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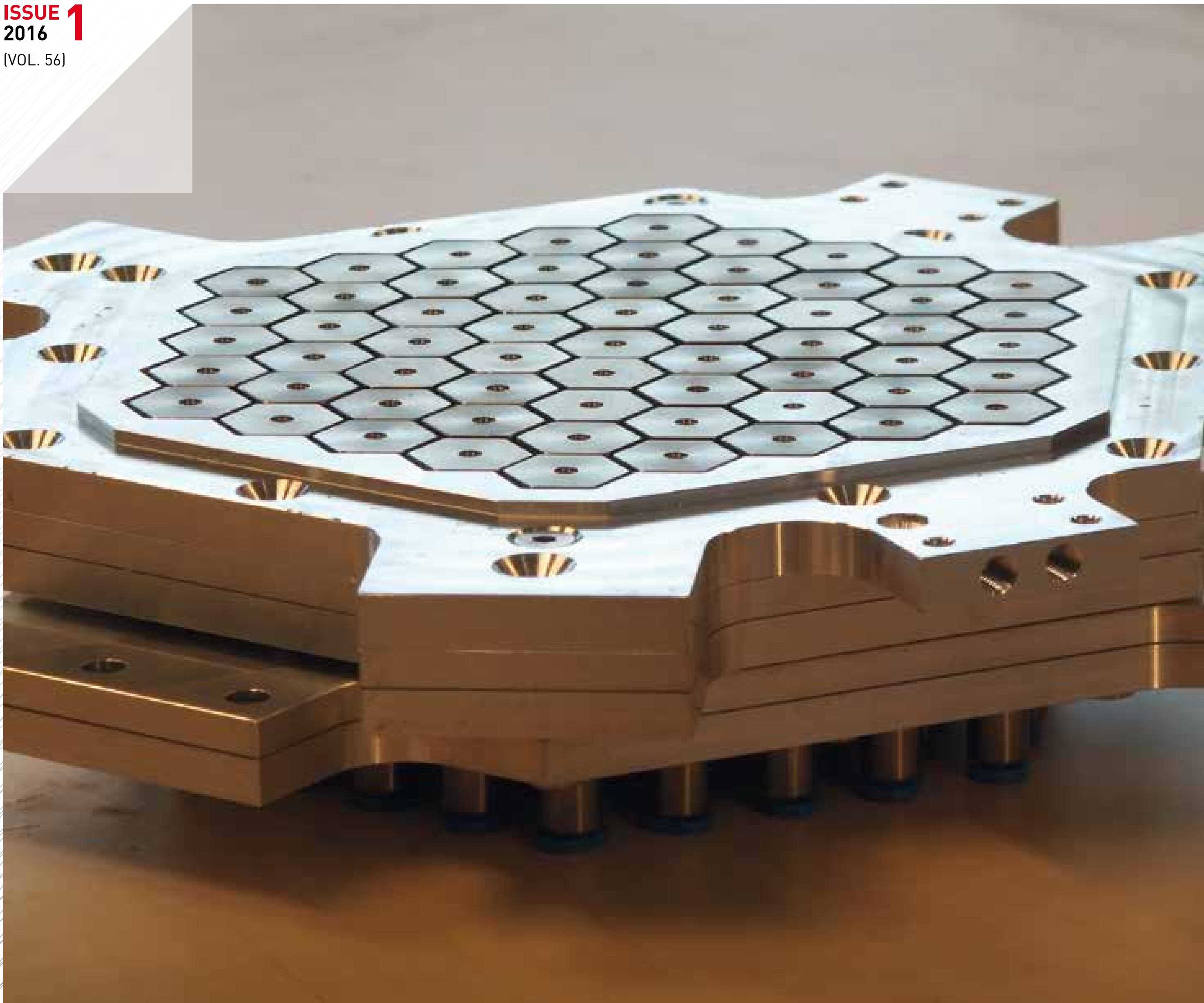

- **CONTACTLESS** TRANSPORT
- LARGE-SERIES **HYBRID** MANUFACTURING
- **THERMAL ISSUES** IN ADDITIVE MANUFACTURING
- **CARBIDE** WEAR PARTS

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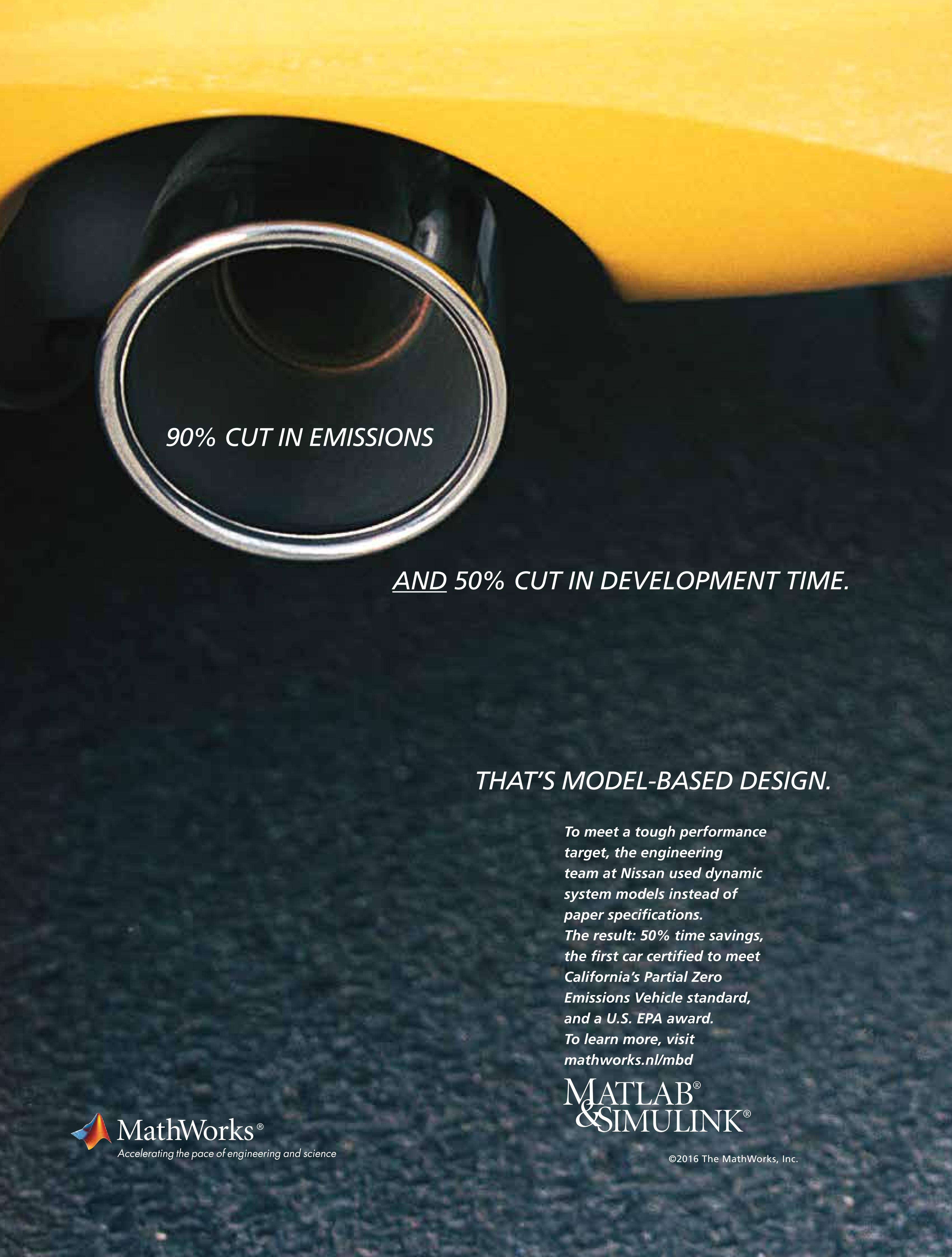
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The main cover photo (featuring the FlowerBed) is courtesy of TU Delft. Read the article on page 5 ff.

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FEATURES

EDITORIAL

THE SECRET INGREDIENT OF HIGH-TECH SYSTEMS

In November last year, Additive Industries, the company I founded together with Jonas Wintermans in 2012, launched its first industrial additive manufacturing system, aka 3D metal printing system, MetalFAB1. Developed by a team of excellent mechanical and software engineers, materials scientists and system integrators in a record time of just over two years.

This incredible project was possible only because of a secret ingredient we added to our system and software development that made the difference between failure and success... It is an ingredient that is found naturally in this region around Eindhoven, the Netherlands. It was developed decades ago and it has been polished and refined ever since. And today it is still being tested, improved and applied broadly. This secret ingredient is embedded in the DNA of the people living in the southern part of the Netherlands. Eindhoven especially bears fruit from this ingredient, so it seems. And it is used both in the development process and in the supply chain where the realisation of new high-tech ideas takes shape.

Our company is addicted to this ingredient from the start, because without it we wouldn't have lived to see this day. It makes work fun, it creates new insights, it breeds better solutions, it allows us to focus, it gives access to a complete ecostructure of high-tech equipment competences. It gives us an infinite capacity and at the same time saves money. It is open within and restricted on the outside. But most importantly, especially today, it allows us to share and multiply our successes. With our partners.

This ingredient is **teamwork**.

The world's first industrial metal additive manufacturing system, MetalFAB1, is the prime example of what teamwork can do. From the start we have built a team within Additive Industries. A dream team it is. With a large variety of backgrounds, characters, competences, positions and years of experience. But with one shared value and common denominator: the drive to deliver. We aim high, think big, work hard and celebrate the successes while enjoying the ride (and an occasional beer).

The teamwork is extended beyond our team, as we were lucky to find development partners with competences we lacked, knowledge we needed and capacity we craved for. The start was sometimes a little bit strange. Our demands were unusual, our expectations were high, our pockets empty and ambitions seemed unrealistic. But these partners gave us the benefit of the doubt, some directly, others after a nudge or two. And, critically, they decided to trust us, as we trusted them and they became part of our team.

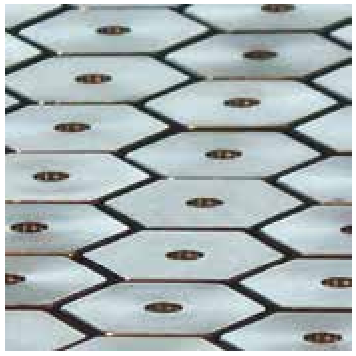
And then magic happened, we went to work and ideas became designs, designs became parts, parts became subassemblies and modules. In the last quarter of 2015 these modules were joined to become one system and they are the perfect metaphor for this project and our secret ingredient.

(Photos by Bart van Overbeeke, © Additive Industries)

Daan Kersten
CEO Additive Industries
www.additiveindustries.com

FLOATING ON A FLOWERBED

By applying a thin pressurised air film beneath a substrate, it can be levitated as well as transported and precisely positioned in all planar degrees of freedom. This avoids mechanical contact and reduces risk of damage and contamination of sensitive surfaces. Two fundamental ways of realising this combination of functions have been invented and built. High-precision positioning accuracy in the nm range and multiple-g accelerations have already been achieved in the lab. Industrial implementation is expected in the near future by a dedicated start-up.



MARTIJN KRIJNEN, VUONG HONG PHUC AND RON VAN OSTAYEN

Introduction

In high-tech industry thin, fragile, cost-intensive products, such as silicon wafers and solar cells or glass sheets (flat-panel displays), are routinely handled and used. These substrates are susceptible to contamination, damage or even breakage as a result of any mechanical contact. Currently, special product carriers and transport systems are used for the transport of these substrates in and between the many stages that these products undergo during their manufacturing. In these existing systems mechanical contact is inevitable.

It is a strategic goal of the high-tech industry to introduce zero-contact handling and transport systems. In other words, from the introduction of the substrate at the start of the production line to the release of the product at the end of the line, there should be no (avoidable) mechanical contact between substrate and production line.

Note that existing systems that are sometimes referred to as 'contactless' are in fact only carrying the substrate without contact, but in order to transport or position the substrate accurately and fast, most of these systems still rely on mechanical contact.

