AM UPDATE

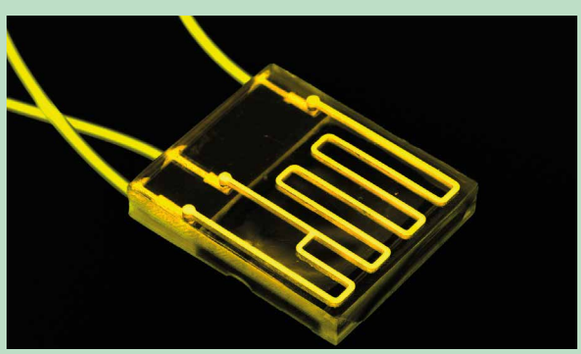
The news about additive manufacturing (AM) was buzzing in the run-up to, during and in the aftermath of the leading fair in this area, Formnext 2022, which attracted nearly 30,000 visitors in Frankfurt (Germany) last November. Numerous AM technology suppliers presented their latest developments for the technology that is becoming increasingly relevant in the high-tech precision community. Mikroniek presents a few Formnext highlights and other developments in the AM arena.

Template-based 3D microfabrication

Horizon Microtechnologies, located in Karlsruhe (Germany), launched its ground-breaking template-based 3D-microfabrication technology, which produces conductive micro-AM-derived parts with micrometer-scale precision. At Formnext 2022, it showed the company's post-build processes, which introduce the versatility of micro-AM to such applications as electrodes and electrical contact pins, ESD-safe parts, 3D microfluidics, and MEMS and optics packaging for the very first time.

Template-based 3D microfabrication is effectively a mechanism to exploit the usefulness of polymer micro-AM-produced 3D microstructures (the template) for hitherto unserved areas of industry, by adding material and functionality to the microstructure, typically with a coating process. This is a real game changer for industry. Today, a number of commercially viable polymer-based micro-AM platforms exist that can achieve exacting tolerances, quickly, cost-effectively, and above all repeatably. However, these platforms are almost exclusively restricted to the production of parts in resin or plastics.

Horizon Microtechnologies now bridges the gap between micro-AM and parts with enhanced functionality through the use of proprietary post-build processes. This provides a solution to companies that require the flexibility, innovation and agility that is driven by AM for parts with conductive, ceramic, heat-resistant, or other polymer-incompatible functionalities.



A microfluidic device chip, for use in lab-on-a-chip applications, as an example of what could be produced with Horizon's template-based 3D-microfabrication technology. (Image: Adobe stock)

Horizon specialises in the production of micro-scale conductive parts and environmentally resistant parts. To introduce conductivity, once the part is produced on a polymer-AM platform, it is either wholly or selectively coated with a conductive layer. Even difficult areas can be coated homogeneously, such as long narrow channels and undercuts. Obvious application areas include electrodes, electrical sensor heads, and ESD-safe components. Microfabricated 3D templates can also be coated with metal-oxides to make parts compatible with aggressive chemical environments and in some cases can notably increase the resistance to high temperatures and mechanical stresses. This allows, for example, the fabrication of nozzles and 3D microfluidics for aggressive solvents and certain acids with the full AM design freedom. In some cases, it is also possible to make bulk ceramic or glass objects.

Hence, for electrodes almost arbitrary geometries can be realised and their stiffness and electrical properties can be tuned. In addition, electrodes can be made with different conductive materials to cater for biocompatibility or bio-inertness. Similar benefits apply to the design and fabrication of electrical contact pins. In the area of microfluidics, the AM approach lends itself very well to prototyping and small-batch production of complex, multi-level microfluidic chips, including chips with integrated filters and interfaces to external components. Using Horizon's post-print processes, the surfaces in contact with the liquid can be coated to improve wetting behaviour, control surface energy, or even introduce electrically conductive areas.

EDITORIAL NOTE

This article is based on press releases and Formnext fair reports.

Finally, while AM is not typically considered a mass-production technology, the reduction in the size of electronics and optics — and the accompanying shrinkage of packaging — has made it a viable production alternative for MEMS and optics housings for small to medium batch sizes. In addition to the precision offered by micro-AM, Horizon's post-processes can increase the functionality of the packaging, for example by reducing stray light in the infrared, or by having integrated electrical conductors.

