

» INNO «

Innovative Technologies / New Applications

NEXT- GENERATION MATERIALS

SOLUTIONS FOR ADVANCED
TECHNOLOGY CHALLENGES



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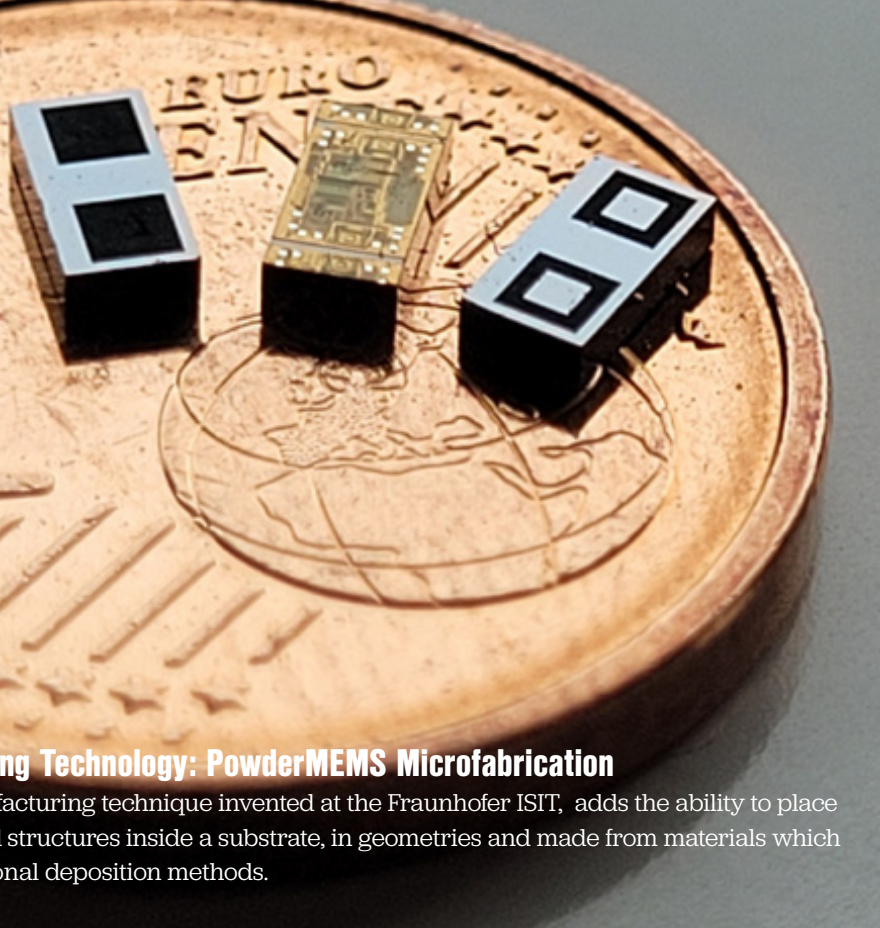
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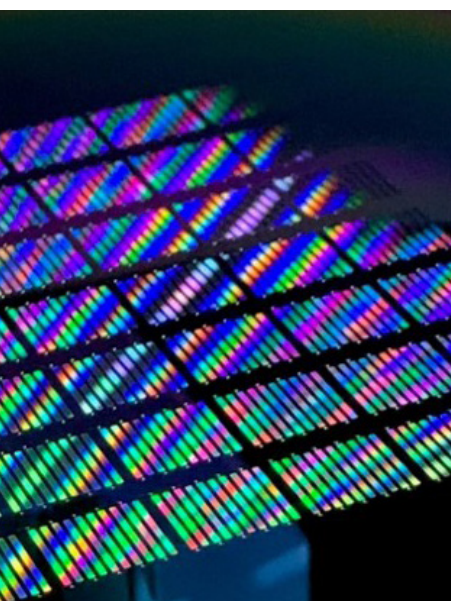
**Materials Technologies
Cluster - Connected
Expertise
for Innovative
Manufacturing, Value
Creation & Industrial
Resilience**

Materials technologies are
a key driver of industrial
transformation.



ing Technology: PowderMEMS Microfabrication

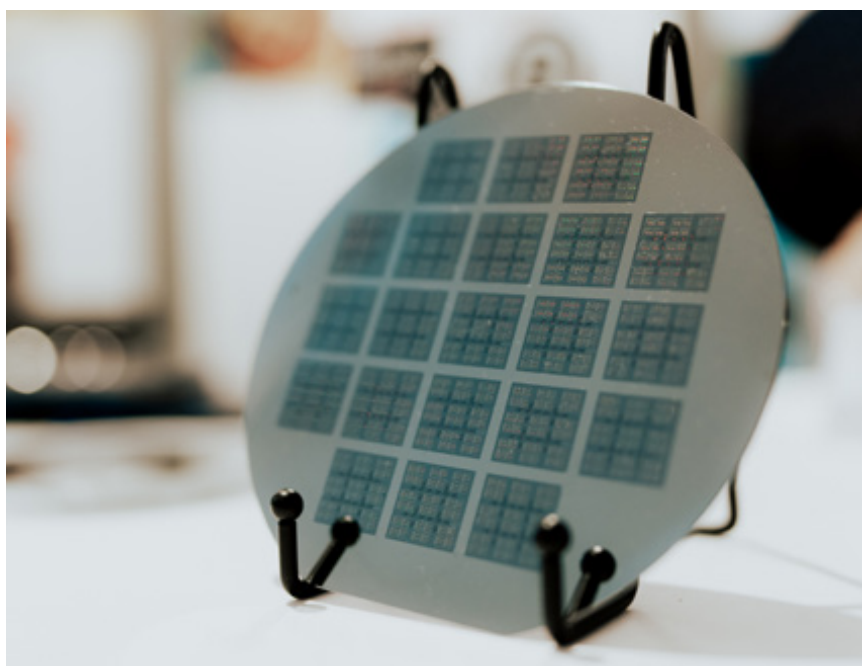
Manufacturing technique invented at the Fraunhofer ISIT, adds the ability to place microstructures inside a substrate, in geometries and made from materials which are not possible with conventional deposition methods.



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Microstructures for liquid phase chromatography

From biological samples to pharmaceutical mixtures, analytical laboratories routinely deal with complex substances that must be separated before their individual components can be reliably identified.



»INNO 94«

Next Generation Materials: Solutions for Advanced Technology Challenges,

Every technological breakthrough depends on materials that make new ideas possible. Their properties shape what we can sense, manufacture and integrate, and how we meet the demands of tomorrow's applications.

In this issue of INNO we explore this enabling role across a wide range of technologies. From functional yarns for sensing and resorbable materials for medical implants to glass platforms for advanced packaging, semiconductor integration and precision microstructures, our contributors show how material innovation opens new possibilities. Advances in microfabrication and conductive plastics further demonstrate how materials and processing expertise work together to turn ambitious concepts into practical solutions.

These contributions reflect the creativity and specialist knowledge within the IVAM network. They also highlight the value of bringing expertise together: through a new Materials Technologies Cluster in Dortmund and opportunities for international exchange, including the IVAM joint pavilion at NANO KOREA next year. We invite you to discover fresh perspectives, explore unfamiliar applications and find inspiration for your own technological challenges. Perhaps the material enabling your next innovation is waiting in these pages.

Enjoy reading.
Mona Okroy-Hellweg

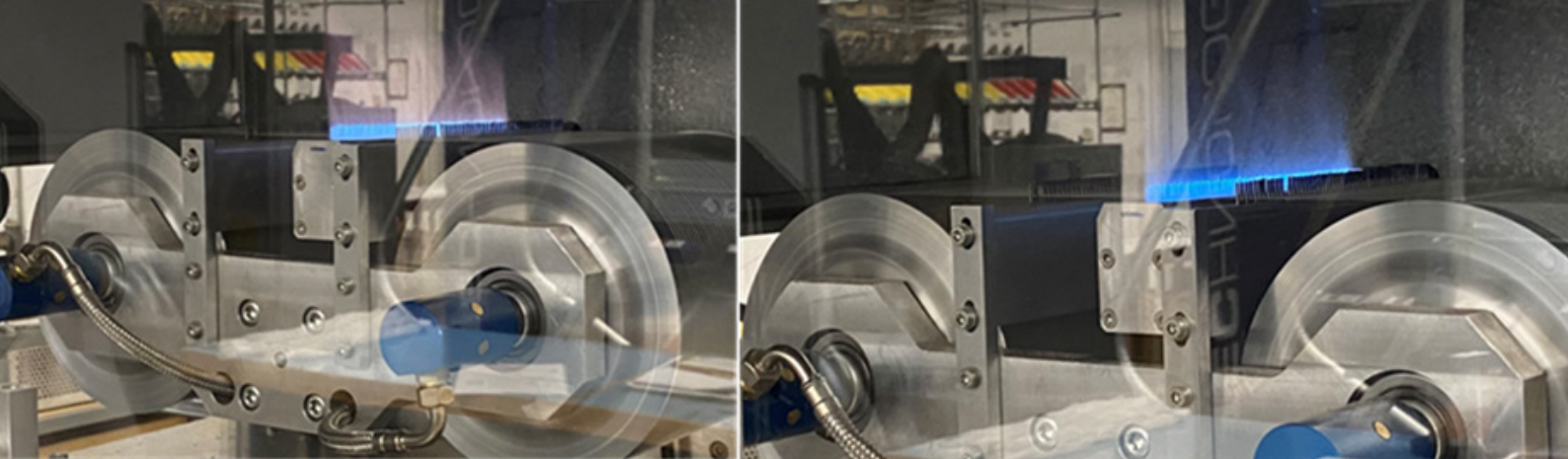


Fig.1: Different flame colors in the CCVD coating system. Left: orange flame, precursor present; right: blue flame, only an air-gas mixture is being burned, no precursor present.