Other contactless systems, such as Bernoulli grippers, which apply a levitation technique based on the Bernoulli principle, cannot freely move the object in all planar degrees of freedom (DoFs). They merely float the object to reduce contact, and rely on edge effects to maintain a centred position of the substrate on the gripper. Other systems exist that use magnetic and electric levitation, and are able to produce in-plane forces. These are promising concepts, where high precision is possible. However, they rely on specific magnetic and electric properties of the material. In air-based levitation the material itself plays a lesser role.

The concepts presented in this article are able to handle various substrates: Si-wafers, solar panel surfaces, flat-panel displays and glass, but also foil.

Operating principle

The concept is based on air-bearing technology, i.e. two surfaces with a thin film of pressurised air in between that separates both surfaces. Note that although in this article air is used as the acting medium, it is in fact possible to realise the same functionality using any gas, and with some consideration and design modifications liquid media can be used as well.

The gas-bearing concept is in itself promising in precision design, because it avoids many traditional engineering issues, such as friction, wear, backlash and lubricants. Although the concept is well-known, used mainly because of its extremely low, viscous friction, it is possible to increase this viscous traction to a level where it can be effectively used in an actuator.

A schematic example of the concept is shown in Figure 1. The actuation surface is divided into an array of regular

AUTHORS' NOTE

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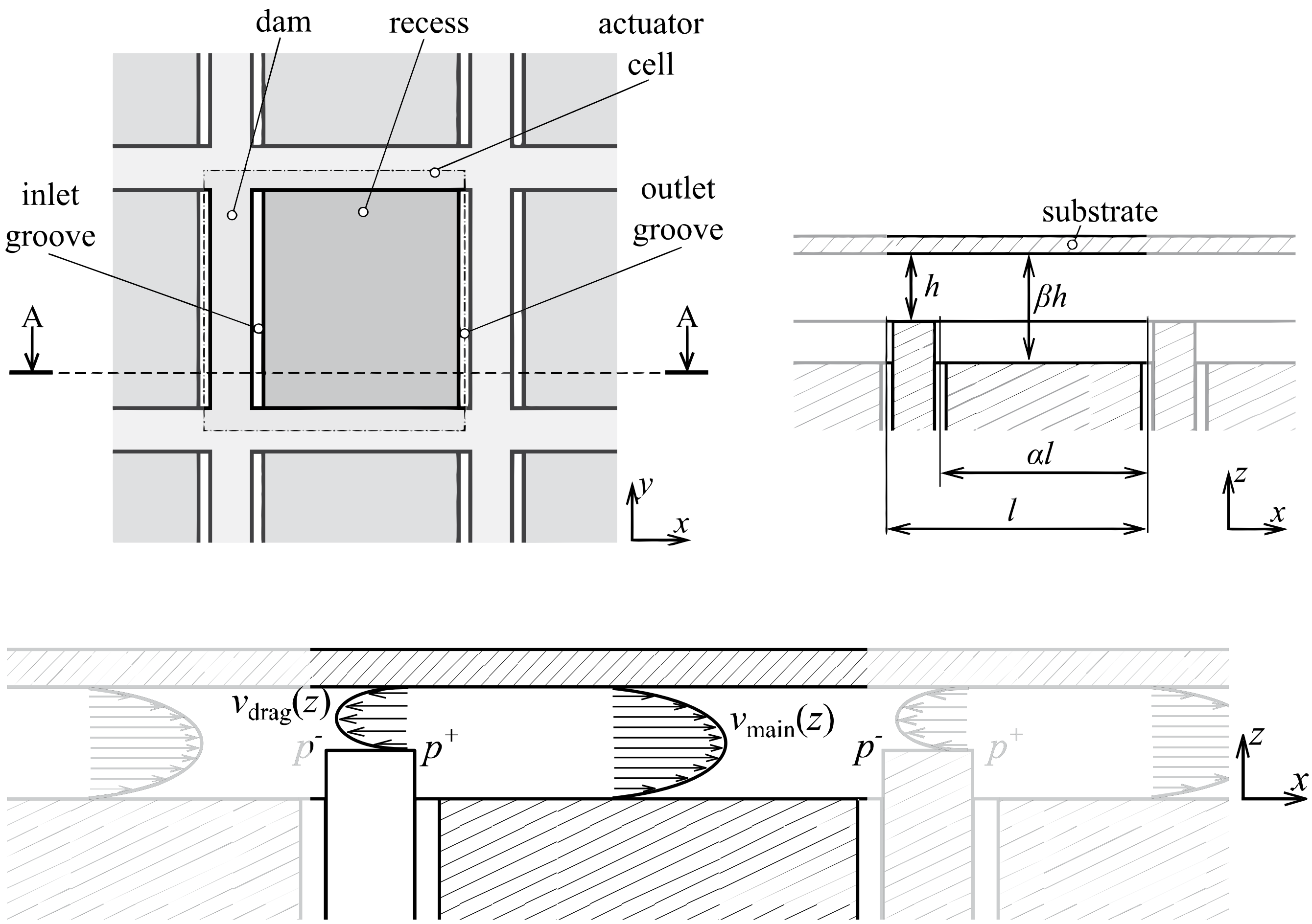

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1 *Basic principle of the contactless actuator, with the larger flow to the right creating a net viscous force on the substrate above.*

surface sections where each section consists of a pocket surrounded by dams. A typical actuator section has an in-plane length of 10 mm. The optimal pocket depth is related to the intended fly height of the substrate; for a typical fly height of 10 μm a pocket depth of 40 μm is advised. Each pocket has at least one high-pressure inlet and at least one low-pressure (sub-ambient or vacuum) outlet.

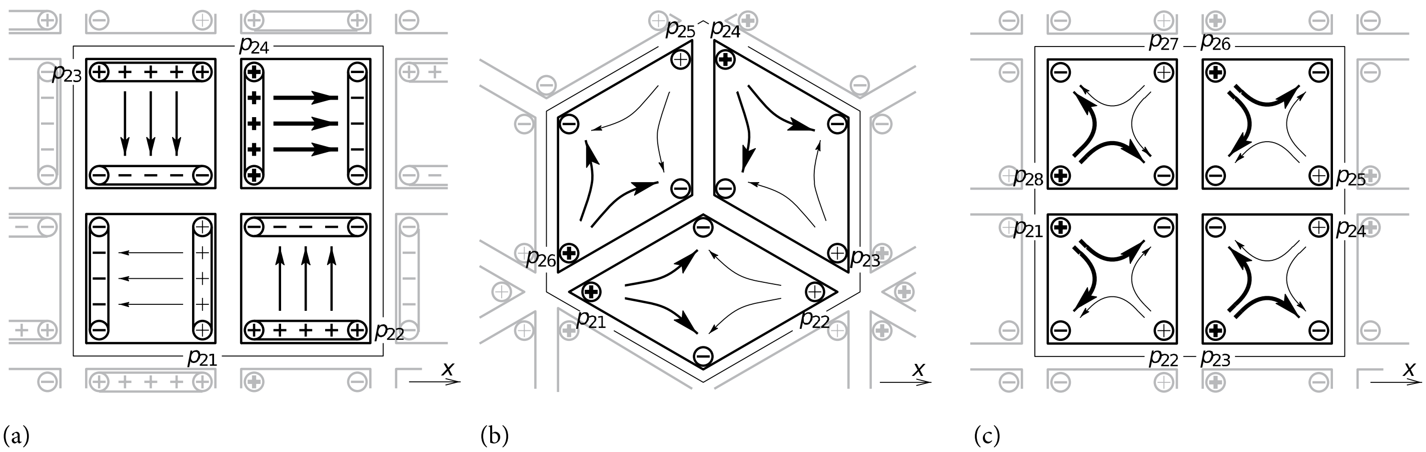
The pressure distribution under the substrate is determined by the geometry in combination with the inlet and outlet pressures. The average pressure under the substrate balances the distributed weight of the substrate that is being carried. Note that due to this combination of high-pressure inlet and vacuum outlet (push-pull concept) it is straightforwardly possible to flip the vertical orientation of the system and carry a substrate without contact hanging beneath a transport system.

The pressure difference creates a flow through the pocket from inlet to outlet, and a smaller flow across the dam that separates the pockets. Both flows are indicated in Figure 1. Due to the viscous shear of the flow a traction force on the substrate is created.

There are two variables that influence this traction, which can therefore be used to control the force on the substrate. The first variable is the pressure. By increasing the pressure difference between inlet and outlet both the flows as well as the force acting on the substrate increase. This allows the creation of a certain system with a fixed geometry, and by controlling the pressure the substrate can be positioned. Positioning systems operating on this principle are denoted to be of Gen-I (generation 1).

The second variable is the geometry. By changing the depth of the pockets, the flow distribution and the effective surface area for the pressure difference to act on will change, resulting in a change in traction imparted on the substrate. Systems operating on this principle are denoted to be of Gen-II.

Research on Gen-I was started in 2007 [1], followed by research on Gen-II in 2011 [2]. Both concepts are viable and comparable in performance, and research continues into both concepts. The combination of both concepts in one system is promising as well (Gen-III) and is another subject of study. Gen-III is not further described in this article.



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Gen-I: pressure variation

A big advantage of the pressure variation concept over traditional positioning stages is the elimination of the moving mass within the actuator. The substrate itself can be considered to be a monolithic moving mass, with zero in-plane stiffness and a small amount of viscous damping.

The performance of the system is defined by a number of parameters: the achievable actuation force, the deformation of the substrate due to the spatial pressure variation in the actuator and the total required volume flow of air. These main criteria were used to evaluate several designs.

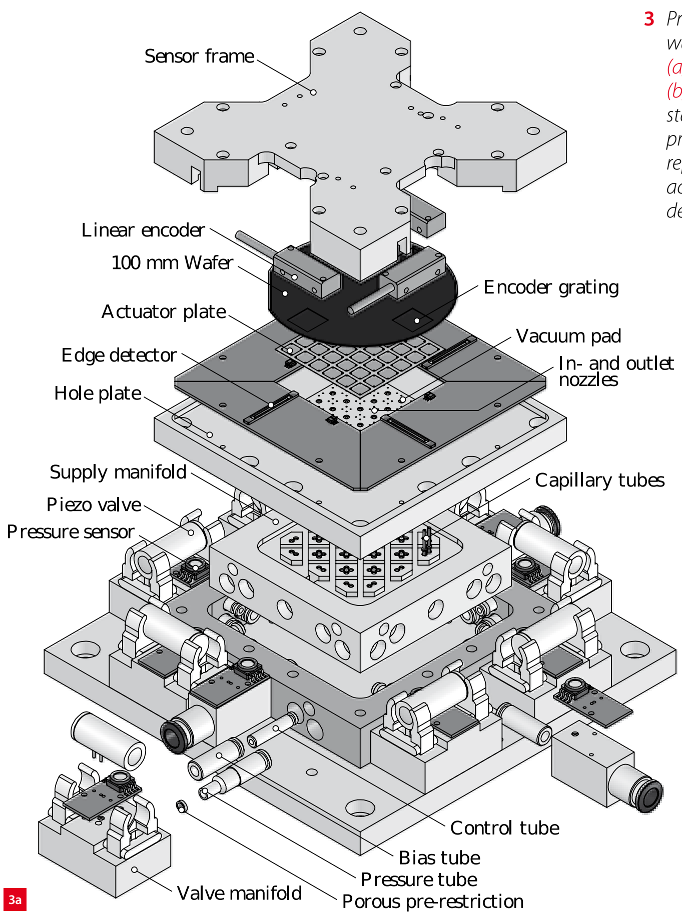
Three designs are shown in Figure 2. In each of the designs, one actuator cell can produce a force in the two translational DoFs and a torque. Design (a) has four pressure inlets per cell, design (b) has six and design (c) eight. In design (a), a translational force also produces a so-called parasitic torque, tilting the substrate relative to the actuator. This is due to the lateral movement of the resulting force carrying the substrate. In the last design, (c), this is greatly reduced.

Finite-element models (FEM) have been used to analyse the performance parameters. The design with eight pressure inlets was shown to provide the best trade-off between actuation force, parasitic pitching torques, substrate deformation and practical implementation.