WWW.3DMICROFABRICATION.COM

Automation of post-processing

At Formnext 2022, Rivelin Robotics, located in Sheffield (UK), launched their NetShape Robot. The robot was developed to solve one of the most difficult challenges of producing metal parts using AM – specifically the bottleneck in the workflow that happens once the parts come off the machine and the labour-intensive process of removing supports and finishing starts.
For OEMs and their supply chain, Rivelin NetShape is an automation solution for support removal and targeted finishing that supplements high-mix production lines. Unlike automation found in casting, NetShape does not need pre-defined toolpaths or specialist robot programmers.

Rivelin's system scans and creates a 3D model of each part. Proprietary AI snaps the scanned 3D model to the net-shape CAD model. Rivelin NetShape software recognises variability and generates intelligent finishing paths to compensate, adapting to imprecise parts, fixturing variation and slipping in the chuck. The Rivelin system continuously builds a map of surface topologies, high/low spots and tool wear. It uses standard finishing tools like belt sanders, micro grinders, ultrasonic polishers, nippers and pneumatic hammers – only manipulated by a robot.

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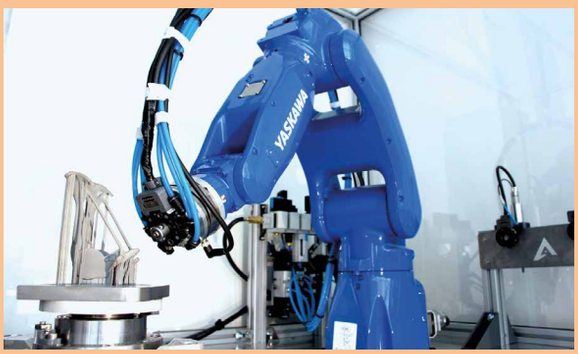

Rivelin's NetShape Robot and a close-up of a finishing operation.

Anvil Industries incorporates AM

Machinefabriek De Valk from Valkenswaard (NL) has been taken over by Anvil Industries, a Dutch group of high-tech companies that bundle their competences in the field of mechanical processing. De Valk is specialised in producing mechanical components flexibly and quickly. Think of prototypes and rush orders (Quick Response Manufacturing, QRM). In addition, De Valk has developed into a specialist that can print and finish complex products in stainless steel, aluminium or titanium.

With the acquisition of De Valk, Anvil Industries adds the specialism of 3D metal printing to its technological competences. De Valk will continue to operate as an independent company under the current management. It realises complete projects and produces components for the optical and semiconductor industry. In addition to these activities, De Valk also realises advanced 3D-printing projects; it is one of the partners in the K3D-AddFab consortium, the printing and expertise centre located at the Brainport Industries Campus in Eindhoven (NL).

WWW.ANVIL-INDUSTRIES.NL
WWW.MACHINEFABRIEKDEVALK.NL

Complementing micro-moulding with micro-AM

Leading micro-moulding specialist Accumold has announced a further investment in its micro-AM capability having just finalised the purchase of a second Fabrica 2.0 machine from Nano Dimension. It will make the prototype stage of the product development process more flexible and quicker, as micron-level detail in intricate and geometrically complex prototypes can be achieved without the need to fabricate tools. In time, Accumold will move towards small- to medium-sized production runs and also promote mass customisation as well as creative geometric complexity by exploiting AM design freedom, in "the quest for the smallest features on the most innovative products possible." Nano Dimension's technology is based on using an ultrahigh-resolution digital light processor (DLP) engine, achieving repeatable micron-levels of resolution by combining the DLP engine with adaptive optics that electronically controls various critical optical working point parameters such as focus, tilt and astigmatism. The Fabrica 2.0 (50 mm x 50 mm x 100 mm build envelope) delivers 1-5 micron additive layers for the highest-precision 3D parts, so Nano Dimension claims. While the Fabrica 2.0 can cater for volume applications, the introduction of an AM solution for micro manufacturers also means that OEMs are able to reduce their reliance on economies of scale.