**Joy Weinberger | Dr. Martina Schweder |
Carmen Marschner | Dr. Fabian Schreiber**

CHEMICALLY MODIFIED YARNS FOR SENSOR APPLICATIONS

The integration of chemical sensing functionalities into textile structures offers new opportunities for the continuous and spatially resolved analysis of liquids. In particular, textile-based multipotential sensors could enable applications ranging from water-quality monitoring and contamination detection to medical diagnostics. However, transferring laboratory-scale sensor concepts into reproducible and economically viable manufacturing processes remains a major challenge. Within the MoGaSens project, the focus was therefore placed on developing a

scalable manufacturing technology for chemically functionalized conductive yarns and their subsequent integration into textile multipotential sensors.

The foundations for the sensor yarns developed within the MoGaSens project were laid several years ago. Initial experiments began with just a few meters of conductive yarn, coated using SiOx adhesion promoter layers, provided by Combustion Chemical Vapor Deposition (CCVD) and chemical functionalization in beakers. Based on these initial samples, a small

number of manually produced functional multipotential sensors were produced. It quickly became apparent that the sensor was capable of reliably distinguishing between different liquids. This finding raised the subsequent question of whether the sensor concept could be transferred to a reproducible and cost-effective manufacturing process.

The objective of the research project was therefore to develop a manufacturing technology suitable for establishing a cost-effective production line for textile

multipotential sensors. Potential applications include water-quality analysis, detection of water contamination caused by detergents, urea, and high concentrations of sodium chloride, as well as applications in medicine.

What Application of SiO_x Adhesion-Promoter Layers

As first process step, conductive silver-coated polyamide yarns (ELITEX 117 dtex f17 x2) were equipped with nanoscale adhesion promoters using flame pyrolysis deposition (Fig. 1). Comparable planar electrodes were produced on planar polyamide films and silver-coated polyamide films. Different deposition parameters were investigated to determine the best SiO_x adhesion promoter layers in reproducible manner. Due to the high coating speeds, the coated yarns can only be wound onto disc spools. However, these spool formats were unsuitable for the subsequent process steps. Several rewinding operations were therefore required to transfer the yarns onto formats suitable for small-batch industrial production of the multipotential sensors.

The rewinding processes subject the conductive-coated yarns to considerable mechanical forces. In

addition, the deposited SiO_x adhesion promoter layer is highly reactive. Its reactivity decreases with increasing exposure to ambient air. The chemical functionalization must therefore be initiated within a maximum of 48 hours after CCVD coating; otherwise, successful chemical reaction can no longer be guaranteed. Consequently, all rewinding processes must be completed within a correspondingly narrow time window. To determine whether the mechanical stresses during

rewinding resulted in degradation of the coated surface, the electrical resistance of the yarns was measured after each process step. The results showed that the electrical resistance changed only marginally with an increasing number of process steps, indicating that the rewinding operations did not cause significant degradation of the conductive coating.

Transfer to Continuous Yarn Processing

A further objective of the project was to transfer the chemical functionalization process from laboratory-scale processing in beakers to a more industrially applicable process. For this purpose, a yarn dyeing line was employed. The coated yarns therefore had to be rewound onto suitable perforated dyeing bobbins (Fig. 2 and Fig. 3). The planar substrates provided by INNOVENT e.V. were functionalized by dip-coating using a tensile testing machine.

The functionalization process was based on diluted solutions and dispersions of the respective substances, analogous to established conventional dyeing processes. The investigated

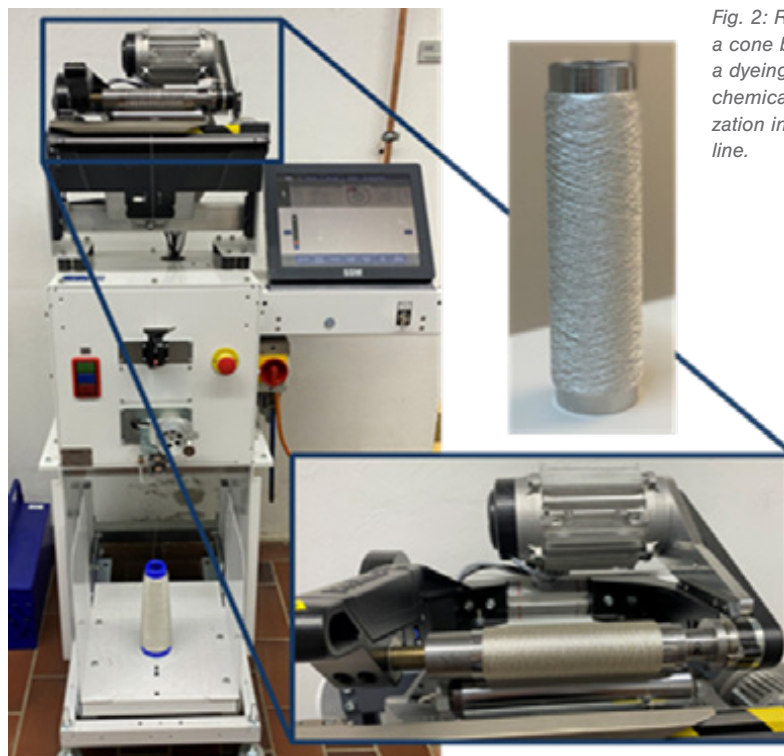


Fig. 2: Rewinding from a cone bobbin onto a dyeing bobbin for chemical functionalization in a yarn dyeing line.

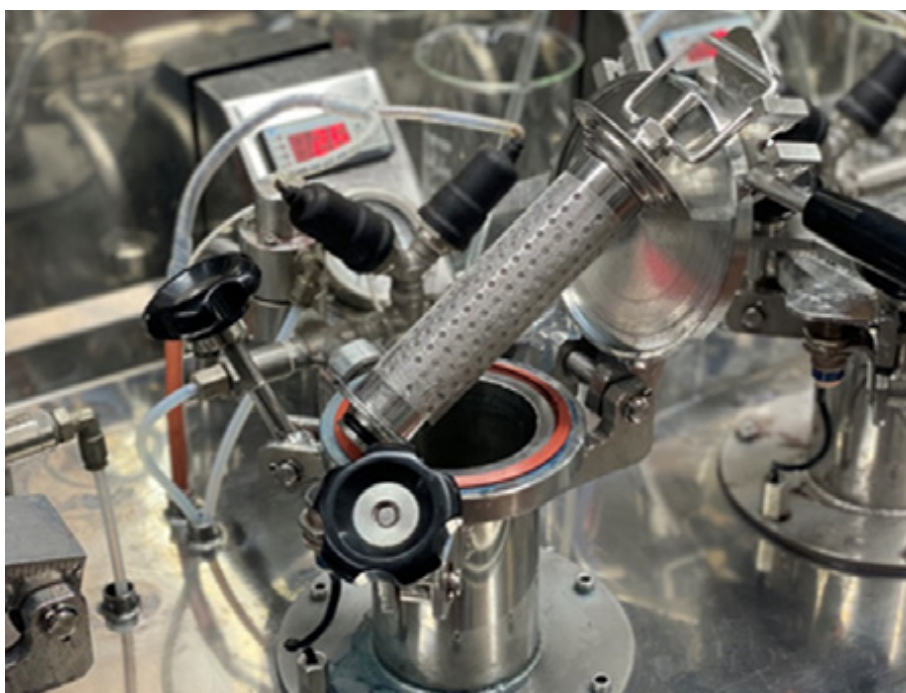


Fig. 3: Dyeing station of the yarn dyeing line with a perforated dyeing bobbin.

chemical functionalization included, among others, a sodium salt of polyacrylic acid, amino-substituted triazoles, aminoalkanes, and bifunctional compounds of the general formula $(\text{HO})_3\text{-Si-(CH}_2)_n\text{-R}$ containing silane functionalities, such as (3-glycidyloxypropyl)trimethoxysilane.

The yarns were treated with aqueous solutions of the respective chemicals for five hours at ambient temperature. They were subsequently rinsed with water and dried at ambient temperature. Electrical resistance was again measured after this process step. The measurements revealed significant changes in electrical resistance depending on the chemical functionalization applied. Together with the results obtained from scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDX), these findings provided evidence that the respective chemicals had been successfully immobilized on the fiber surface.

Electrochemical Response of the Functionalized Yarns

The chemically modified conductive yarns and planar substrates exhibited altered electrical potentials when immersed in electrolytic solutions. These potentials were measured, for example, against a reference electrode and demonstrated the electrochemical response of the functionalized substrates.

In the fundamental investigations conducted by INNOVENT e.V., the CCVD applied adhesion promoter layer was optimized to enable the subsequent deposition of the functional layer while minimizing the thermal load on the substrates. Among the investigated approaches, dip-coating from an aqueous solution proved to be the most suitable method for applying the functional layer. At the same time, the process met the requirements of imbut GmbH for a solvent-free system.

Integration into Textile Structures

The integration of the chemically functionalized conductive yarns into textile structures represented a further essential step toward an industrially applicable sensor concept. The weaving process was therefore investigated using industrial weaving machines. Initially, the functionalized electrodes were incorporated as weft threads, although this approach still required manual intervention. To enable efficient industrial implementation, the electrodes were subsequently successfully incorporated as warp threads despite the high mechanical forces acting on the yarns during weaving (Fig. 4). The resulting textile-technologically manufactured chemical multipotential sensors were produced from the developed chemically modified conductive yarns and were electrically contacted via flex buses. Their electrical potentials were measured against a fixed reference electrode. The resulting potential curves enabled the chemical analysis of electrolyte-containing liquids.

Reproducibility and Project Results

The process steps developed within the research project were repeated to assess their reproducibility. At the end of the project, more than 20 functional textile multipotential sensors had been produced and tested. The results demonstrate the feasibility of transferring the initial laboratory-scale sensor concept to a sequence of textile and chemical processing steps with potential for small-batch industrial production.

Textilforschungsinstitut Thüringen-Vogtland e.V., <https://www.titv-greiz.de/de>

imbut GmbH, <https://www.imbut.de/de>

INNOVENT e.V., <https://www.innovent-jena.de>



Fig. 4: Schematic illustration of the weaving process for textile sensors with long floating sections.

“**Textile-based multipotential sensors could enable applications ranging from water-quality monitoring and contamination detection to medical diagnostics.**”

This work received financial support from the Thüringer Aufbaubank through the research and development project “Forschungs- und Entwicklungsvorhaben Thüringen Verbund Dynamik MoGaSens” (2024 VDY 0060).

