ralph Huybers, Tom Kampschreur,
Dennis van Raaij, Abhishek Bareja, Mark Otto,
Joep Stokkermans (NXP Semiconductors)

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Constantly striving for quality and the lowest DFPC (die free package cost), the ITEC (Industrial Technology & Engineering Center) department of NXP develops state-of-the-art equipment for testing, die bonding and taping discrete components and integrated circuits. ITEC's Automatic Die ATtach (ADAT3) platform already has a capability of handling 6" (150 mm) and 8" (200 mm) wafers at extremely high production speeds. The next step in the equipment roadmap is to enable 12" (300 mm) wafer handling and increase the production speed significantly. Since package miniaturisation is ever ongoing, the product placement also requires improved accuracy.

The Wafer Table project started in 2013 with an exploratory concept study. In 2014 the concept had to be made in slightly more detail to estimate the volume claim of the frame design. At the end of 2014 the first prototype development was started.
An additional design cycle was used to implement changes that followed from the prototype tests and to improve serviceability and reliability. In the complete project timeline, MI-Partners was involved to support in architecture and concept design and prototype development. The software application development and integration on ITEC's dedicated FlexDMC motion platform was done by ITEC.

The Long Stroke / Short Stroke stage concept was successfully introduced on ITEC's ADAT3-XF platform. The experience of MI-Partners with MIMO planar stage technology and the experience of NXP ITEC with system integration and industrialisation were combined to develop an industry-ready module starting from concept design without large setbacks. In the third quarter of 2016 the first 300mm-capable ADAT3-XF machine was shipped to one of NXP's assembly plants. ■

SESSION 1: SYSTEM DESIGN 1 - 2

Large dynamic range atomic force microscope development

Stefan Kuiper, Erik Fritz, Thomas Liebig,
Geerten Kramer, Max Baeten, Gert Witvoet,
Tom Duivenvoorde, Ton Overtoom, Ramon
Rijnbeek, Erwin van Zwet, Will Crowcombe
(TNO Technical Sciences)

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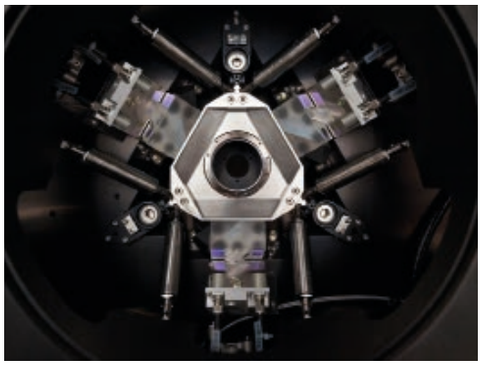
Semiconductor and nano-manufacturing demands for metrological tools that allow accurate measurements of both the nanometer-scale dimensional properties of individual features and the distance between individual features. For instance, in semiconductor manufacturing accurate characterisation of both the shape of the alignment markers, as well as their distance with respect to the functional product features would allow significant improvement of the overall overlay performance.

The major advantages of Atomic Force Microscopy (AFM) are its direct imaging method, high resolution and the fact that it is non-destructive. However, AFM systems are mostly used as pure imaging tools and they are not suitable for high-accuracy metrology tasks. Moreover, most AFM systems have a positioning range of 10 to100 microns, which is not sufficient here. Therefore, TNO is developing a metrological AFM system with an extremely large measurement range of several millimeters.



Top view of hexapod used for positioning the AFM head with respect to the wafer.

The major challenge is posed by the huge dynamic range requirements, requiring subnanometer measurement uncertainty over a range of several millimeters. On top of that, large substrates such as 300mm wafers or reticles result in a relatively large metrology loop, which poses additional stability challenges. ■