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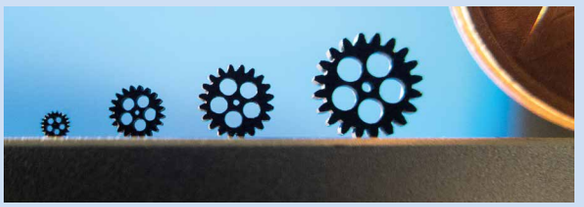


The Nano Dimension Fabrica 2.0 and some typical printed products; on the right, a 2 eurocent coin for comparison.

eBeam PBF technology comes with post-processing

One of the rising stars at Formnext 2022 was Wayland Additive, located in Huddersfield (UK), showcasing its Calibur3 metal AM machine. The Calibur3 features the NeuBeam® process, which – so Wayland Additive claims – delivers on all of the advantages of metal electron beam (eBeam) powder bed fusion (PBF) technology, while overcoming the troublesome issues that have traditionally limited wider adoption. NeuBeam technology was developed at Wayland Additive from the ground up by a team of physicists who have worked for many decades with electron beam technology and industrial systems in the semiconductor industry.

A complete Wayland Additive set-up, with the Calibur3 eBeam PBF system on the right. The inset shows the machine in action.

The Calibur3 produces fully dense parts in refractory metals such as tungsten and also highly reflective alloys. Being a hot-part rather than a hot-bed process, NeuBeam creates parts that are free from residual stresses because the high processing temperatures required are applied to the part, not the bed, ensuring free-flowing powder post-build (no sinter cake) and stress-free parts with reduced energy consumption. This opens up the ability to process a range of metals that are difficult or impossible to process on traditional metal AM machines, such as titanium alloys (including titanium aluminide), copper alloys, nickel-based alloys, nickel-based super alloys, high-carbon steels, stainless and duplex stainless steel, tungsten alloys, and cobalt-based alloys.

The nature of the NeuBeam process results in easier powder removal, no requirement for post-build heat treatment to remove residual stress, and no requirement to wire erode the part off the start plate. Subtractive

post-processing of the part is also simplified. Despite the fact that the Calibur3 system therefore radically reduces traditional metal AM post-processing issues, the nature of the eBeam PBF process still requires further steps once the build is complete, specifically around powder removal and management.

To ensure that an investment in Calibur3 is an investment in an AM process that facilitates the production of end-use parts quickly and cost-effectively, supplied along with Calibur3 is the CaliburDPR (Depowdering & Recycling) system and/or a mobile vacuum cleaner and cyclone. When using the Calibur3 metal AM system, a small amount of local powder sintering occurs near the part due to the nature of the hot-part process. This sintered powder breaks down easily and can be fully recovered and re-used in the next build.

CaliburDPR provides an enclosed environment that accommodates the whole Calibur3 Build tank on a moving table within the enclosure. The moving table displaces the loose powder, which flows through the CaliburDPR system to be used as blast media to blast the locally sintered material free from the part's surface. CaliburDPR also features an integrated sieving system, to remove large particles that cannot be re-used. The refined metal powder flows directly into the Calibur3 powder hopper, ready for reloading onto the Calibur3 system.

WWW.WAYLANDADDITIVE.COM

3D laser manufacturing in the sub-micrometer range

Founded in 2013 as a spin-off company of the Laser Research Centre of Vilnius University (Lithuania), Femtika specialises in hybrid micromachining technologies. For example, Femtika produces universal tools with femtosecond lasers suitable for multiphoton polymerisation, laser ablation and selective laser etching technologies. The heart of a Femtika Laser Nanofactory workstation always consists of a femtosecond laser in combination with a nanopositioning system from Aerotech. Overall, this enables fast and highly precise 3D manufacturing across the entire workspace.

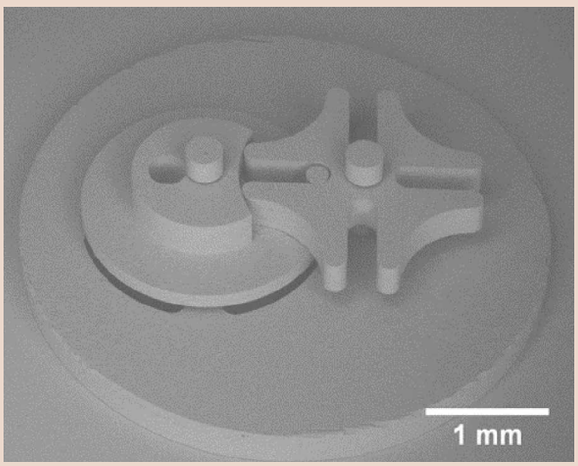
Femtika's Laser Nanofactory workstation for multiphoton polymerisation, laser ablation and selective laser etching technologies.