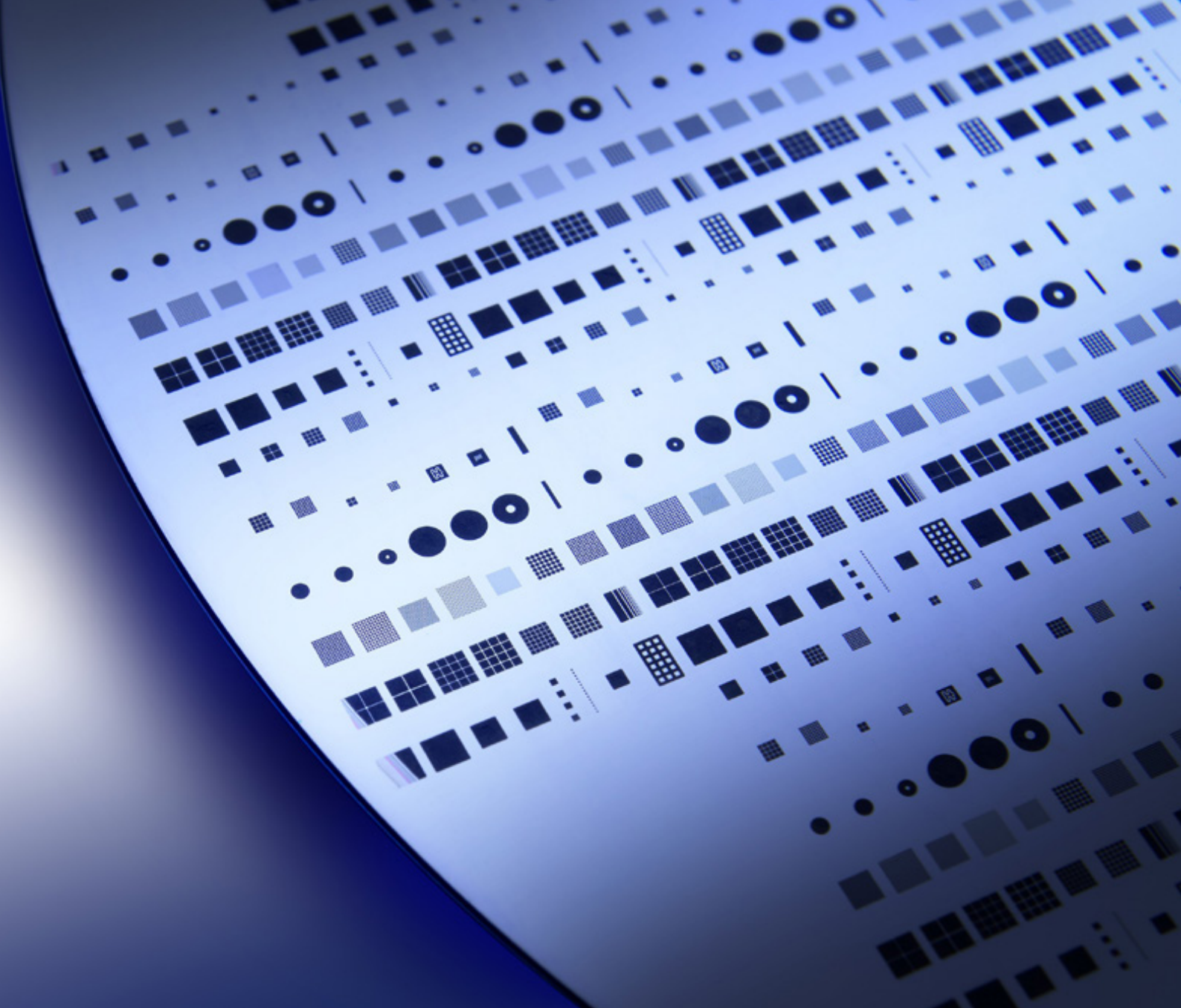
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500 μ m thick PowderMEMS NdFeB micromagnets in a 200 mm silicon wafer.

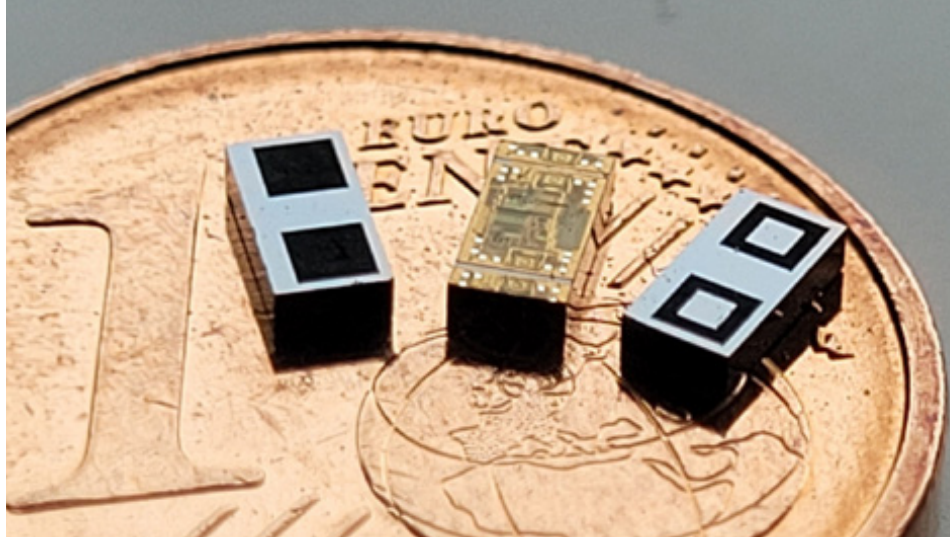
Dr. Björn Gojdka

ENABLING TECHNOLOGY: POWDERMEMS MICROFABRICATION

The history of microelectronics is largely a history of manufacturing processes. The planar process, photolithography, chemical-mechanical polishing, deep reactive ion etching, wafer bonding – each of these steps made device concepts possible that had been out of reach before. Progress in semiconductor technology has rarely come from new physics alone; it has come from new ways of building things. PowderMEMS, a micromanufacturing technique invented at the Fraunhofer Institute for Silicon Technology ISIT, follows that pattern. It adds the ability to place three-dimensional functional structures inside a substrate, in geometries and made from materials which are challenging for conventional deposition methods.

New freedom for designing micro components

The process sequence is short. Cavities are patterned into a silicon, glass or ceramic substrate with depths of up to several hundred micrometres and placement accuracy in the low micrometre range. These cavities are then filled with dry, micrometre-sized powder – no solvents and no organic binders, so neither viscosity nor trapped air constrain the geometry. Fraunhofer ISIT has integrated the technique into its 200 mm line for MEMS and microelectronic devices with Fraunhofer IFAM contributing its powder-metallurgical expertise to an automated wafer-level filling method. The loose powder bed is subsequently consolidated by atomic layer deposition: Al_2O_3 grows conformally on every individual particle until neighbouring grains connect into a mechanically stable, porous body. Unlike sintering, this happens at temperatures as low as 80 °C. Decisive for many applications, the process temperature is low enough to work on substrates that already carry finished components. PowderMEMS can therefore be inserted before, within or after a MEMS or post-CMOS process flow.



Chips with Hall sensor ICs on the front side and PowderMEMS NdFeB magnets in the backside of the silicon.

Why micromagnets are the difficult case

Permanent micromagnets are currently the main focus of development, for a simple reason: they are hard to integrate. Sputtered hard-magnetic films are thin and consequently provide only a small magnetic moment; electroplating is limited in thickness and material choice; sintering would destroy any device already present on the wafer. As a result, permanent magnets in sensor modules are still assembled discretely, adding process steps and package volume.

NdFeB micromagnets made by PowderMEMS reach a remanence of about 0.55 T, with an intrinsic coercivity corresponding to the bulk value of the powder. The magnets can be operated between 150 °C and 4.3 K, making them applicable in automotive and cryogenic applications.

Applications from established sensors to quantum hardware

PowderMEMS NdFeB micromagnets were demonstrated to replace the discrete bias magnets of a commercial AMR current sensor. Integrated directly into the sensor chip, the modified devices met the specifications of the discretely biased version, including step response time and offset after overcurrent pulses. Also, back-biased 3D Hall sensors with a total height below 1 mm were demonstrated on contactless gear-wheel speed measurement together with Fraunhofer IIS. Compared to

discrete assembly, the integrated approach replaces pick-and-place by lithographic alignment, removes the need for magnet assembly and allows smaller packages.

Quantum hardware poses a related problem. Nitrogen-vacancy (NV) centres in diamond require a defined static bias field or field gradient, both for magnetometry and for spin-based quantum processors. Because the magnets work at cryogenic temperatures without dissipating power, they are also relevant for cooled architectures. In trapped-ion computing, where qubits can be addressed by magnetic gradients, ion traps on structured glass wafers with integrated micromagnets have been fabricated and handed over to an industrial partner for evaluation

From idea to pilot series

Fraunhofer ISIT continuously advances the PowderMEMS process together with IFAM. Novel micro components are realized with other research organizations and companies, covering simulation and design, prototypes and pilot series on ISIT's 200 mm line. For higher volumes, the technology can be transferred to the partner's own fabrication environment under license. Not every technological step forward needs a new material or a new physical effect - sometimes all it takes is finding a better way to manufacture.

Fraunhofer Institute for Silicon Technology ISIT

<http://www.isit.fraunhofer.de>

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Dr. Georg Pöhle | Dr. Christian Redlich

MOLYBDENUM – THE KEY TO THE NEXT GENERATION OF RESORBABLE IMPLANTS?

Temporary Functions, Permanent Problems?

The Implants such as bone fixation screws, cardiovascular stents, and artificial joints restore essential functions after injury, disease, or wear. Metallic materials remain indispensable because they combine high strength and ductility with reliable processing and reproducible properties. However, many implants are needed only temporarily, for example to support bone healing or stabilize a vessel until the tissue has recovered (Fig. 1). Once their function is fulfilled, permanent implants may offer no further benefit and can even increase the risk of complications. Clinicians then face a dilemma: leave the implant in the body or remove it in a second procedure, exposing patients to additional surgical risks and increasing healthcare costs. In some cases, removal

is not possible at all. Cardiovascular stents, for example, integrate into the vessel wall and cannot be explanted without causing damage.