A laboratory demonstrator was developed to study the Gen-I concept using the 8-pressure-inlets layout. An exploded view of the entire system, including a sensor frame for measuring the position of the wafer using linear encoders, is shown in Figure 3.

2 Three designs (see text for explanation), all capable of producing two translations and one rotation. High-pressure inlets are denoted with (+) and low-pressure outlets with (–), while fat arrows indicate the highest airflows. In these cases they create a net force to the right. Each complete system comprises arrays of these actuator cells.

3 Pressure variation waferstage [1].
(a) Exploded view.
(b) Top view of the stage with the high-precision linear encoder replaced by a less accurate, low-cost edge-detection system.



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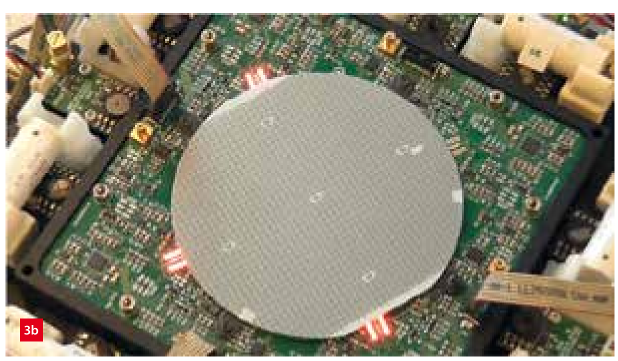

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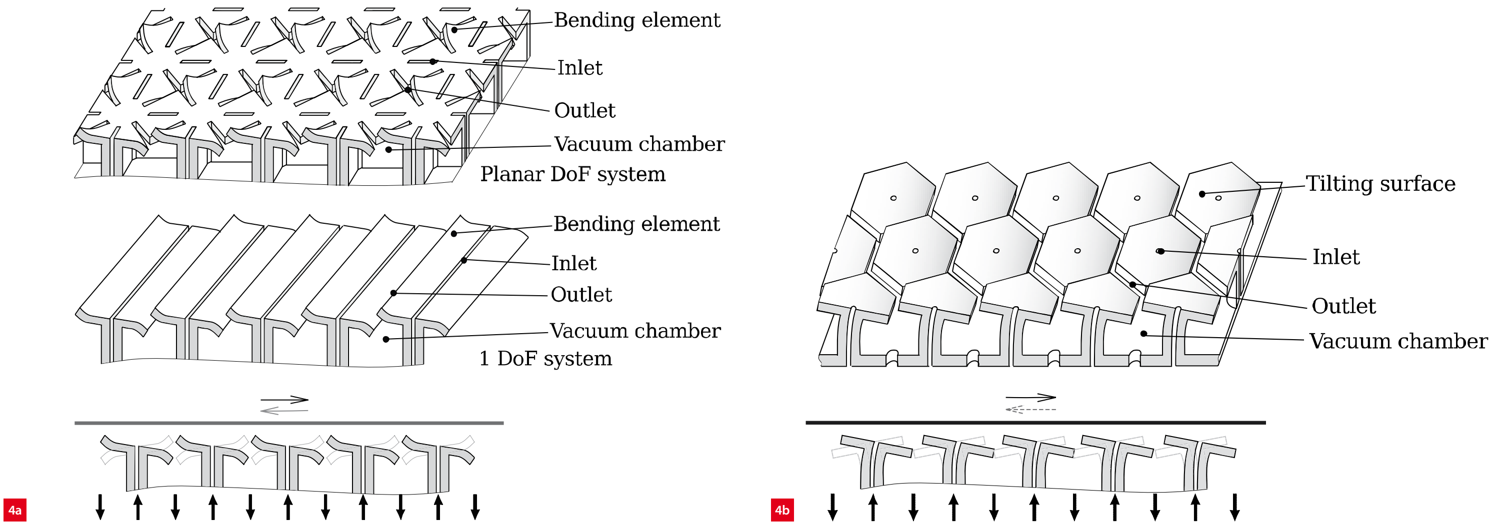


4 *Two actuator concepts.*
(a) Surface with bending sections.
(b) Surface with tilting sections.

In this demonstrator a wafer was placed on top of the manufactured actuator. With a pressure controller a steady fly height of 15 μm was achieved. For a video demonstration of this system see [3] and [4].
Lower fly heights are desirable because they come with an increase of the pressure difference in each pocket, and hence of the actuation force. Also the required airflow is substantially reduced. On the other hand, the risk of contact between plate and wafer increases.

With PID control tools and a positioning bandwidth of 50 Hz, servo errors below 100 nm were achieved, down to 6 nm (1 σ) with active vibration isolation. An acceleration of 600 mm/s^2 was achieved, limited by the maximum actuation force. By improving manufacturing tolerances, a lower fly height and therefore a higher force and acceleration can be reached.

Smaller actuators provide better performance on nearly all criteria. Therefore, the pocket size is only limited by manufacturability. Another intrinsic limitation is the delay in the pressure lines. From the pressure controller to the surface of the substrate, the change in pressure is not instantaneous, thus causing a delay that limits the bandwidth of the system. A solution to this could be pressure control right at the surface. The next concept puts this into practice.

Gen-II: deformable surface

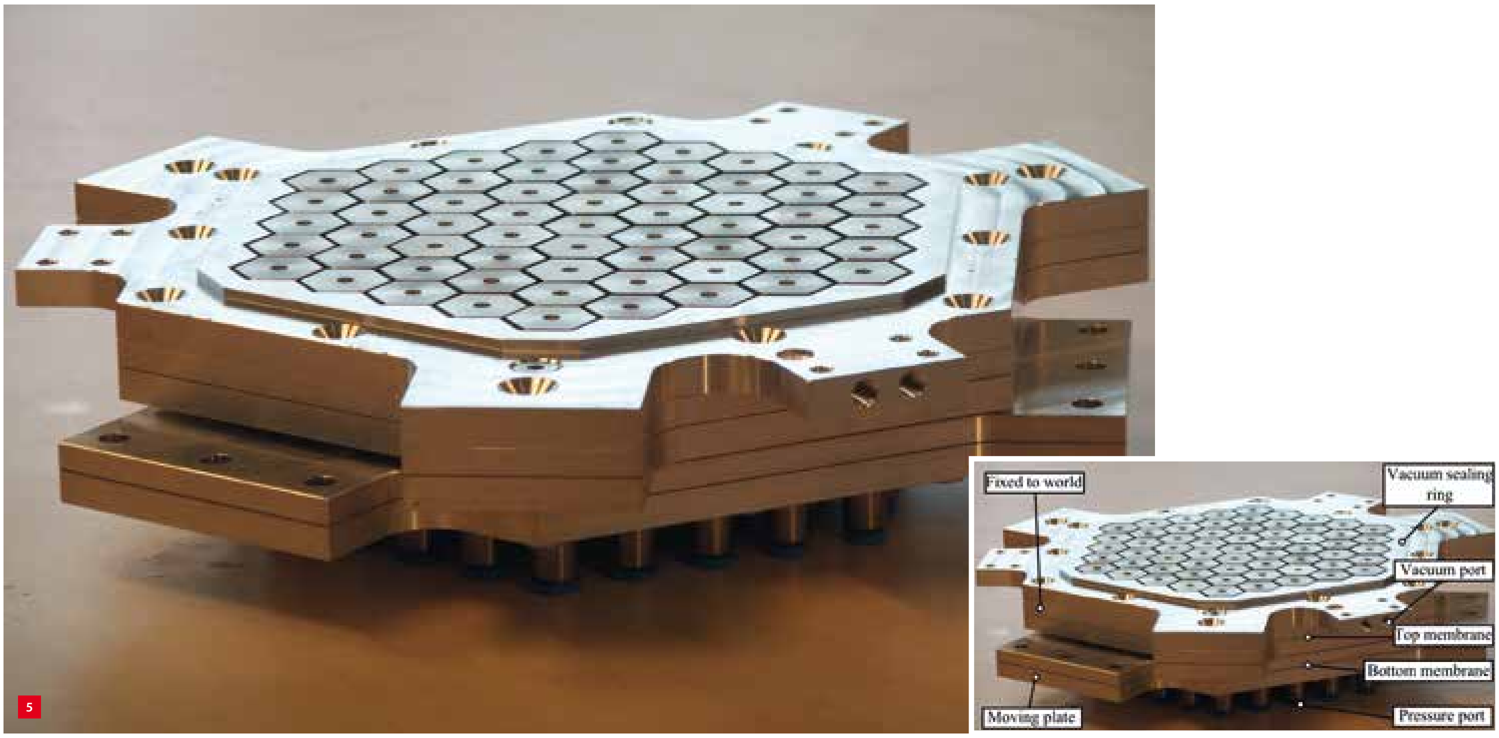
Control of the geometry of the actuator results in a direct control of the shear force generated by the flow, and does not suffer from a delay between controlling action and result. This is in contrast with the Gen-I concept where the unavoidable distance between the controlled pressure valve and the actuator surface results in a control delay, possibly limiting the overall performance of the system.

Two schematic concepts to control the surface geometry are shown in Figure 4. Surface sections may be deformed by bending piezo actuators or similar actuators, or surface sections may be tilted by deforming the carrying structure. Both concepts were found to be similar in performance, and in the first demonstrator the tilting surface concept was selected for testing. This is a variation of the concept in Figure 4b, using rigid stems: the rotation of the flowers is achieved by a translation of the bottom of the stem relative to the top of the stem [2].

The tilting surface was found to be similar in performance and a basic mechanical solution was developed to enable and synchronise the tilting of the surface sections. It turns out that the shape of the surface has very little influence on the performance with respect to the generated traction. Therefore, the shape of the final actuator was chosen such that the flow from the actuator is minimal.

Figure 4b shows the design. It consists of arrays of hexagonal surfaces, with a high-pressure inlet in the centre and a low-pressure outlet in between the surfaces. It provokes images of fields of sunflowers, all tilting their heads in unison towards the sun. Therefore, the product was nicknamed 'The FlowerBed'. The current version of the stage is shown in Figure 5.

The flowers need to tilt in unison in the required direction. Instead of actuating each flower individually, a basic mechanical solution was developed to enable and synchronise the tilting of the surface sections. Each flower has a stem connected on one side to the high-pressure inlet



5 *The FlowerBed [2].*

and on the other side to the flower head. This stem is then connected to two thin and bendable plates. One of the plates is rigidly connected to the frame, while the other is actuated in its planar DoFs. By moving this plate, all flowers tilt in unison, and direct the actuation force.

The traction control is now located right at the surface, and the time it takes from the tilting of the flowers to the variation of the traction is negligible. However, the advantage of the variable-pressure design, i.e. the lack of a moving mass, is lost because of the plate carrying the moving membrane. Therefore, the limitation of the system will in general be the actuator providing the force to move the internal mass of the system. Using capable actuators, with high speed and high force, a very high bandwidth can be achieved, dependent on the actuator characteristics. For a video demonstration of this concept, see [5].

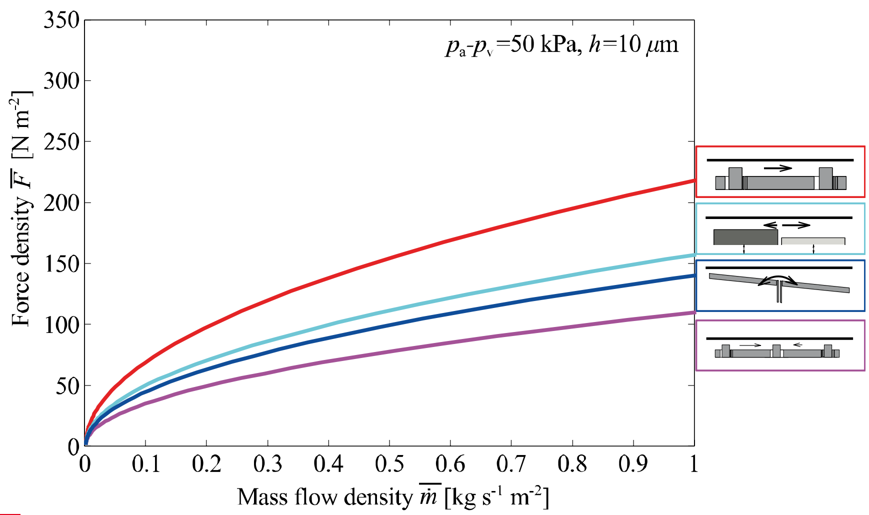
Comparison and discussion

The variable-pressure design has proven its accuracy, while the speed may leave room for improvement. The limiting delay in the pressure lines is fully omitted in the deformable-surface design, but replaced with a mechanism with inertia and stiffness.