Initially, Femtika used piezo stages mounted on a larger, less precise mechanical stage. This approach was sufficient for small structures, but for larger structures there was a problem with stitching and extremely long manufacturing times. A solution was provided by Aerotech's high-precision linear stages, which immediately improved the quality for larger microstructures and increased production speed, by at least a factor of 10. The speed could be increased by a further factor of 10 by incorporating Aerotech's AGV galvo scanner.

Multiphoton polymerisation is among the 3D printing technologies with the highest resolution. This process is based on photopolymerisation reactions that are triggered only in a focal volume of the sharply focused femtosecond laser focal point. Microstructures are printed by scanning the laser beam over the volume of the photopolymer. A key advantage of this process is the ability to print structure sizes in very high resolution, down to 150 nm, according to a Femtika spokesperson. In addition, there is an exceptionally high surface quality and the ability to create 3D micro-objects of any shape without the need for supports.

Examples of applications for multiphoton polymerisation are micro-optical and photonic elements, which are not only printed on planar surfaces but also directly on fibre tips, photodiodes, semiconductor ICs, etc. The process is also frequently used for biomedical applications such as the production of 3D scaffolds, which are support structures for cell growth that can be used for drug testing.

Femtika's Laser Nanofactory machines are not just very-high-resolution 3D printers. They also offer many other microfabrication techniques made possible by femtosecond lasers. This means that the same machine can perform a variety of processes that would not be possible in the traditional 3D printing world, such as the subtractive processes of selective laser etching (SLE) of glass or micro-ablation for modifying surfaces. Each laser process places its own unique demands on the positioning system. Some processes require precision and resolution, others speed, still others a working range, and all this together results in quite a demanding list of requirements.



The Geneva gear is one of the most commonly used devices for generating intermittent rotary motion; its mechanism contains two interlocking elements. With SLE technology, such mechanisms can be made from a single piece of glass without the need for an assembly step.

Stitching together small areas to create a larger part is one of the most essential aspects in the world of submicrometer printing. This is not only caused by inaccuracies of the positioning system, but also by the material's behaviour in reaction to the laser pulses. To minimise the number of stitching errors, infinite-field-of-view technology is used, where the movement is automatically divided into a fast and a slow movement and executed simultaneously with Aerotech's galvo scanners and linear tables, respectively. In this way, the stitching is eliminated and the structures produced become more uniform.

With direct laser writing techniques, the structures are written while the table/galvo scanner is moving. When the positioning system is accelerating or decelerating, the distance between consecutive laser pulses hitting the material changes. This can lead to various errors or even material damage in these areas. To counteract these effects, position control of the galvo scanners and mechanical tables has to make sure that the laser pulses are fired 'at a constant distance' from each other.

WWW.FEMTIKA.COM
UK.AEROTECH.COM

New event: AM for Production

The Dutch independent high-tech knowledge institute Mikrocentrum has launched a new event: AM for Production. AM is ready for the factory of the future, according to Mikrocentrum. "AM is in grande finale to break through in the high-tech and manufacturing industry. (...) Not only have great strides been made in terms of material use, accuracy, quality and standards, but the areas of application and possibilities for system integration have also grown enormously. Moreover, mass customisation is becoming a reality thanks to AM, offering new opportunities to stay ahead in a highly competitive (world) market."

The AM knowledge and networking event for high-tech and manufacturing companies will premiere on 29-30 March 2023 in the Brabanthallen in Den Bosch (NL). The event is targeted at specialised companies and organisations in the field of AM machines, peripherals, support services, software for AM implementation, and the delivery of high-quality end products, as well as standardisation, qualification, quality assurance and approvals for AM technology.

WWW.AMFORPRODUCTION.NL

AM for Production