Heal and disappear

Resorbable implant materials offer an alternative: they gradually degrade under physiological conditions, while their reaction products are metabolized, excreted, or incorporated into natural stores. Ideally, degradation begins once the implant has fulfilled its function, leading to complete resorption within months or a few years. This can help avoid follow-up procedures, reduce the burden on patients and lower the costs in healthcare systems. Medical device manufacturers gain a competitive edge with a new generation of implants attuned to the needs of patients and clinical users. However, developing such materials is

challenging. Their properties continuously change during degradation and interact with the complex biological environment, requiring close collaboration between materials scientists, life scientists, clinicians, and industry. For clinical and industrial application, resorbability must not compromise established workflows, reliability, or predictability. Compatibility with established manufacturing processes is equally important for translating new implant materials into medical products. Among resorbable metallic implant materials, magnesium (Mg)-based alloys have reached the highest technological maturity. The first Mg-based implants received EU market authorization in 2013. They offer favorable properties, including bone-like stiffness that helps avoid stress shielding, excellent biocompatibility, full resorbability, and even osteogenic and angiogenic effects.

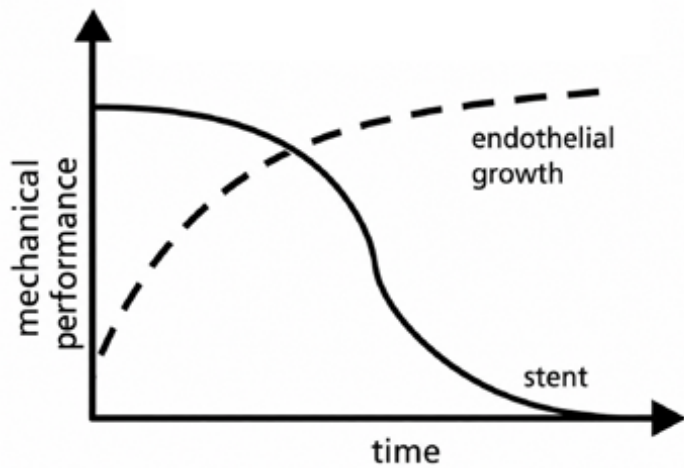


Fig1: Desired mechanical performance over time – resorbable stent and regenerating tissue in a vessel.

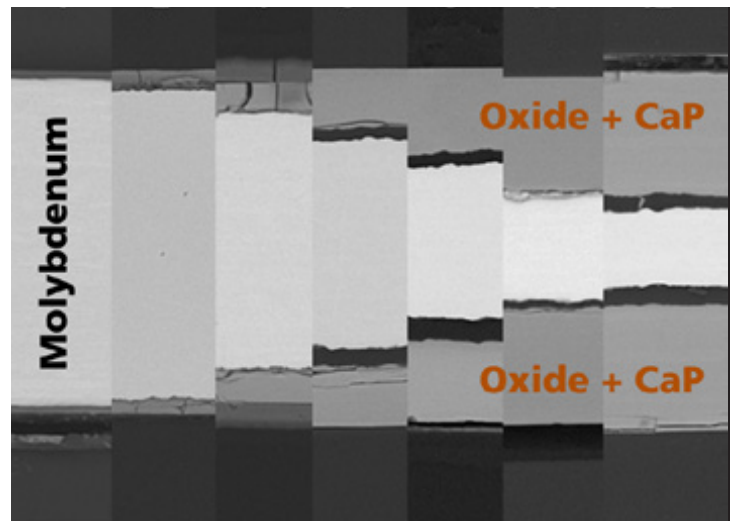


Fig. 2: Uniform degradation of molybdenum in simulated body fluid: The metallic cross-section (center) diminishes from approx. 100 μm to 20 μm within 12 months. The proportion of molybdenum oxides in the corrosion product layer steadily decreases and is replaced by calcium phosphate (CaP).

However, magnesium alloys are not the final answer. Their limited mechanical strength makes them less suitable for implants that must bear high loads or withstand many load cycles, such as cardiovascular stents or cerclage wires. In addition, controlling their characteristically rapid and localized degradation remains a constant concern. These limitations drive the search for alternatives.

Molybdenum: A new challenger

At the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM in Dresden, molybdenum has emerged as a strong candidate for a new generation of resorbable implants combining strength, reliability, and biocompatibility. It exhibits excellent mechanical properties: its strength is more than twice that of Mg-based alloys and comparable to cobalt-chromium alloys, one of the standards for high-strength permanent implants. At the same time, molybdenum is resorbed in a highly uniform and predictable manner. Its degradation rate lies in the range of several tens of micrometers per year. Given its high mechanical strength, this makes molybdenum suitable for many applications in orthopedics, trauma surgery, and cardiovascular intervention. Its high radiopacity also

“Molybdenum has emerged as a strong candidate for a new generation of resorbable implants combining strength, reliability, and biocompatibility.”

supports follow-up care by X-ray imaging.

Preclinical biocompatibility results are encouraging. Good cell compatibility has been demonstrated in a broad range of cell studies and in several in vivo animal studies. No detrimental effects on cell viability – including in muscle cells, endothelial cells, osteoblasts, and fibroblasts – were observed at molybdenum concentrations expected from release during implant resorption. In addition, no molybdenum depositions or histological alterations were found in organs such as the liver, kidneys, or spleen.

From materials research to clinical applications

Based on these findings, several R&D projects with medical research institutions and medical device manufacturers are now underway to evaluate implant designs in preclinical settings. In

these projects, Fraunhofer IFAM contributes its decade-long expertise in molybdenum and its alloys, advances manufacturing processes that meet the standards of the industry, and applies specifically developed analytical methods. The institute is also developing and testing strategies to tailor degradation behavior to the needs of patients and clinical users.

Resorbable metals are a striking example of how advanced materials open new pathways for high-tech healthcare. With its unique combination of high strength, predictable degradation, and promising biocompatibility, molybdenum could become the key material for the next generation of temporary implants.

Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM

<https://www.ifam.fraunhofer.de/de/Ueberuns/Standorte/Dresden.html>

Tyler J. Myers | Dr. Patrick Moder

NANOLAMINATE INTEGRATION IN SEMICONDUCTOR MANUFACTURING

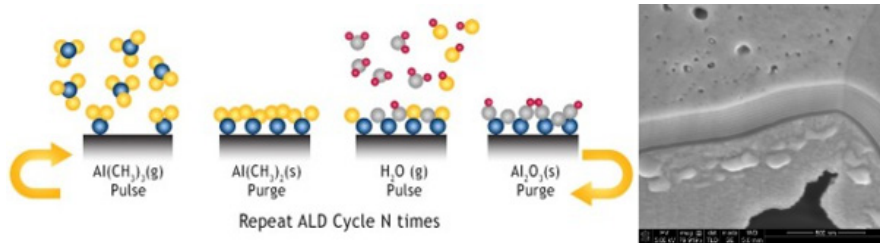
Catalysed ALD: A Practical Route to Nanolaminate Integration in Semiconductor Manufacturing

Microelectronics are fundamentally stacks of engineered material layers, each serving a specific electrical, chemical, or mechanical function. Device performance depends not only on the properties of individual layers but also on the quality of the interfaces between them. As device architectures become increasingly complex, manufacturers require deposition technologies capable of delivering atomic-scale precision, excellent conformity, and precise control of material composition.

Atomic Layer Deposition (ALD) has become a critical enabling technology in microelectronics manufacturing because it deposits films through sequential, self-limiting surface reactions. Since growth effectively occurs one atomic layer at a time, ALD provides exceptional thickness control and uniform, pinhole-free coatings, even on complex three-dimensional structures with high aspect ratios. These advantages have led to widespread adoption of ALD for applications such as gate dielectrics, spacers, and diffusion barriers. One of ALD's most powerful capabilities is the creation of nanolaminates: engineered thin films composed of alternating layers of different materials. By combining materials at the nanoscale, nanolaminates enable functionality that cannot be achieved

with a single film alone. They can reduce defect propagation, improve barrier performance, tune film stress, and precisely tailor electrical properties through controlled composition and doping.

Despite their promise, nanolaminates have historically been difficult to integrate into high-volume manufacturing. Many material combinations require different deposition conditions, particularly temperature. A common solution is to use plasma-enhanced ALD (PE-ALD) for one material and thermal ALD for another. While effective in the laboratory, moving wafers between plasma and thermal chambers introduces complexity and significantly reduces throughput, creating a barrier to large-scale adoption.



(Left) Illustration depicting a typical ALD cycle. (Right). Nanolaminate moisture barrier deposited on the cavity of an MMIC.

Coating	Thickness (nm)	96 hours	384 hours
PECVD	>800	Fail	Fail
ALD	10	Pass	Fail
ALD	20	Pass	Pass

Performance of moisture barriers during reliability testing of optical field effect transistors (FETs) using Highly Accelerated Stress Test of 125°C/85% relative humidity.

Case Study 1: Ultrathin Moisture Barriers

Moisture ingress remains one of the primary reliability concerns for many electronic devices. Water vapour typically diffuses through defects within a film, eventually reaching sensitive device structures. While conventional deposition methods such as CVD can provide moisture protection, they often require thick (500nm to >1µm) films to compensate for higher defect densities.

Nanolaminates improve barrier performance by creating a more tortuous diffusion path through the film. Alternating material layers disrupt defect continuity and prevent diffusion pathways from aligning throughout the film stack. Forge Nano's ALD-Cap technology leverages an $\text{Al}_2\text{O}_3/\text{SiO}_2$ nanolaminate deposited in a single chamber using catalysed ALD. These barriers are typically less than 100 nm thick while delivering reliability and moisture

To address this challenge, Forge Nano developed a suite of catalysed ALD processes that enable low-temperature film growth without plasma. During deposition, a small amount of catalyst promotes surface reactions, allowing materials that traditionally required plasma activation to be deposited thermally. This capability reduces process complexity, eliminates chamber-to-chamber transfers, and enables multi-material nanolaminates to be deposited under a common process window.