Figure 6 shows the theoretically obtainable shear force density for a given mass flow density, compared for four concepts. It can be proven that for the assumptions inherent in thin-film theory, it is theoretically impossible to reach a higher traction value for a given mass flow density than that indicated by the red curve in Figure 6. However, note that for a traction of something like 100 N/m^2, a standard wafer with a typical mass of less than 2 kg/m^2 can be accelerated with more than 50 m/s^2. In the lab, accelerations of well over 10 m/s^2 were realised, allowing the system to move a wafer without mechanical contact along a vertical surface, working against gravity.
The best curve is related to the variable-pressure single-DoF concept (red). When the design is modified to achieve multiple DoFs (magenta), the performance drops below the deformable-surface curves (blue, light-blue). This shows that for one-directional actuation systems the variable-pressure concept would be the better choice, while for bi-directional actuation systems the deformable surface would be better.

From Figure 6 it can also be observed that the required airflow to obtain these high accelerations is huge, much higher than standard available. The use of a circulation system between vacuum outlet and supply inlet alleviates part of this disadvantage. Figure 6 is valid for a nominal fly height of 10 μm; for a smaller fly height the required mass flow density is substantially reduced. However, reliably reducing the fly height is a manufacturing challenge.

In all concepts the performance is limited by manufacturability. Tolerances, flatness, waviness and roughness determine the achievable fly height and therefore



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6 *The force per substrate area plotted against the amount of gas flow per substrate area [2], for a comparison of four fundamental concepts – in the legend on the right, from the top down:*
- Unidirectional pressure control
- Variable height
- Tilting surface
- Bidirectional pressure control.

the achievable actuation force for a certain volume flow. The current design of the FlowerBed surface consists of many separate parts, which introduces an extra challenge regarding the exact surface characteristics, compared to the advantageous monolithic surface of the variable-pressure concept.

Future development and conclusions

Two designs have been presented with comparable basic working principles but different characteristics. The variable-pressure concept can both carry and transport the substrate and achieve accurate positioning. The FlowerBed design will, in theory, improve the bandwidth and force characteristics. Since the FlowerBed is still in the experimental phase, some details of the achieved advantage are not yet available.

The limitation of the variable-pressure concept, the delay in the pneumatic lines, may be overcome by placing the control as close to the surface as possible. To achieve this, the complicated manifold should be replaced with small proportional controllable valves, just before the outlets.

Since this concept is most efficient in one DoF, transport is a logical application. In this case the valve control is extended such that only the actuator cells near the substrate are activated, while the other cells are dormant to reduce the total gas flow. In this concept cells can either fulfil bearing and motor function simultaneously, as previously discussed, or they can be divided into function-specific cells. Having separate motor and bearing cells reduces complexity and each function can be controlled separately.

Exploration of the limits of manufacturability will continue, to achieve smaller actuator cells with smaller tolerances in order to lower the fly height, increase the actuation force and reduce the pressure difference and substrate deformation.

Furthermore, the FlowerBed is still being improved mechanically. Difficulties arise in the high-precision alignment of each separate flower surface compared to the others, and in the control of the newly introduced dynamics due to the moving plates.

A start-up is exploring how to bring current technology to the market, in cooperation with partners in industry, while Delft University of Technology will continue to research next generations of this highly innovative concept. ■

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MAPAL DRILLS AND CHUCKS

Additive manufacturing (AM) used to be a production technology for prototypes or small series. But MAPAL Dr. Kress KG in Aalen, Germany, has succeeded in producing drills with complicated cooling channels in large series, as well as precision hydraulic chucks. It combines conventional cutting and grinding technology with additive manufacturing in an innovative hybrid process.

FRANS ZUURVEEN

1 *A Mapal QTD drill with a carbide insert.*

Dr Georg Kress started Mapal in 1950. One of their first products was a single-bladed reamer with two guiding pads, for which they acquired an Italian patent. At first the reamer didn't function at all but then the first Mapal engineers succeeded in developing a one-blade reamer that really did work. Gradually, Mapal expanded its product range to become a wide range of cutting tools.

In the 70s, the manufacturing programme was drastically restructured. The manufacturing of tap drills and dies, and subsequently the thread roller tools, was discontinued. Mapal then concentrated on fine-boring tools with blades for precision machining of bores. Later, the product programme widened out to many sorts of metalworking tools for reaming and fine-boring, drilling, milling, turning, clamping and measuring. Nowadays the Mapal Group employs over 4,500 employees.

Insert drills

High-performance drills are provided with a liquid-cooling channel to allow higher cutting speeds. For a long tool life, the preferred material for cutting edges is carbide. But because of the high price of carbide, Mapal has so-called QTD drills in its product range with a relatively inexpensive drill holder from tool steel with a carbide insert on top, see Figure 1. Originally, the circular cooling channel was situated in the centre of the drill. But because the body's cross-section was weakened by such a central bore, the minimum diameter of conventionally machined insert drills was limited to 13 mm.

Recently, Mapal introduced AM in its workshops by acquiring two M1 Cusing systems from Concept Laser with a working volume of 250 mm x 250 mm x 250 mm. (Cusing is a combination of the words *concept* and *fusion*.) By combining conventional cutting and grinding with 3D printing, Mapal could expand the product range of QTD insert drills to smaller diameters down to 8 mm, see Figure 2. This hybrid technology enabled Mapal to create drill holders with differently shaped cooling channels. An extra feature was the positioning of helically formed channels out of the drill centre, making the drill holder considerably stronger and stiffer. Moreover, tests showed that non-circular channels provided better cooling performance.

Large-series production

This application of AM can be considered as large-series production, because 121 drill holders are additively manufactured in one production cycle. Each drill holder is 3D-printed on a conventionally machined ISO 9766 shank, making this a hybrid technology. Depending on the drill

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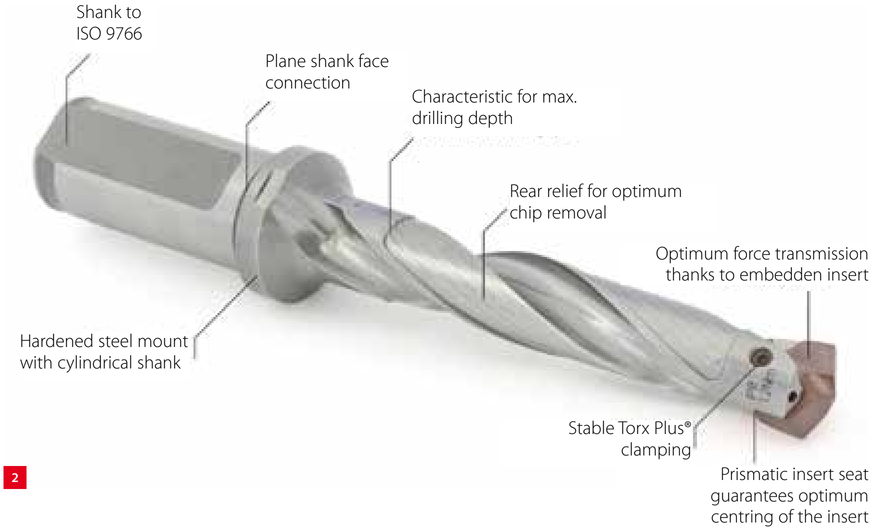

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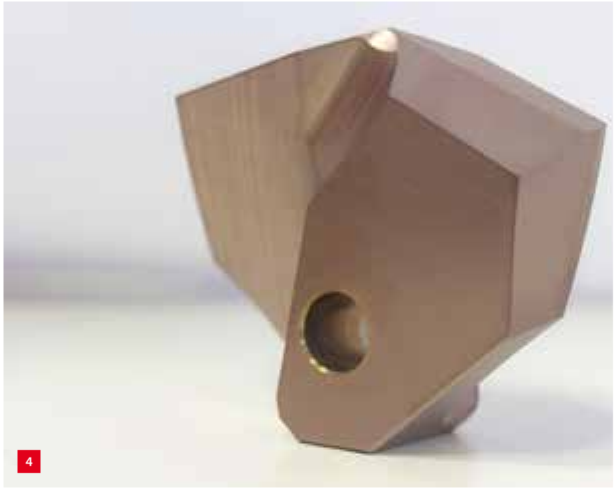
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diameter and length, the duration of one AM cycle is approximately 50 hours.

The M1 Cusing machine functions with a 200 W fibre laser with a focus diameter of 50 µm in a process called SLM (Selective Laser Melting, see Figure 3). The layer thickness amounts to between 20 and 80 µm with particle dimensions between 10 and 45 µm. To prevent corrosion, the printing takes place in an inert nitrogen atmosphere. Remarkable is the stochastic exposure strategy by deposing metal powder in chessboard-like square segments. This procedure ensures a significant reduction in stresses with less warping and better accuracy as favourable results.
For the best run-out accuracy each holder is externally ground, as well as the insert positioning planes.

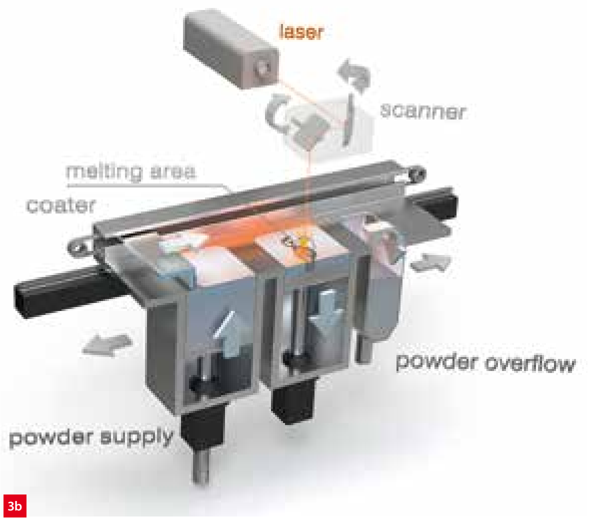
2 *A QTD drill of 8 mm cross-section with a conventionally machined shank and a 3D-printed insert holder.*
3 *3D printing using a Concept Laser M1 Cusing machine. (Photos Courtesy of Concept Laser GmbH)*
(a) The machine.
(b) Working principle; a new layer of metal powder is deposed by moving the coater.
(c) 3D printing of a Mapal QTD drill on a conventionally machined shaft.
4 *A QTD insert in carbide.*

Four kinds of inserts

Figure 4 shows a QTD carbide insert, which is a product that is difficult to machine precisely. Precision is required, because these insert drills equal the performance of solid carbide drills with ISO quality 9 to 10, corresponding to a tolerance field of about 40 µm for an 8 mm bore diameter, for example. The only method to manufacture such a Mohs-scale-9 product is to machine it with a Mohs-scale-10 material: diamond. The insert is clamped into the holder with only one torque screw, see Figure 1. When replacing an old insert with a new one, the position is precisely defined because the holder supports the insert on a V-groove.