The result is a practical route to integrating advanced thin-film architectures into high-volume manufacturing environments. Forge Nano has successfully applied catalysed ALD to several nanolaminate solutions for compound semiconductor manufacturing. Below are two examples that illustrate the impact of this approach.

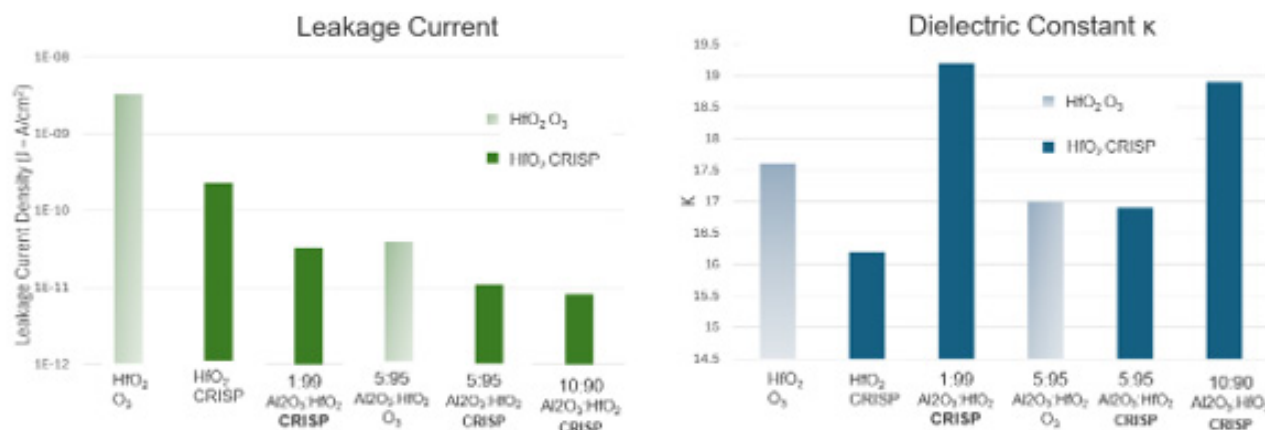
protection that outperform significantly thicker conventional solutions. The ability to deposit both materials under a common process window enables a practical manufacturing route for high-performance barrier films.

Case Study 2: Tuneable Dielectrics

Dielectrics used for passivation, gate insulation, and capacitor structures often require optimisation across multiple parameters, including leakage current, dielectric constant, and breakdown. By engineering $\text{HfO}_2/\text{Al}_2\text{O}_3$ nanolaminates with different compositions using standard thermal and catalysed deposition methods, Forge Nano demonstrated that catalysed ALD can reduce contamination levels and promote crystallisation at lower temperatures. By carefully controlling composition and layer structure, dielectric properties can be engineered to meet the needs of specific applications, creating bespoke insulating films with enhanced performance.

These case studies demonstrate how nanolaminates can unlock new material functionality while catalysed ALD removes many of the manufacturing challenges traditionally associated with their implementation. By combining advanced chemistry with its high-throughput ALDx platform, Forge Nano provides a practical pathway for integrating nanolaminates into volume semiconductor production, enabling thinner, higher-performance materials without sacrificing manufacturability.

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Leakage current and dielectric measurements for various single film and nanolaminate compositions of $\text{HfO}_2/\text{Al}_2\text{O}_3$ dielectrics, deposited with either standard thermal or catalysed (CRISP = catalysed) ALD.



Jonathan Nagusch

MATERIALS TECHNOLOGIES CLUSTER

**Connected Expertise for Innovative Manufacturing, Value
Creation, and Industrial Resilience**

Materials technologies are a key driver of industrial transformation. From the energy transition and sustainable mobility to microelectronics and the circular economy, future industries depend on innovative materials, advanced manufacturing technologies, and the rapid transfer of research into practical applications. The Dortmund region already boasts a strong, highly diverse research and industrial landscape. However, many of these capabilities are not yet sufficiently visible or connected. The Materials Technologies Cluster aims to change this by creating an active platform that brings together companies, research institutions, start-ups, professional associations, and public-sector stakeholders. For the Cluster, resilience means more than simply being prepared for crises. It means creating a regional innovation ecosystem that can identify change early, seize new opportunities, and develop solutions collaboratively. By connecting expertise from business, science, and the public sector, the Cluster will strengthen technological sovereignty, reduce dependencies, and improve the region's overall ability to respond to global developments. By bringing individual strengths together, the Cluster will also increase the region's international visibility as a hub for advanced manufacturing and materials technologies. This opens the door to new international partnerships and helps compensate for declining or changing markets.

Starting Point and Motivation

The region has a long-standing track record in manufacturing, mechanical and plant engineering, materials development, and industrial production. It is home to top-tier universities, research institutions, technology centers, professional associations, and technology-driven companies with deep expertise in materials science, manufacturing technologies, digitalization, and applied research. Yet, considerable potential remains untapped. Regional expertise is not always sufficiently connected, available infrastructure



and know-how are difficult to identify, and the region's capabilities are rarely promoted collectively. This is particularly relevant for small and medium-sized enterprises (SMEs), which often lack the resources to identify emerging technologies early or to pursue extensive in-house research. At the same time, businesses face growing challenges from skilled-worker shortages, rapidly accelerating innovation cycles, sustainability requirements, and decarbonization. The Cluster acts as a connecting force, systematically bridging companies, research institutions, and public-sector stakeholders. Key challenges targeted include:

Visibility & Transparency:

Making regional expertise, infrastructure, and know-how easy to locate and leverage.

Value Chains & Talent:

Closing gaps in regional value chains while addressing skilled-worker and qualification needs.

Innovation Speed:

Harnessing digitalisation, artificial intelligence, and faster transition cycles.

Strategic Objectives

The Cluster aims to establish the Dortmund region as a leading innovation hub for materials technologies and intelligent manufacturing systems. Its main priorities center on strengthening regional value creation, building resilient supply and production

chains, and accelerating innovation. Closer cooperation between research institutions and companies makes it easier to jointly develop new technologies and bring them to market faster. The Cluster acts as an active engine for implementation: initiating projects, bringing the right partners together, and supporting innovation along the entire value chain. Its work is guided by four principles: pragmatic, entrepreneurial, technology-open, and partnership-based. Another key objective is to strengthen the region's profile as a high-tech location. By increasing visibility, the Cluster attracts national and international partners while making the region far more attractive to skilled workers, investors, and relocating businesses.

Technological Fields of Action

The Cluster deliberately follows a technology-open approach. Traditional strengths in metals and steel provide a crucial foundation, complemented by emerging material systems and cross-cutting technologies aimed at solving societal and economic challenges:

Materials & Production:

Metallic materials, high-performance steels, composites, advanced material systems, semiconductors, bio-based materials, and surface/coating technologies.

Testing & Sustainability:

Additive manufacturing, recycling, circular economy practices, materials testing, lifetime analysis,

“

**We strengthen
the region
through
connected
materials
technology
expertise,
reliable
partnerships
and resilient
value creation.”**

and energy-efficient production processes.

Digitalization & AI:

Digital twins, digital material histories, data management, sensor technology, metrology, simulation, robotics, and Digital Product Passports. Potential applications span a wide array of sectors, including energy technology, semiconductor manufacturing, the hydrogen economy, aerospace, mobility, microelectronics, and mechanical engineering.

Working Approach & Added Value

The Cluster's distinct strength lies in its role as a networker and innovation accelerator. Through targeted matchmaking, it connects the right partners, supports the development of project consortia, and helps companies and research institutions access funding programmes, research infrastructure, and new markets. It also provides a unified voice for the sector in dialogue with policymakers and funding organisations.

For Companies:

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For Research Institutions:

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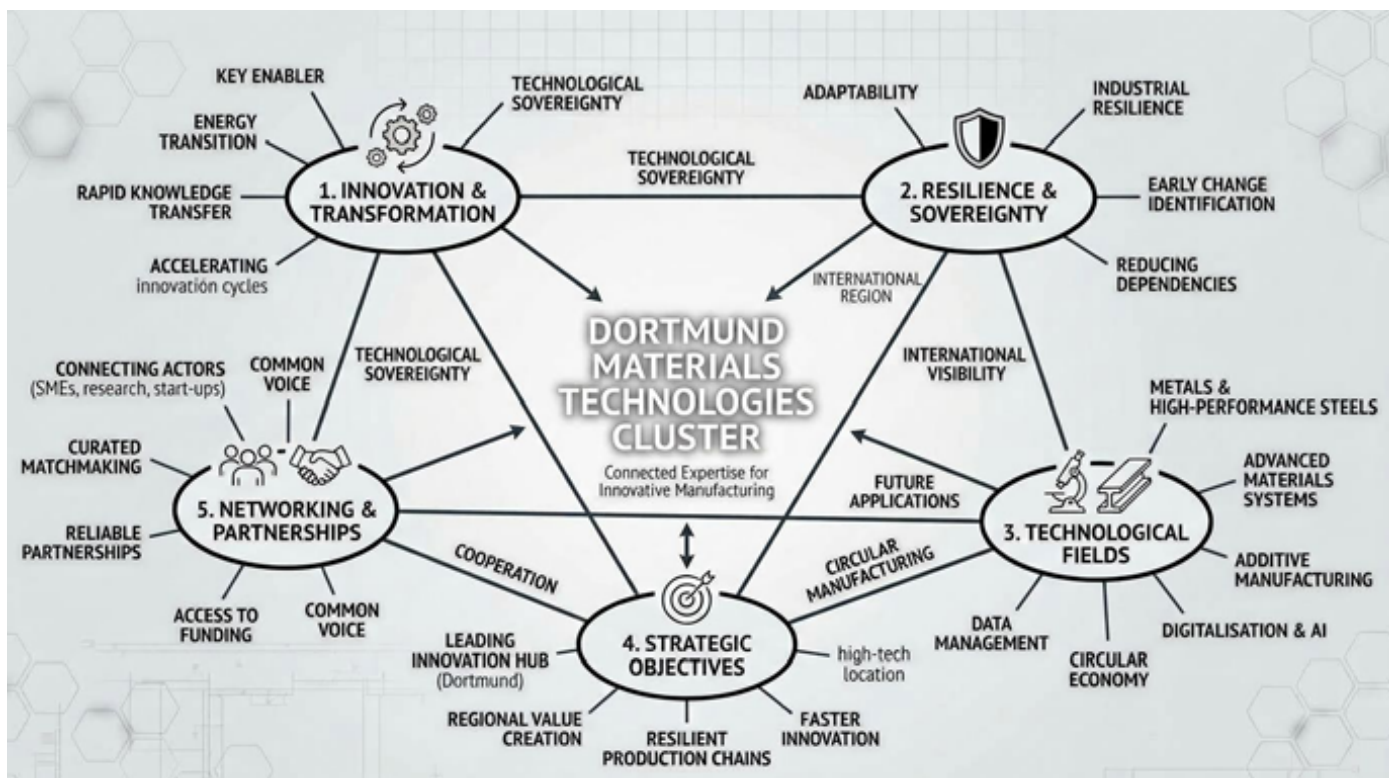
For Start-ups:

Direct entry into established networks, mentoring, and immediate access to potential industrial customers.

Organisation and Measuring Success

The Cluster is coordinated by a professional Cluster Office, a strategic Advisory Board, and thematic working groups. Its success will be measured by joint R&D projects, external funding, start-ups, new jobs, and active participation. Over the next five years, it aims to establish the Dortmund region as an internationally leading hub for materials technologies and advanced manufacturing.

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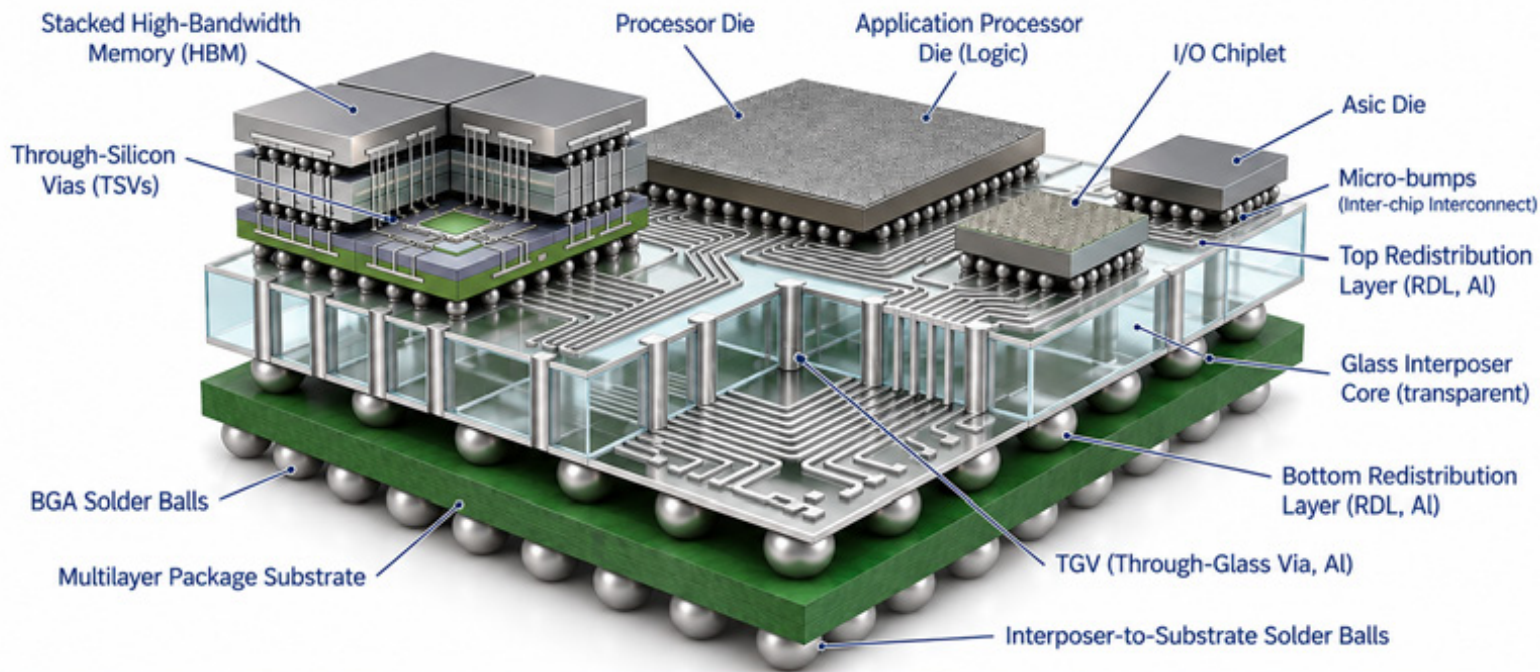
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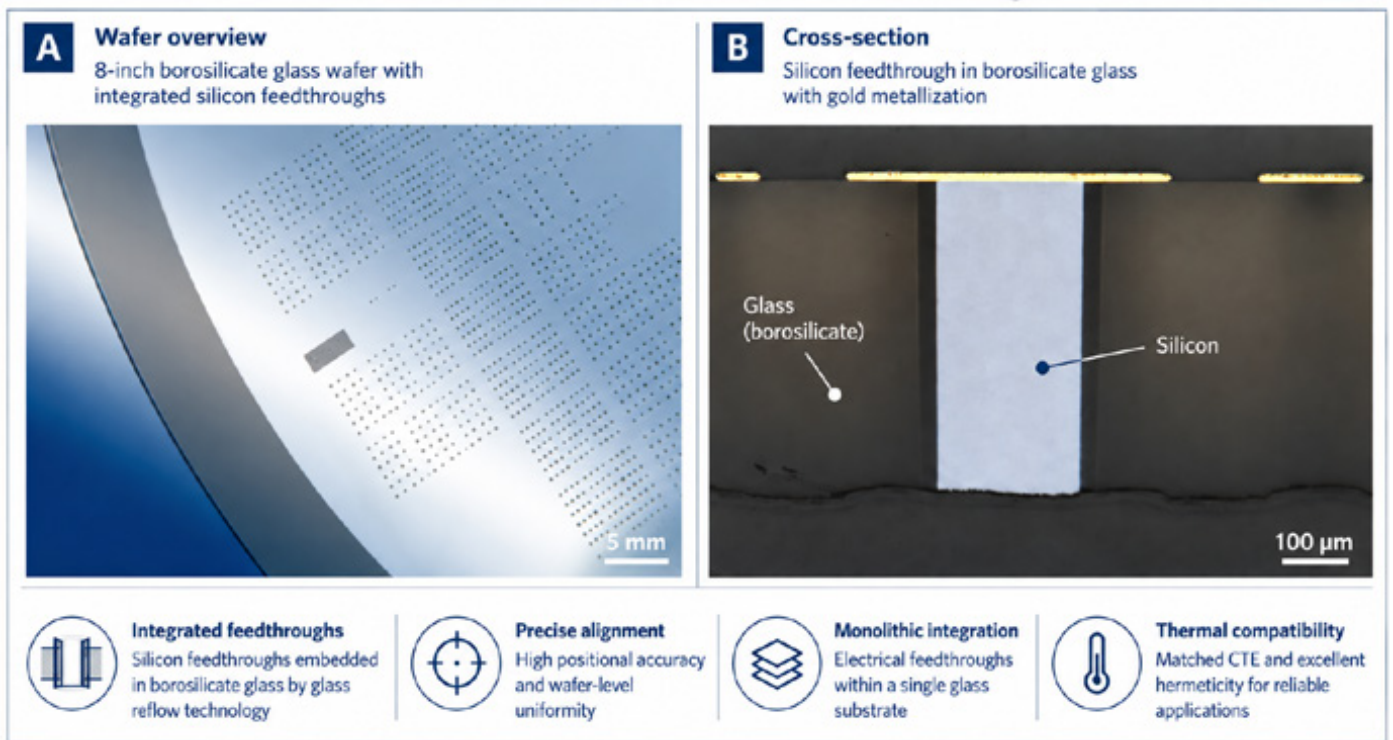
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ELECTRICAL THROUGH-GLASS VIAS – FROM SILICON PINS TO PRESSURE-FILLED ALUMINIUM

Glass-Embedded Silicon Feedthroughs



Functionalized Glass for New Interconnect Technologies

Glass is becoming a key substrate material for advanced electronic packaging, RF applications, photonics and MEMS due to its excellent dielectric properties, low signal loss and high dimensional stability. Realizing reliable electrical interconnects through glass, however, remains one of the major technological challenges. Through-Glass Vias (TGVs) enable vertical electrical connections and are therefore a key building block for highly integrated glass-based semiconductor packaging (Figure left). This article presents established and emerging technologies for conductive through-glass interconnects, culminating in a novel pressure-assisted aluminium filling process developed at Fraunhofer ISIT.

Laser Structuring (2D-LIDE and 3D-SLE) Enables Advanced TGVs

Reliable electrical feedthroughs require precisely structured glass substrates. Since glass cannot be processed by conventional deep reactive ion etching, ultrashort-pulse femtosecond laser technologies enable micrometer-scale structuring with minimal thermal impact.

Fraunhofer ISIT has established two complementary approaches: 2D Laser-Induced Deep Etching (2D-LIDE) enables high-throughput fabrication of high-aspect-ratio vias with excellent sidewall quality, while 3D Selective Laser-Induced Etching (3D-SLE) enables arbitrary three-dimensional geometries such as slanted interconnects, microfluidic channels and conductive coils. Together, both technologies provide the geometric flexibility required for advanced glass microsystems.

Technologies for Conductive Through-Glass Interconnects

The realization of conductive pathways is the key process step following laser structuring. Electroplated copper is the established industrial standard for TGV metallization, but requires seed and barrier layers as well as electroplating, resulting in significant process complexity and long filling times for deep vias. As an alternative, Fraunhofer ISIT has established glass-embedded silicon feedthroughs based on its proven glass reflow technology. High-aspect-ratio silicon pillars fabricated by deep reactive ion

etching (DRIE) are embedded into glass by anodic bonding and subsequent glass reflow. Wafer thinning and planarization then expose the highly doped silicon pillars, forming precisely aligned vertical electrical feedthroughs.