Mapal supplies four kinds of inserts (see Figure 5) for different materials: standard steel, stainless steel, aluminium and cast iron. The first, second and fourth are differently

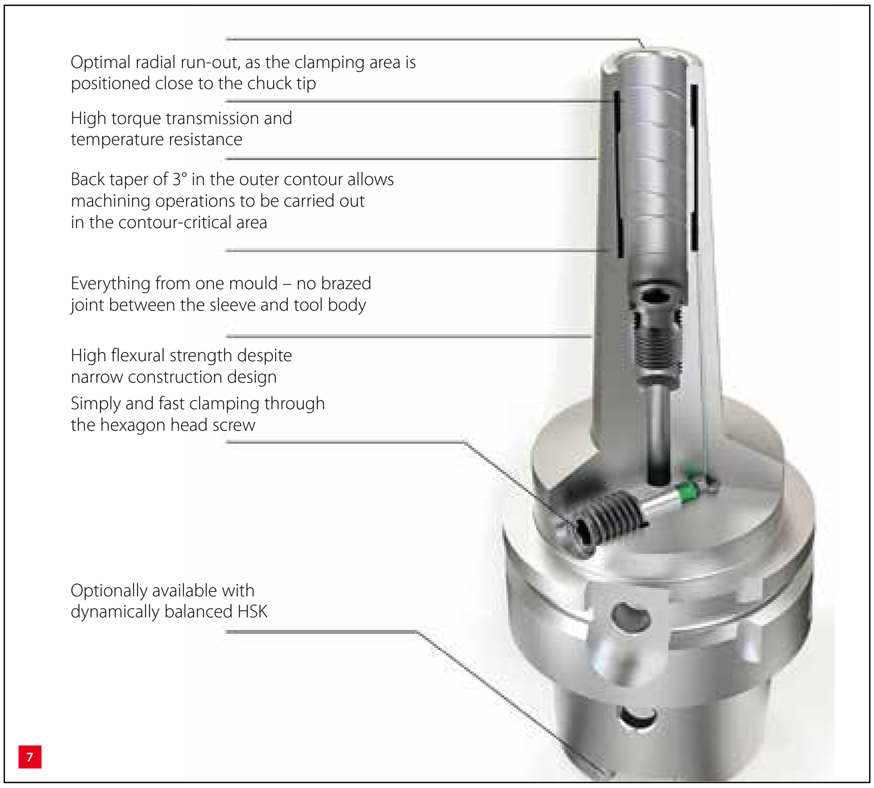

3a



3b


3c

5



7

6

8

PVD-coated (Physical Vapour Deposition: evaporating or sputtering), the third insert is uncoated. Their tip angle is 135°.

Other AM hybrid products

Precision machining technology very often requires tool clamping with hydraulic chucks, see Figure 6. Tightening a screw increases oil pressure inside the chuck with decreasing inside diameter as the result aimed for. But conventional hydraulic chucks require a brazed joint to connect the basic body to the expandable internal sleeve. Besides the risk of leakage, this joint limits the application of the chuck to temperatures down to 50 °C. But modern high-speed cutting technology causes much higher temperatures. That is why Mapal introduced AM to eliminate the disadvantages of brazed joints.

Figure 7 shows the new Mapal HTC products: High-Torque Chucks with a narrow contour. Thanks to AM-SLM production technology, the expandable sleeve is manufactured in one operation together with a conventionally machined part of the basic body, see Figure 8. Thus AM provides a reliable internal hydraulic cavity without the need for an extra joint. 3D-printing a large series of products in one cycle makes work piece costs acceptable, but nevertheless somewhat higher than with conventional technology.

The Mapal HTCs with tool diameters from 6 to 12 mm conform to HSK-A63 standards and withstand operating temperatures up to 170 °C. The clamping area of these AM chucks is positioned closer to the tool than with conventionally made hydraulic chucks. Radial run-out accuracies for the tool near the chuck tip are better than 3 μm.

To conclude

These innovative additive manufacturing applications from Mapal are evidence that this technology is especially valuable when complicated internal cavities have to be manufactured. And this example shows that AM also works when large series have to be produced. ■

5 *Four kinds of QTD inserts for different materials: steel, inox, aluminium and cast iron.*

6 *Mapal high-precision hydraulic tool chucks.*

7 *The new Mapal HTC: High-Torque Chuck with narrow contour.*

8 *A series of AM-SLM manufactured HTC parts on conventionally machined basic bodies. The AM parts are provided with internal hydraulic-fluid cavities.*

INFORMATION

WWW.MAPAL.COM
WWW.CONCEPT-LASER.DE

AM IS A HOT TOPIC

In common with many aspects of precision manufacturing, thermal issues are at play in the additive manufacturing process that need to be addressed in order to allow it to graduate as a truly appropriate manufacturing technology. Euspen will be running a Special Interest Group Meeting focused on thermal issues 17-18 March 2016 in Prague. Leading experts will discuss thermal issues in precision manufacturing, including additive manufacturing.

EDITORIAL NOTE

This article was contributed by euspen (European Society for Precision Engineering & Nanotechnology).

www.euspen.eu

Despite the booming consumer interest in '3D printing', the real business case for the use of additive manufacturing (AM) technologies is in the industrial arena, where it has been used as a rapid prototyping technology for many years. Today, however, the key push from technology providers in this arena (in response to OEM demand) is to bridge the gap between AM as a prototyping technology and AM as a production technology.

The advantages of this are obvious, as AM is a less wasteful means of manufacture, is ideally suited to complex, precise and feature-rich parts, requires no tooling, and can be used to 'customise' products economically compared with traditional manufacturing technologies. So what needs to be done to make additive manufacturing a cost-effective and efficient production technology?

Thermal effects

Thermal effects are regarded as a major contributor to errors on machine tools, on measuring equipment and on workpieces. Measurement of thermal effects is becoming even more important as workpiece tolerances decrease, as thermal effects not only use a larger part of the tolerances, but also influence repeatability and long-term stability of machine tools, and measuring equipment. As a consequence, several research groups and industries are working on simulation of thermal effects, in order to finally compensate thermally induced errors, or help to develop new concepts to reduce thermally induced errors.

Volume production

A lot of emphasis is being placed on developing platforms that can provide medium- and even high-volume production runs, which is where AM technologies struggle to compete. The technology is ideally suited to the production of customised single products (with material developments allowing the manufacture of plastic, ceramic, and metal parts), and can cater for small-volume production, but even here, there are issues that need addressing.

For a production part, dimensional accuracy and surface finish are of critical importance, and a great deal of research and development is focused on enhancing these characteristics of parts produced using AM. It is when these issues are successfully addressed that AM will truly take a huge step towards becoming machines used on the factory floor.

Research on dimensional accuracy and surface finish are key to elevating AM to a production-appropriate technology. Specifically, work is underway looking at heat treatment and secondary machining, grinding, and polishing to achieve dimensional tolerances. It is also important that the technology is integrated properly in the manufacturing process, and the ability to measure internal and external features is enhanced.

AM thermal issues

In common with many aspects of precision manufacturing, thermal issues are at play in the additive manufacturing process that need to be addressed in order to allow it to graduate as a truly appropriate manufacturing technology. Euspen will be running a Special Interest Group Meeting focused on Thermal Issues 17-18 March 2016 in Prague in the Czech Republic. It is the intensive on-going work in this area that led euspen to organise this two-day event, and leading experts from around the world will discuss thermal issues in precision manufacturing, including AM.

Nick Jones from Renishaw will be making the point in his presentation, 'Thermal Issues in Additive Manufacturing', that OEM customers require above all else from AM process reliability, the ability to monitor and control the AM process, closing and controlling more feedback loops, and enhanced productivity, which means higher thermal inputs.

The challenges are numerous when addressing thermal issues. The machine structure itself often needs to be reconsidered as it is asymmetric, there are often large offsets between critical components, and the time and location of thermal inputs vary significantly. When it comes to thermal loads, the technology typically uses 200W to 2kW lasers, with heat often being 'scattered', and argon and nitrogen are frequently used as 'coolant'.

Other thermal topics

The euspen Thermal Issues event will also cover modelling techniques and model reduction techniques, temperature measurement and control, thermal actuators, correction and compensation strategies, and thermal design principles. Speakers include Professor Hans Vermeulen from ASML Research in the Netherlands looking at thermal issues for next generation lithography, and Dr Jeroen de Boeij from FEI in the Netherlands discussing thermal challenges in electron microscopy systems and applications. ■

SIG Meeting tours

The SIG Meeting programme includes two (optional) tours. Kovosvit MAS, based in Sezimovo Ùsti (Czech Republic), has a 75 year old tradition in the production and development of machine tools. The company has developed several new machine tools with the goal of minimising thermal errors – development of new thermal compensation models, thermal optimisation of machine tool structure based on finite-element simulations, advanced cooling, research of the cutting impact on thermal errors, thermal influence on machine tool volumetric accuracy, etc.

One of the highlights of the Kososvit MAS tour is the multitasking five-axis machining center MCU 700; its control features an advanced compensation algorithm for thermal errors based on transfer functions.

The other tour is at the Czech Technical University in Prague, Faculty of Mechanical Engineering Research. There, the Research Center of Manufacturing Technology (RCMT) was established in 2000 as a professional and well-equipped educational and training facility and a research base for the Czech machine tool industry. The RCMT team comprises 70 professionals specialising in design, engineering analyses and research. One of RCMT's divisions focuses on thermal issues in the machine tool industry, including the development of new measurement techniques and methods, and the modeling of thermal effects for optimisation and compensation.

PRECISION TECHNOLOGY IN CARBIDE WEAR PARTS

Tungsten carbide is rightly regarded as a brittle, difficult-to-machine material. But this material has proven its high value for precision components that have to resist wear. How to select the optimum composition of the material and how to achieve micron or even submicron tolerances? Ceratizit is specialised in manufacturing a complicated 'rough' work piece and finishing this as well, when necessary with the high accuracy specified.

FRANS ZUURVEEN

Dr Paul Schwarzkopf founded the predecessor of Ceratizit in Reutte, Tyrol (Austria) as long ago as 1921. Today, Ceratizit is a large company with 5,800 employees and 24 production sites worldwide. The main locations are situated in Luxembourg, Germany and Italy. Ceratizit not only concentrates on the production of carbide components but also on manufacturing ceramic parts. It handles the complete process chain, from raw base material to the finishing of precision products.
As is widely known, carbides consist of hard particles in a binder of comparatively soft material. The ultimate mechanical properties of carbides depend largely on the composition and dimensions of these particles and the selected binding material, in general cobalt. This means that thorough knowledge is required to optimize a carbide application.

Production process

The carbide production process involves four steps: powder preparation, forming, sintering and finishing. The base material is APT, ammonium paratungstate, a white crystalline salt of ammonium and tungsten acid. This is calcined into tungsten oxide WO_3, which is reduced to tungsten metal in a hydrogen atmosphere. The metal powder is then mixed with carbon and carburized to WC at high temperature in an inert atmosphere. The parameters in these powder preparation processes are decisive for the tungsten carbide grain size.
The WC grains are mixed with binder particles: mostly cobalt, less often nickel or rarely iron, with some other – secret – components influencing grain growth. The result is a suspension with good flow characteristics, acting as the basis for subsequent forming processes: pressing, extrusion or metal injection moulding. Finally, the 'green' products are sintered at temperatures between 1,300 and 1,500 °C, with a volume reduction of up to 50%.

Figure 1 shows how the cobalt content of carbides influences their mechanical properties. A higher Co content decreases the modulus of elasticity E and increases the transverse contraction, also called Poisson's ratio ν. Understandably, a high Co content decreases the density ρ and increases the coefficient of thermal expansion α.

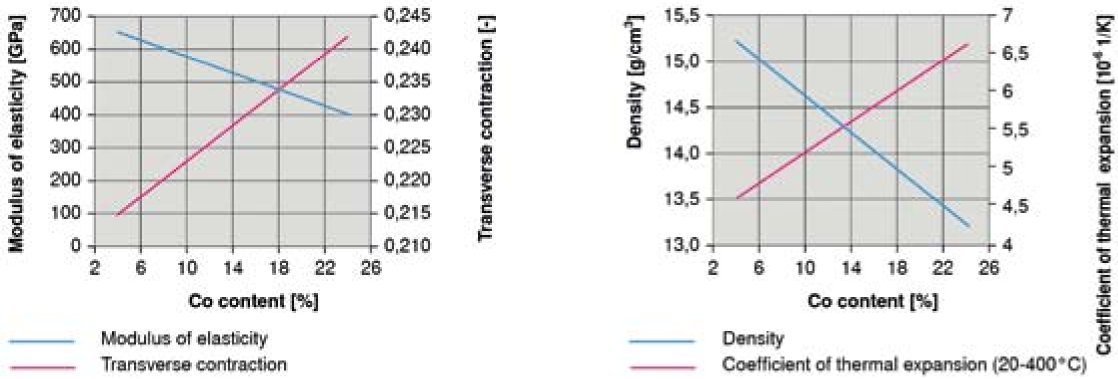
Table 1 indicates application areas for various carbide grades with different grain sizes. The strongest and toughest carbides are characterized by an ultrafine grain size. Other tables – not depicted here – show that ultrafine finishing methods like honing and lapping make it possible to achieve surface qualities up to 0.25 μm R_z (peak-to-valley roughness depth).