While silicon offers excellent precision, advanced packaging increasingly requires metallic interconnects with high throughput and low process complexity. Fraunhofer ISIT therefore developed a pressure-assisted aluminium filling process for laser-structured TGVs. Molten aluminium is pressed directly into the glass structures, enabling complete wafer metallization within approximately five minutes, largely independent of via depth or geometry. The process produces fully filled TGVs without seed, adhesion or diffusion barrier layers. The resulting aluminium/glass interface provides excellent adhesion and hermetic sealing, while the ductility of aluminium helps compensate thermomechanical stress. Together with its high thermal conductivity, these properties make the approach attractive for robust glass packaging and high-frequency applications.

Applications of Aluminium-Filled Through-Glass Vias

The capabilities of the pressure-assisted aluminium filling process extend well beyond the realization of conventional vertical Through-Glass Vias. The Figure below demonstrates the reliable filling of high-aspect-ratio vias in 500 μm thick fused silica substrates using the LIDE process. In combination with the SLE technology, even complex three-dimensional structures such as embedded coils with channel lengths approaching 10 mm can be completely metallized. These results illustrate the flexibility of the process for both conventional electrical feedthroughs and highly integrated three-dimensional microsystems.

The technology has already been transferred to application-oriented demonstrators. Within the European APECS Pilot Line, aluminium-filled TGVs together with embedded aluminium redistribution tracks have been integrated into hermetic glass packages for advanced microsystems. In addition to excellent mechanical robustness and hermetic sealing, the aluminium interconnects exhibit

low transmission losses at frequencies up to 40 GHz, making them highly attractive for RF electronics, photonic packaging and sensor systems.

By combining precise laser structuring with rapid pressure-assisted aluminium filling, Fraunhofer ISIT provides a scalable manufacturing technology for next-generation glass integration. The significantly reduced process time, elimination of complex barrier layers and excellent mechanical reliability make aluminium-filled Through-Glass Vias a promising alternative for future electronic, photonic and quantum applications.

The work was carried out in the APECS Pilot Line (101183307) and national funding authorities of Germany (16ME1013K). We acknowledge the support of FMD-QNC. The process technology is applied for patent.

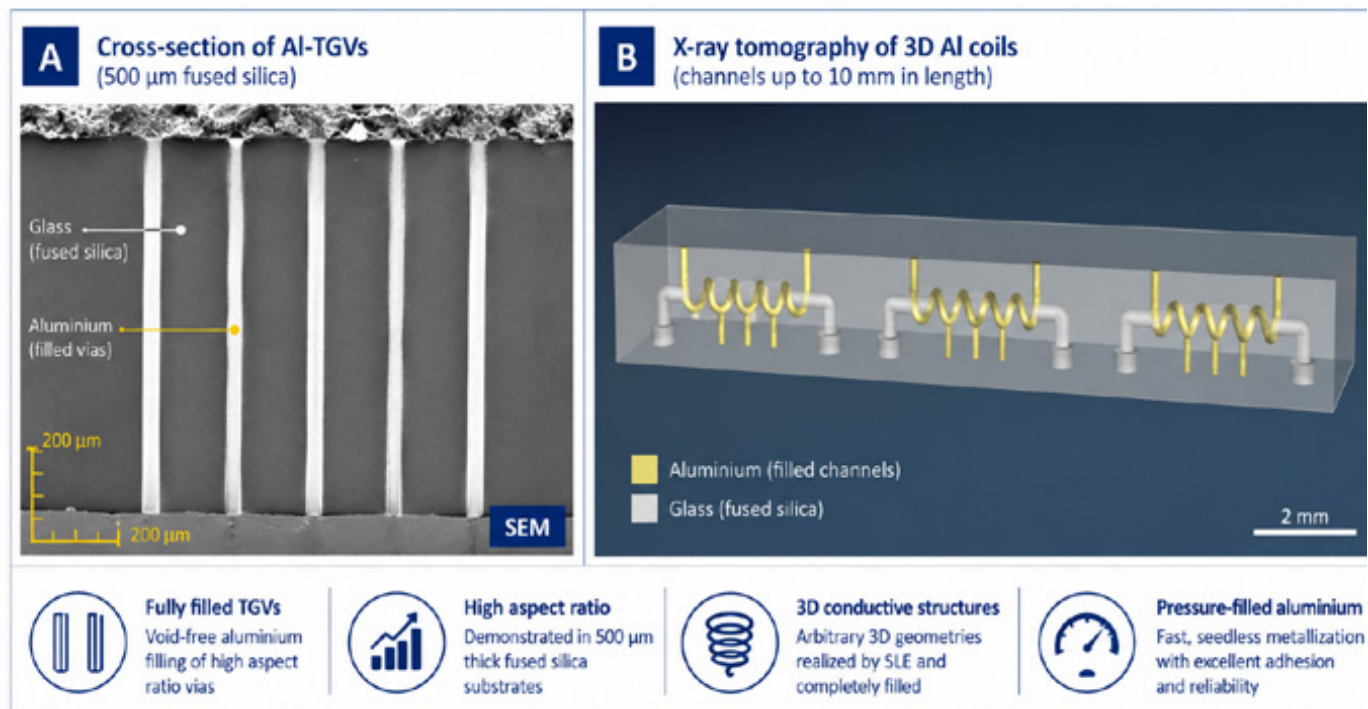
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“

Through-Glass Vias are the key to unlocking glass as a high-performance substrate for highly integrated semiconductor packaging.”

Pressure-Filled Aluminium Through-Glass Structures





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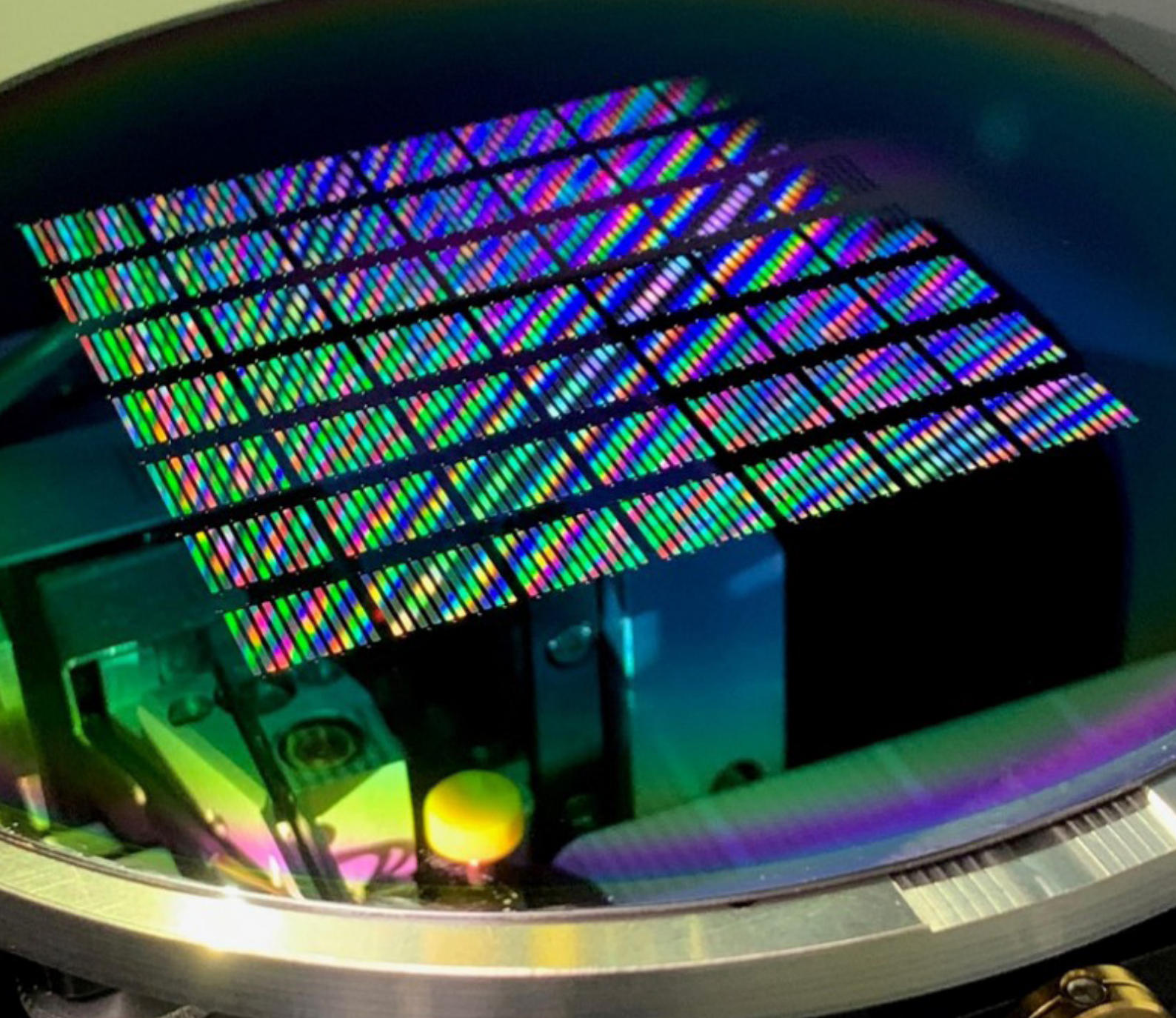
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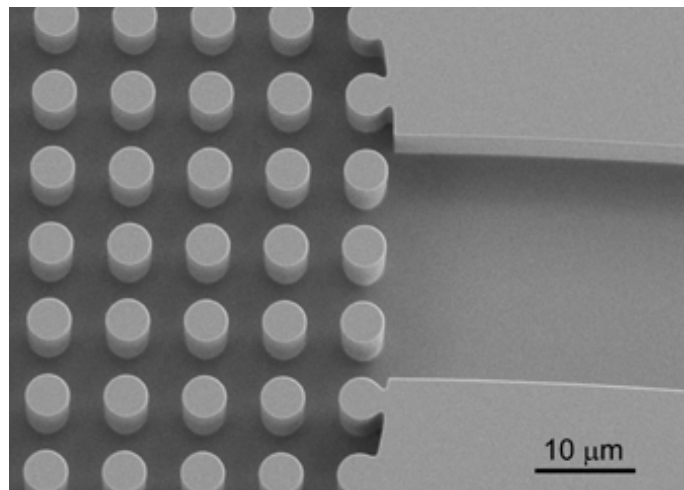


Wafer with modular chromatographic separation structures fabricated at AMO GmbH. The manufacturing technologies developed in ChiSePha are compatible with complex Lab-on-Chip applications.