AUTHOR'S NOTE

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

Table 1. Fundamental guidelines for the selection of the right carbide grade.

Grain size	Impact strength	Stress caused by notch tensions	Tension and bending stress (with good surface quality)	Resistance to adhesion (against metal)
Coarse/medium	++	+	o	o
Fine	+	o	o	+
Submicron	o	–	+	++
Ultrafine	–	––	++	++



1

The foregoing makes it clear that thorough knowledge of the influence of several parameters helps to select both the optimum carbide composition and the best finishing operation. Figure 2 shows examples of unfinished carbide components, called preforms. They are dark in colour because of oxidation during the sintering process. The photo also displays some foil and sheet products made by blanking tools assembled from these carbide components after finishing, including a stamping tool for electric motor lamination. Figure 3 displays a series of finished precision carbide products. Hereafter we will describe in detail some precision applications realised thanks to Ceratizit's craftsmanship.

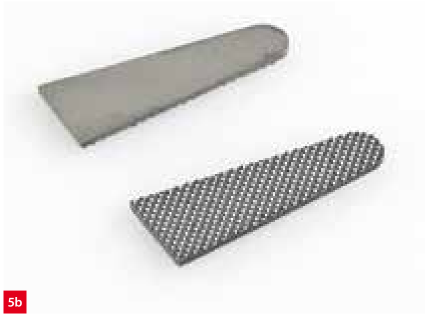
Carbide precision products

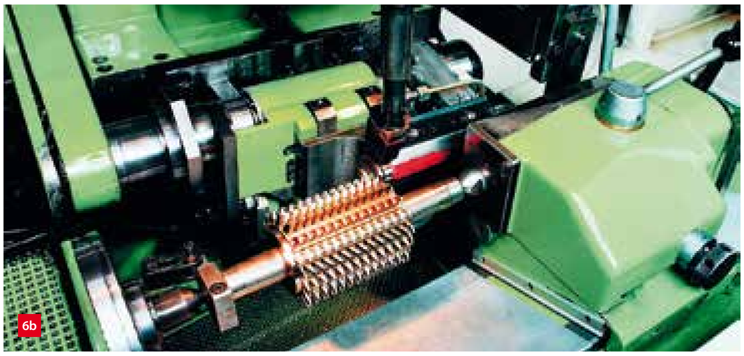
Figure 4 shows carbide shear blades for cutting fluid glass gobs to be deposed in a glass pressing die. These blades appear to be simple products but have to be manufactured to meet stringent precision requirements. When making drinking glasses or other 'aesthetical' glass products, a rough cut causes unwanted ugly blemishes in the finished glass product. Such a rough cut is due to poor finishing of the shear blades. That's why both cutting edges have to be carefully machined and their bodies have to meet stringent flatness requirements. Ceratizit also delivers carbide glass cutting wheels and glass lens polishing tools.

1 *Modulus of elasticity and transverse contraction (at left), density and thermal expansion (at right), as functions of cobalt content in carbide.*
2 *A collection of unfinished Ceratizit carbide products, so-called preforms.*
3 *Completely finished Ceratizit carbide precision products.*
4 *Carbide shear blades for the cutting of glass gobs.*

Other examples of carbide precision products are medical aids for treating teeth and bones, see Figure 5a. The lower part of the picture shows dental tools meeting stringent healthcare regulations. Needless to say, such products have to be hard at the one hand and resistant to breakage at the other. Some of the tools are provided with soldered inserts, see Figure 5b. They improve the tool grip, as shown in the squeezing tool in Figure 5a and the jaws in Figure 5c. Ceratizit delivers the preforms only, which are subsequently finished by third parties.

Hobs for cutting gear teeth are without doubt real precision products, see Figure 6a. Such tools generate involute gear wheels with a precision correlating to the precision of the revolving tool itself, see Figure 6b. The application of homogeneous carbide guarantees stable cutting edges.





5 *Some medical carbide precision products.*
(a) Dental tools at left below.
(b) Carbide inserts to improve the grip of medical instruments.
(c) Forceps jaws with carbide inserts.

6 *Hobs for cutting gear teeth.*
(a) A preformed hob.
(b) A finished gear hob in action.

7 *Carbide-made knives.*
(a) Slitting knives and distance rings for winders, which convert large-diameter reels into smaller rolls.
(b) Winder knives cutting sheet material.

Winder slitting knives convert large-diameter reels of various sheet materials into smaller rolls meeting customer requirements, see Figure 7a. Opposite knives need to have a well-defined small distance without touching each other, see Figure 7b. And they must have extremely sharp cutting edges, which are subsequently achieved by grinding, lapping and polishing with extremely tight tolerances. Ceratizit masters the complete manufacturing process from powder preparation to highly accurate finishing. Figure 7a also shows the spacer disks necessary to achieve the accurate positioning of several knives in one row.

To conclude

These various examples of applications of carbide show that thorough knowledge of material composition, manufacturing procedures and finishing operations are indispensable to achieve the best performance of wear-resistant precision products. ■

INFORMATION
WWW.CERATIZIT.COM
WWW.YOUTUBE.COM/USER/ECERATIZIT

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GENERAL INFORMATION

OPENING HOURS
Thursday 24 March 2016: 09:00 - 17:30 hours

ENTRANCE FEE
Entrance for exhibitors and visitors is ***free of charge*** when registered before 22 March 2016.
When visitors do not register before 22 March 2016, an entrance fee of € 30 (including VAT) will be charged for visiting the event.

REGISTRATION
Preregistration is possible until 22 March 2016 via *www.hightechsystems.eu/visitors*. When preregistered you receive an entrance ticket which you should bring to Van der Valk Eindhoven. Upon showing this ticket you will receive your badge.

ORGANISATION
High-Tech Systems 2016 is organised by Techwatch, publisher of Mechatronica&Machinebouw and Bits&Chips, Snelliusstraat 6, 6533 NV Nijmegen, the Netherlands.

INFORMATION
Presentation programme:
Alexander Pil, *alexander@techwatch.nl* or
T +31 24 3504580
Other questions:
events@techwatch.nl or +T 31 24 3505544.

LOCATION
Van der Valk Eindhoven
Aalsterweg 322
5644 RL Eindhoven
The Netherlands
www.hoteleindhoven.nl

CONTACT
Techwatch bv
T +31 24 3505544
events@techwatch.nl
www.hightechsystems.eu

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HIGH-TECH SYSTEMS

24 MARCH 2016 EINDHOVEN

CONFERENCE PROGRAMME

09:30 — Introduction by Maarten Steinbuch, HTSC

09:45 — **LASSE KIEFFER UNIVERSAL ROBOTS**
Collaborative robots and international standards

10:30 — BREAK

TRACK	SMART INDUSTRY	ADDITIVE MANUFACTURING	ROBOTICS
	CHAIRMAN: FRANK SPERLING, NOBLEO AND HTSC	CHAIRMAN: ERWIN MEINDERS, TNO	CHAIRMEN: TON PIJNENBURG, VDL ETG AND HTSC & JESSE SCHOLTES, ROBONED AND HTSC
11:30	Egbert-Jan Sol, TNO The 4th industrial revolution in the Netherlands towards Factories 4.0	Richard Hague, University of Nottingham 3D deposition of functional materials for the additive manufacturing of smart devices	Simon Jansen, Smart Robotics & Eelke Halbertsma, Philips Empowering companies to configure their robots
12:00	Marcel Swinnen, TBP Not all pcba's are created equal	Ralph Pohl, Demcon Design of a 3D printer jetting metals directly from the melt	Niels Jul Jacobsen, MIR Why mobile robots will invade our factories
12:30	LUNCH		
14:00	John Blankendaal, Brainport Industries & Paul Schuurmans, Praetimus Productization of supply companies	Mark Vaes, Additive Industries Metal additive manufacturing from lab to fab	Joris De Schutter, Flexible Robotic Solutions Skillful robots for difficult tasks
14:30	Sandro Etalle, TU Eindhoven Cybersecurity and the machine	Mathijs de Schipper, TNO The next generation of industrial additive manufacturing	Herman Bruyninckx, KU Leuven Robot systems of the future: moving them badly makes them better
15:00	BREAK		
16:00	Philipp Wallner, Mathworks Predictive maintenance for production machines	Joris Biskop, Luxexcel 3D printing of optics via inkjet printing	Nico Nijenhuis, Clear Flight Solutions Remotely piloted robotic falcons to control nuisance birds
16:30	Bert Thuis, NLR Automation in aerospace composites	Mathieu Cornelis, Materialise Automation flexibility: Designing a 3D-printed gripper concept	Jordan Bos, TU Eindhoven Robosculpt: A surgery robot for precision bone sculpturing
17:00	DRINKS		

YPN VISIT TO VDL ETG

VDL Enabling Technologies Group (VDL ETG), part of the VDL Group, is a tier-one contract manufacturing partner with worldwide activities for OEM manufacturers, playing a leading role in high-end technical equipment, and users of advanced production lines. Early December last year, YPN (DSPE's Young Precision Network) paid a visit to this interesting company in Eindhoven, the Netherlands.

Guustaaf Savenije, CTO of VDL ETG, introduced VDL; how it has grown from a small company in stormy weather into a successful and unique family company with about 10,500 employees. He showed examples of VDL's products and why VDL ETG is transforming from a build-to-print into a build-to-spec company. This transfer makes VDL ETG very attractive for higher educated young professionals in precision technology. Moreover, his pitch was reaching out towards other companies in the Eindhoven region to follow the same path since in his opinion this is required to reach the top in today's market.

The following tour gave a glimpse of the production capabilities of VDL ETG and the products which VDL ETG machines and assembles. This ranges from semiconductor products (e.g. the wafer handler for ASML), medical (C-arms for Philips) and space (gigantic aluminium blocks).

After the tour, Gerrit Oosterhuis (engineer) presented how additive manufacturing (AM) is used within VDL ETG; especially how AM in metal sometimes can be used to outperform conventional techniques. An example was the design of a cooling manifold; shapes and structures can be produced using AM which are optimised for optimal flow, cooling capacity and mass, and which would be impossible to obtain with conventional techniques.

Pierre van den Hurk (technologist) talked about high-speed machining; how knowledge about the dynamical behaviour and performance of the total milling set-up can help VDL ETG to machine both faster and more accurately at the same time. Finally, Rick Baade (Ph.D. student) showed typical starting opportunities at VDL ETG, by walking the YPN guests through his first project on a wafer handler robot.

■ *Clean-room assembly at VDL ETG of a vacuum chamber for a plasma source.*

YPN would like to extend their gratitude towards VDL ETG for the hospitality. ■

WWW.VDLETG.COM

■ *The YPN visiting group at VDL ETG.*

MARTIN VAN DEN BRINK AWARD
GALA DINNER

DSPE has been presenting awards for years now: the Rien Koster Lifetime Achievement Award, the ir. A. Davidson Award for encouraging young precision engineering talent, and the Wim van der Hoek Award for the best graduation project in the field of design in mechanical engineering. Wim van der Hoek and Rien Koster were renowned professors in precision engineering, ir. A. Davidson was the authority in the field of precision mechanics at Philips in the 1950s and 60s. The Dutch precision engineering community benefited a great deal from their contributions.

In 2012, the DSPE Advisory Board suggested that another award would be welcome: for the best system architect in precision engineering. A name was easily found. Martin van den Brink is by far the most successful system architect in the Netherlands, bringing ASML to where it is today. He would say: "I did it with my team", which is of course true, but Martin van den Brink played the crucial role of giving direction.
The first Martin van den Brink Award was awarded in 2012, to ir. Erik Loopstra of ASML. The second ceremony should have taken place in 2014, but DSPE's ambitions to grow the award into an international event for the high-tech industry are taking more time.

As a start, the Martin van den Brink Award gala dinner will be held on 26 May 2016 during the Dutch Technology Week in the Evoluon in Eindhoven, the Netherlands. Prominent representatives from the high-tech industry will attend. Members of DSPE and Brainport Industries can participate as a partner and reserve tables at cost-price. They can entertain their business relations in this particular ambiance, which underlines the importance of system architecture for the success of the Dutch high-tech systems industry and the leading role our country is playing in this field. ■

INFO@DSPE.NL (APPLICATIONS)

First female precision engineer to receive bronze CPE certificate

Late last year, Tasja van Rhee, precision engineer at ASML, department of System Engineering, received a bronze certificate under the DSPE Certification Program (also see page 26). She followed post-graduate courses like Applied Optics, Motion Control Tuning, Mechatronics System Design, etc., receiving points for each course. To reach the bronze level she collected 25 points. She is the second person, and the first female, to reach this bronze level – a stepping stone towards ultimately reaching 45 points – which corresponds to the full certificate and the title 'Certified Precision Engineer'.

The DSPE certification program started in 2011 and aimed at improving the level of knowledge and cooperation in the field of precision engineering in the Netherlands by promoting post-graduate technical education. In November 2015, a cooperation agreement was signed between DSPE and its European counterpart, euspen, allowing each course in the DSPE Certification Program to be certified at the European level by euspen.

The result of this collaboration is the European Certified Precision Engineering Course Program (ECP^2), which reflects the demand for multidisciplinary system thinking, excellent cooperative skills and in-depth knowledge of the relevant disciplines. Late January the first ECP^2 certificates were handed out to sixteen participants who had successfully completed the Mechatronics System Design course.

■ *Tasja van Rhee receiving the CPE bronze-level certificate from DSPE Certification Program chairman Jan-Willem Martens.*

WWW.DSPE.NL/EDUCATION/CERTIFICATION-PROCESS

ECP2EU.WPENGINE.COM

CPE COURSE CALENDAR

The DSPE Certification Program has been incorporated in ECP², the European Certified Precision Engineering Course Program. See ecp2eu.wpengine.com

COURSE (content partner)	CPE points	Provider	Starting date (location, if not Eindhoven)
BASIC			
Mechatronics System Design - part 1 (MA)	5	HTI	4 April 2016
Mechatronics System Design - part 2 (MA)	5	HTI	11 April 2016
Design Principles	3	MC	9 March 2016
System Architecting (Sioux)	5	HTI	7 March 2016
Design Principles Basic (SSvA)	5	HTI	17 March 2016
Motion Control Tuning (MA)	6	HTI	15 June 2016
DEEPENING			
Metrology and Calibration of Mechatronic Systems (MA)	3	HTI	8 March 2016
Actuation and Power Electronics (MA)	3	HTI	14 March 2016
Thermal Effects in Mechatronic Systems (MA)	3	HTI	21 March 2016
Summer school Opto-Mechatronics (DSPE/MA)	5	HTI	4 July 2016
Dynamics and Modelling (MA)	3	HTI	12 December 2016
Summer School Manufacturability	5	LiS	to be planned
SPECIFIC			
Applied Optics (T2Prof)	6.5	HTI	3 March 2016
Applied Optics	6.5	MC	3 March 2016
Machine Vision for Mechatronic Systems (MA)	2	HTI	23 June 2016
Electronics for Non-Electronic Engineers – Basics Electricity and Analog Electronics (T2Prof)	6	HTI	to be planned
Electronics for Non-Electronic Engineers – Basics Digital Electronics (T2Prof)	4	HTI	5 September 2016
Modern Optics for Optical Designers (T2Prof)	10	HTI	to be planned (2016)
Tribology	4	MC	5 April 2016 1 November 2016 (Utrecht)
Design Principles for Ultra Clean Vacuum Applications (SSvA)	4	HTI	to be planned
Experimental Techniques in Mechatronics (MA)	3	HTI	28 June 2016
Advanced Motion Control (MA)	5	HTI	7 November 2016
Advanced Feedforward Control (MA)	2	HTI	14 November 2016
Advanced Mechatronic System Design (MA)	6	HTI	to be planned
Finite Element Method	5	ENG	in-company only
Design for Manufacturing – Design Decision Method	3	SCHOUT	March 2016 / in-company

DSPE Certification Program

Precision engineers with a Bachelor's or Master's degree and with 2-10 years of work experience can earn certification points by following selected courses. Once participants have earned a total of 45 points (one point per course day) within a period of five years, they will be certified. The CPE certificate (Certified Precision Engineer) is an industrial standard for professional recognition and acknowledgement of precision engineering-related knowledge and skills. The certificate holder's details will be entered into the international Register of Certified Precision Engineers.

WWW.DSPE.NL/EDUCATION/LIST-OF-CERTIFIED-COURSES

Course providers

- Engenia (ENG)
  WWW.ENGENIA.NL
- The High Tech Institute (HTI)
  WWW.HIGHTECHINSTITUTE.NL
- Mikrocentrum (MC)
  WWW.MIKROCENTRUM.NL
- LiS Academy (LiS)
  WWW.LISACADEMY.NL
- Schout DfM (SCHOUT)
  WWW.SCHOUT.EU

Content partners

- Dutch Society for Precision Engineering (DSPE)
  WWW.DSPE.NL
- Mechatronics Academy (MA)
  WWW.MECHATRONICS-ACADEMY.NL
- Settels Savenije van Amelsvoort (SSvA)
  WWW.STTLS.NL
- Sioux
  WWW.SIOUX.EU
- Technical Training for Professionals (T2Prof)
  WWW.T2PROF.NL

UPCOMING **EVENTS**

10 March 2016, Hilvarenbeek (NL)
Motion & Drives 2016
One-day event organised by Mikrocentrum on trends in factory automation.

WWW.MIKROCENTRUM.NL

15-18 March 2016, Utrecht (NL)
ESEF 2016
The largest and most important exhibition in the Benelux area in the field of supply, subcontracting and engineering.

WWW.ESEF.NL

17-18 March 2016, Prague (CZ)
Special Interest Group Meeting: Thermal Issues
Meeting organised by euspen, featuring sessions on modelling techniques & model reduction techniques, thermal control strategies, temperature measurement & control, thermal actuators, correction & compensation strategies, and thermal design principles. Read the article on page 14 ff.

WWW.EUSPEN.EU

22 March 2016, Delft (NL)
ZIE 2016
The Zuid-Holland Instrumentation Event 2016 is organised by Holland Instrumentation, a network of CEOs/CTOs from high-tech companies, institutes and universities, aimed at promoting Zuid-Holland's instrumentation industry

WWW.HOLLANDINSTRUMENTATION.NL

24 March 2016, Eindhoven (NL)
High-Tech Systems 2016
One-day conference and exhibition with the focus on high-tech systems and key enabling technologies. See the programme overview on page 20 ff.

WWW.HIGHTECHSYSTEMS.EU

12-13 April 2016, Aachen (DE)
Aachen – Polymer Optics Days 2016
International Conference featuring injection moulded optics, continuous production of planar optics and films, innovative optical grade polymers and applications, and light sources and optical systems. Organised by Fraunhofer IPT and ILT, and the Institute of Plastics Processing (IKV) in Industry and the Skilled Crafts at RWTH Aachen University.

WWW.IKV-AACHEN.DE

14 April 2016, Cranfield (UK)
Optical Materials Day
Outreach event at Cranfield University organised by the EPSRC Centre for Innovative Manufacturing in Ultra Precision.

WWW.ULTRAPRECISION.ORG/NEWS/EVENTS

20-21 April 2016, Veldhoven (NL)
Materials 2016, engineering & technology
Trade fair, with exhibition and lecture programme, targeted at product developers, constructors and engineers. The focus is on properties - applications - solutions.

WWW.MATERIALS.NL

30 May - 3 June 2016, Nottingham (UK)
Euspen's 16th International Conference & Exhibition
This event will once again showcase the latest advances in traditional precision engineering fields such as metrology, ultra-precision machining, additive and replication processes, precision mechatronic systems & control and precision cutting processes. Furthermore, new topics will be addressed covering precision engineering for aerospace and applications of precision in biological sciences.

WWW.EUSPEN.EU

31 May - 2 June 2016, Stuttgart (DE)
Parts2clean 2016
International trade fair for industrial parts and surface cleaning.

WWW.PARTS2CLEAN.COM

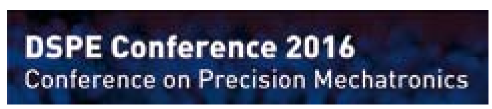
1-2 June 2016, Veldhoven (NL)
Vision, Robotics & Mechatronics 2016 / Photonics 2016
Combination of two events organised by Mikrocentrum.

WWW.VISION-ROBOTICS.NL
WWW.PHOTONICS-EVENT.NL

14-16 June 2016, Erfurt (DE)
Rapid.Tech
International trade fair and users' conference on rapid technologies.

WWW.RAPIDTECH.DE

4-5 October 2016, Sint-Michielsgestel (NL)
DSPE Conference on Precision Mechatronics
Third edition of conference on precision mechatronics, organised by DSPE. The target group includes technologists, designers and architects in precision mechatronics, who are connected to DSPE, Brainport Industries, the mechatronics contact groups MCG/MSKE or selected companies or educational institutes. 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.



WWW.DSPE-CONFERENCE.NL

Impact of photonics on our society

On 3 December 2015, just before the end of the International Year of Light, the closing symposium for the Dutch innovation-oriented research programme (IOP), Photonic Devices, took place under the title of "Impact of Photonics on our society". The research programme, which was designed to promote the use of photonics in products and systems, ended last year. The following offers a brief review of the programme and a preview of the future of integrated photonics. A more in-depth report will appear in a subsequent edition of Mikroniek.

IOP Photonic Devices started in 2006 based on the idea that there should be more collaboration between companies and knowledge institutions involved in photonics. "The Netherlands already had lots of expertise in photonics", says Bart Verbeek, chairman of the advisory board of IOP Photonic Devices. "But that expertise was not being converted enough into commercial activities."

Projects got off the ground as part of the programme in which knowledge institutions joined forces with two or more companies. Various Dutch start-ups were given a boost, among them Quest Medical, which has developed a special camera that, with the help of light, can chart cancer tumours during an operation. The firm Technobis has succeeded in integrating extensive measuring equipment onto one photonic chip, a chip that works with light rather than electricity. It can monitor the stresses on the material in aircraft wings, for example.

IOP Photonic Devices has given the photonics industry a major shot in the arm, says Eddy Schipper, programme coordinator at RVO.nl. "Integrated photonics – the specific technology within photonics that makes use of photonic chips – is on the eve of a breakthrough. A network has been created and various initiatives have been launched. It is now up to the market to use the technology in products on a wide scale." For 2016, RVO.nl has signed a cooperation agreement with Photonics NL, the industry association for photonics in the Netherlands. Through this cooperation, the final IOP activities are transferred to the association.

One of the new initiatives is Photon Delta in Eindhoven, a network of companies, organisations and knowledge institutes in the field of photonics. Photonics has also acquired a firm place within the top sector of High Tech Systems and Materials (HTSM), one of the nine industries that the Dutch Cabinet has designated as top sectors. Likewise, photonics has attracted plenty of attention at a European level too. Schipper: "The Netherlands is in second place in the ranking of subsidies granted for photonics projects as part of the Horizon 2020 programme, a subsidy scheme for photonics projects. It goes to show how strong we are in this field."

WWW.RVO.NL/SUBSIDIES-REGELINGEN/IOP-PHOTONIC-DEVICES

WWW.BRAINPORTDEVELOPMENT.NL/PROJECT/9699 (PHOTON DELTA)

Henny van Doorne appointed CEO/ CTO Irmato Group

Henny van Doorne has been appointed as Chief Executive Officer / Chief Technical Officer of the Irmato Group, which is headquartered in Stramproy, the Netherlands. Previously, he worked for DAF Trucks, Stork and Toolex, and for ten years he was Managing Director of CCM Centre for Concepts in Mechatronics in Nuenen, the Netherlands. After the takeover of CCM by Sioux, he served as a board member of the Sioux Group in Eindhoven, the Netherlands.

Irmato is a leading innovation and technology partner from development up to and including completion of high-tech solutions in machine building and equipment building. Irmato distinguishes between four areas of expertise within the project organisation, namely Industrial Manufacturing Technologies, Qualification Technologies, Tooling & Module Solutions, and Food Handling Technologies.

WWW.IRMATO.COM

Trends in computer vision

In early December 2015, Jaap van de Loosdrecht delivered his inaugural lecture as professor of Computer Vision at the NHL University of Applied Sciences in Leeuwarden, the Netherlands. He discussed a number of developments/trends in computer vision:

- Product quality demands becoming ever more stringent.
- Costs decreasing, enabling low-budget computer vision solutions.
- Inspections requiring more 3D instead of 2D measurements and increasingly involving multi-spectral analysis.
- Form factor reduction enabling more vision applications in mobile devices.
- New sector-transgressing applications emerging, such as integral security, smart farming, serious gaming, multi-media, care & well-being and unmanned aerial vehicles (UAVs)/drones.
- Sensor fusion, the use of cameras in combination with other sensors, being on the rise.
- Complex quality control calling for data science (processing big data into sensible information for improving products and services).
- The increase of image resolution and algorithmic complexity demanding for additional processor capacity.

■ *Professor Jaap van de Loosdrecht delivering his inaugural lecture.*

The NHL Centre of Expertise in Computer Vision conducts research in these subjects. One example is the "Smart Vision for UAVs" RAAK-project. (RAAK is a Dutch government funding programme for applied research projects; it stands for Regional Attention and Action for Knowledge Circulation.) Twelve SME companies and three research institutes, including the NLR (Netherlands Aerospace Centre), are participating in this NHL Computer Vision project. Practical applications that can be explored include wind turbine inspection, fire detection, aerial survey and inspection of small waterways.

WWW.NHLCOMPUTERVISION.NL

Pratt & Whitney – KMWE agreement

Pratt & Whitney, a United Technologies Corp. company, and KMWE / DutchAero have signed a long-term contract to manufacture F135 engine components. The F135 engine is the propulsion system for the fifth generation F-35 Lightning II aircraft.Located in Eindhoven, the Netherlands, precision component manufacturer KMWE, together with its subsidiary DutchAero, has received a 10-year procurement agreement for machined engine components.
This agreement signals a strengthened relationship between Pratt & Whitney and KMWE / DutchAero and positions KMWE / DutchAero well for follow-on F135 opportunities.

WWW.KMWE.COM WWW.PRATT-WHITNEY.COM

Simultaneous testing of optical components in silicon photonics

Although the test procedure for silicon photonics components is essentially the same as for the familiar electrical process, it is nevertheless more sophisticated as far as precision is concerned. The testing process requires an optical fiber to be adjusted with an accuracy of only a few tenths of a nanometer for each individual input and output. If the alignment process is sequential, it quickly becomes uneconomical due to the time factor. As a result, a solution is required for a simultaneous alignment process on the input and output side that shortens the test duration of the components.

In a demonstration set-up, PI (Physik Instrumente) has shown how fast and precise XYZ stages are able to achieve parallel fiber alignment on the input and output side. For demonstration purposes, a waveguide integrated in the wafer is simulated by a single-mode fiber. Fibers with lenses are coupled at the fiber ends via precision piezo-based XYZ stages, such as PI's NanoCube® XYZ system. The positioning systems have a high scanning velocity and are able to perform alignment in several degrees of freedom – simultaneously at the input and output.
The travel ranges along the X, Y and Z axis are 25 mm for initial alignment of the fibers and 100 µm for the position-controlled scan.
PI's modular E-712 motion controller platform with integrated alignment routines serves as controller, which was specially adapted for this task and can control six motorised and six piezo actuator axes.

WWW.PHYSIKINSTRUMENTE.COM

■ *Demonstration set-up for component testing with two multi-axis position systems for simultaneous fiber alignment.*

Affordable micromotor

Faulhaber has expanded its range of drives in the medium power range with the new 1727…CXR DC-micromotor, and had added an extremely compact drive to the CXR series. A powerful neodymium magnet gives the graphite-commutated motor a high power density with a continuous torque of 4.9 mNm. It generates this power in a housing that is just 17 mm in diameter and 27 mm in length. The temperature range in which it can be used is from –30 to +100 °C.

WWW.FAULHABER.COM

New foundry for nanophotonics fabrication

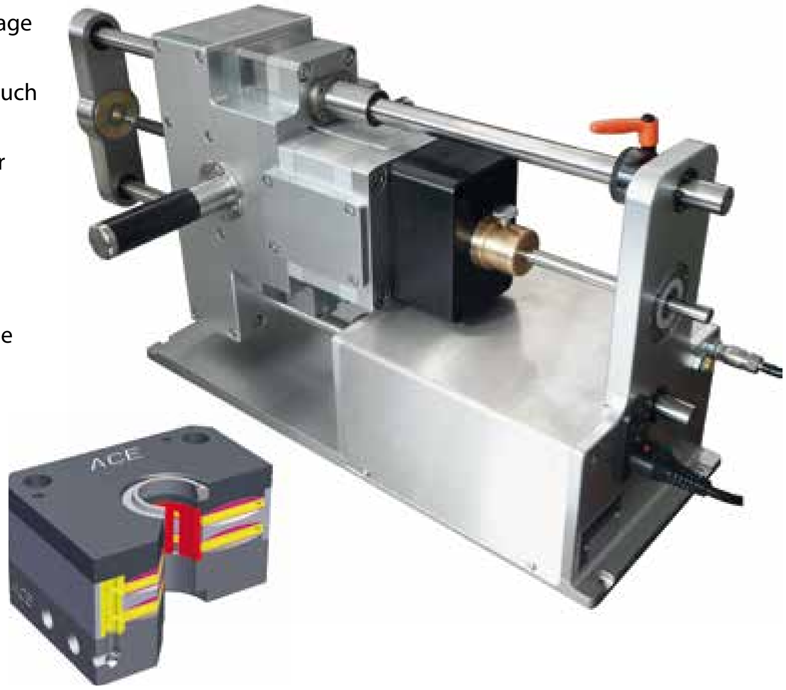
In Eindhoven, the Netherlands, the new company nanoPHAB officially started last December. It offers researchers and companies without appropriate production facilities the opportunity to access R&D and fabrication of photonic devices. NanoPHAB is an Eindhoven University of Technology (TU/e) spin-off and is using the extensive university cleanroom facilities and services for the first phase of its development. NanoPHAB is one of world's first foundries specifically suited for a broad range of photonics products, produced on light-emitting materials with unparalleled properties (III-V semiconductor materials, like GaAs, AlGaAs, InP and InGaAs) and nanoscale feature sizes.

The new foundry will provide fabrication services for the realisation of nanodevices based on customers' ideas. TU/e has an 800 m^2 fully-equipped cleanroom with state-of-the-art equipment for III-V semiconductor materials. The staff has extensive expertise and experience in micro- and nanofabrication of III-V photonic devices. This will be the springboard for nanoPHAB, whose aim is to establish its own facilities in the long term.

WWW.NANOPHAB.COM

Clamped and dampened high-tech cable cutting machine

Modern shielding and braid cutting equipment for cutting high-voltage cables often works electro-pneumatically. Precision mechanics company Feintechnik R. Rittmeyer in Münster (Germany) has enhanced such a solution. In the third generation of its precision cutting machines, the entire head of the machine moves when cables are worked on. Rittmeyer opted for constructional elements from ACE Stoßdämpfer in Langenfeld (Germany) for the safety of machinery and operating personnel.



ACE shock absorbers are used for reliable braking in moving the head against the rear panel. After consideration of all specifications, such as the moving mass and its speed, the specialists from Langenfeld opted to fit the small-format MC75EUM-3 shock absorber. These hydraulic machine elements are maintenance-free and ready to install, and have very short overall lengths and low restoring forces. The selected self-adjusting elements are able to take up 9 Nm/stroke and 28,200 Nm/h. The permissible mass range is 2.7 to 36.2 kg, and applies for a temperature range from 0 to 66 °C.

WWW.RITTMEYER-BERI.DE WWW.ACE-ACE.DE

Large piezo push force

At the Precision Fair 2015, Newport introduced the Picolis™ Model 8525 compact linear stage that incorporates Picomotor™ actuator technology into one simple precise solution. The Picomotor is directly coupled to the moving carriage with no intermediate mechanism, to offer the ultimate in stability and rigidity of a 37.5 x 37.5 x 13 mm³ platform. The thermally matched stainless steel design and precision-manufactured bearing surfaces provide ripple-free and low-friction linear travel. A unique feature of the Picolis is the push force of over 10 N (as compared to 0.5 to 2 N by other piezo stages) that can be generated in the vertical direction using a screw-based mechanism. Minimum incremental motion is below 30 nm.

WWW.NEWPORT.COM/PICOLIS

Scanlab acquires Next Scan Technology

Scanlab, based in Puchheim near Munich (Germany), is a leading and independent OEM manufacturer of scan solutions for deflecting and positioning laser beams in three dimensions. The company has acquired Next Scan Technology to increase its stake in the polygon scanner market. In 2011, Next Scan Technology was the first to introduce a polygon-based scanner system compatible with high-power ultra-short-pulsed (USP) lasers. The Dutch/Belgian company has made a name for itself as manufacturer of the Line Scan Engine (LSE) product family. The two firms together create a team with differing, yet highly integrable polygon system approaches to USP laser processing. Next Scan Technology retains its operational site in Evergem (near Ghent, Belgium).

USP lasers are ideal for ultra-precise micromachining of diverse materials, because cold ablation allows particularly fine, targeted material removal. To achieve industrial-scale productivity, USP lasers are best combined with ultra-fast scanners, e.g. polygon scanners. In 2014, Scanlab introduced its hybrid polygon scan system. Polygon scanners are particularly advantageous for line-oriented full-surface processing of workpieces, at fine resolutions and with freely definable patterns and structures. Thanks to their high speed, these systems can considerably reduce material processing times. USP laser processing applications range from structuring touchscreen surfaces or solar cells, to micro-drilling and processing of electronic components, glass and plastics, as well as sensor manufacturing.

■ *Line Scan Engine (LSE) polygon scan system in production at Next Scan Technology.*

WWW.SCANLAB.DE

WWW.NEXTSCANTECHNOLOGY.COM

ALT becomes PI Benelux

PI (Physik Instrumente) has acquired the majority holding in the Dutch company Applied Laser Technology (ALT) with the objective of increasing the market share in the high-tech industries in the Benelux countries. Since its foundation over 30 years ago, ALT has been a retailer for precision positioning systems from PI, one of the leading players in the global market for precision positioning technology. PI develops and manufactures standard and OEM products with piezo or motor drives.

WWW.PHYSIKINSTRUMENTE.COM

Kees Kooij Award for Henny Spaan (IBS)

Henny Spaan, Managing Director of IBS Precision Engineering, based in Eindhoven, the Netherlands, has been awarded the Kees Kooij award at the Mikrocentrum end-of-year meeting that took place on December 16, 2015. Dr Spaan has been awarded because of his exceptional contributions to Mikrocentrum and the Precision Fair.

Henny Spaan has been one of the initiators of the Precision Fair, which was organised last year for the 15th time. Along with several other leading technologists he gathered a group of companies in 2000 resulting in the first edition of the fair on October 10 & 11, 2001. Meanwhile, the Precision Fair has become one of the biggest international events on precision technology. He also strengthened links between Mikrocentrum and the European Society for Precision Engineering & Nanotechnology (euspen), thanks to his euspen presidency from 2009 to 2011.

WWW.MIKROCENTRUM.NL

WWW.IBSPE.COM

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