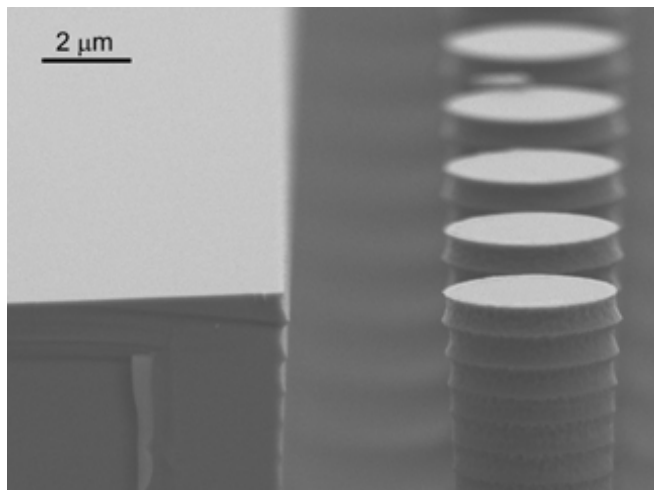
Dr. Ulrich Plachetka | Dr. Federica Haupt

MICROSTRUCTURES FOR LIQUID PHASE CHROMATOGRAPHY

Separation bed with connected entrance channel. The relatively wide spacing between micropillars allows the backpressure to be reduced without sacrificing separation efficiency.



Close-up of the micropillars (without surface functionalization).



From biological samples to pharmaceutical mixtures, analytical laboratories routinely deal with complex substances that must be separated before their individual components can be reliably identified. Chromatography makes this possible. In the ChiSePha project, researchers from AMO GmbH and IUTA e.V. are taking this crucial analytical step to the microscale by integrating a highly efficient separation structure directly onto a microfluidic chip.

Separate to analyze

Many real-world samples contain a complex mixture of molecules that need to be separated from one another in order to be reliably identified. In liquid chromatography, a liquid carries the sample through a separation structure, where different components travel at different speeds according to their physical and chemical properties. As a result, they emerge separately and can then be detected and analyzed. Ultra-high-performance liquid chromatography (UHPLC) takes this principle a step further, enabling highly efficient separations of small quantities of substances with great precision. However, conventional systems can reach their limits when only small sample volumes are available or when chromatography needs to be integrated into compact analytical devices.

From packed columns to engineered microstructures

In conventional UHPLC, the sample

is forced by a liquid at high pressure through columns are typically filled with tiny particles or a porous material. While these provide the large surface-area needed for efficient separation, they also impede the flow of liquid creating frictional heat that might alter the analytes.

ChiSePha takes a different approach. Instead of packing a column with particles, the project develops precisely defined separation structures directly within a microfluidic chip. Microscopic channels and pillar-like structures guide the liquid while providing the surface needed for separation. Their geometry can be tailored to achieve efficient separation with reduced flow resistance. Integrating the separation phase directly into the chip also minimizes so-called dead volumes—small spaces where a sample can spread or become diluted before reaching the detector. This is particularly important when working with very small sample volumes.

Precision manufacturing meets chemical separation

Producing such a chip requires technologies more commonly associated with microelectronics and microsystems engineering. At AMO, lithographic processes define the microscopic structures, while dry chemical etching transfers these designs into the chip material with high precision.

The structure, however, is only part of the equation. The chemical

properties of its surfaces also influence how molecules interact with the separation phase, whose properties can be therefore optimized by surface functionalization – a step that in ChiSePha is performed by AMO's partners at IUTA, who also are also responsible of testing the devices. By precisely engineering both the geometry and the surface chemistry of the separation structure, the ChiSePha aims to develop a system suitable for extremely low volume yet high-performance chromatography applications like drug testing or the investigation of metabolic function and biochemical genetics.

Towards integrated analysis on a chip

The potential of ChiSePha's approach goes beyond optimizing an established laboratory technology. In the future, chip-based chromatography could enable high-performance analysis of extremely small sample volumes and become a key building block for integrated Lab-on-Chip systems that combine several analytical steps on a single compact platform. The manufacturing technologies developed in ChiSePha are compatible with this broader vision.

ChiSePha is a project funded through the INNO-KOM program of the German Federal Ministry for Economic Affairs and Energy (BMWE).

AMO GmbH,
<https://www.amo.de/de/>

GLASS AS AN ENABLING MATERIAL FOR NEXT-GENERATION ADVANCED PACKAGING

Advanced packaging is turning the package from a mechanical enclosure into an active part of the system architecture. Specialty glass combines dimensional stability, electrical insulation, optical transparency and wafer-scale processability - properties that make it relevant to both established wafer-level packaging and emerging glass-core substrates for chiplet-based systems.

From protection to functionality

Glass has been used in wafer-level packaging for many years, particularly as a cap, spacer or functional layer for MEMS and optical devices. At wafer scale, cavities, channels, windows, blind holes and through-glass

vias can be produced before the glass is aligned and bonded to the device wafer. After dicing, each component is already protected and, where the bonding concept is designed accordingly, can contain a defined atmosphere or vacuum cavity. This batch approach supports compact packages for pressure sensors, inertial sensors, microphones, optical sensors and other microsystems.

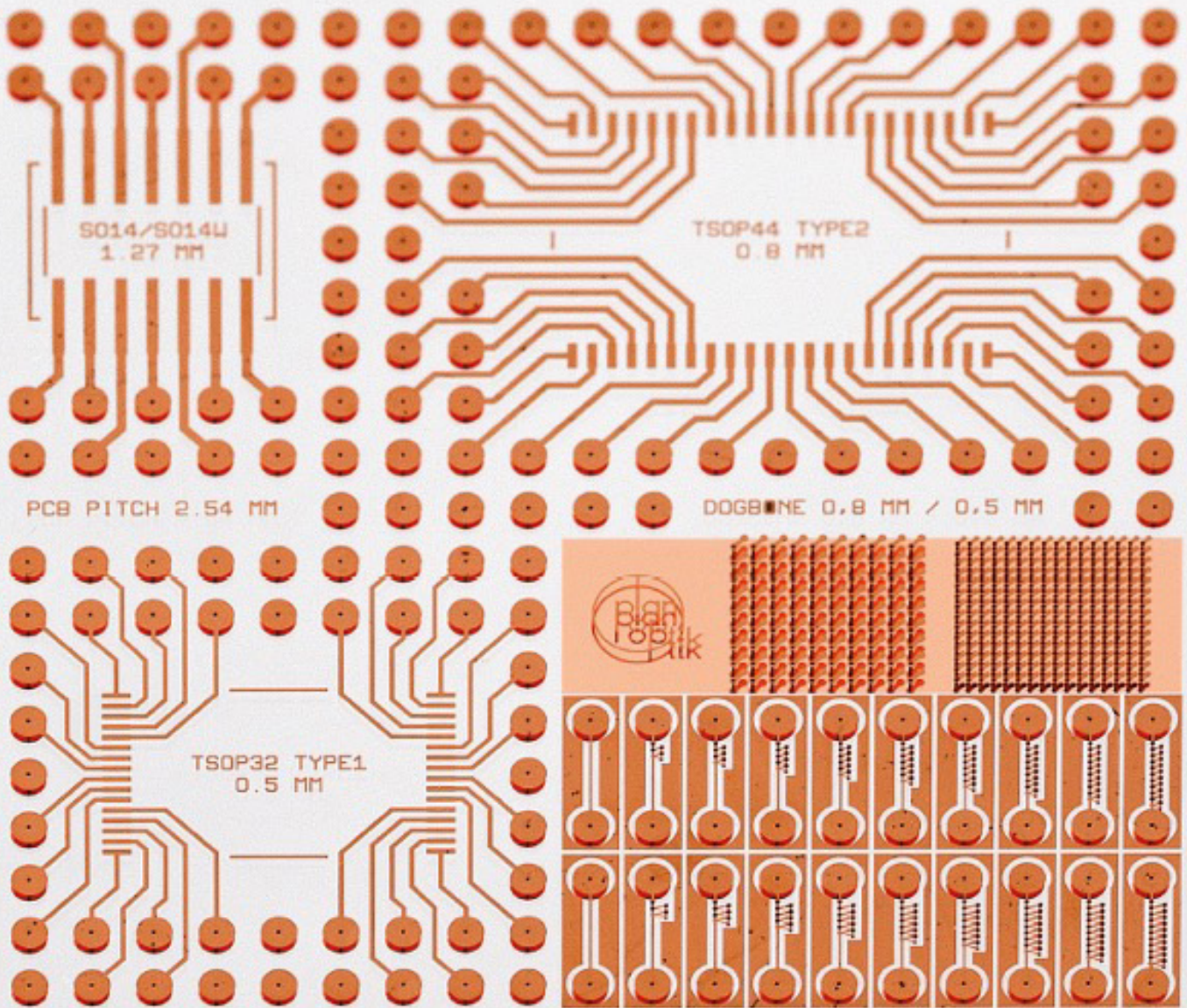
The decisive advantage is that glass can do more than protect. A transparent cover can provide optical access; a cavity can create mechanical clearance; a channel can guide a fluid or gas; and a metallized via can bring electrical signals through the cap. Functions that would otherwise require

several separate components can therefore be combined in one precisely structured wafer.

Material properties that support scaling

The term “glass” covers a broad family of materials. Borosilicate, alkali-free and fused-silica-based glasses offer different coefficients of thermal expansion, dielectric properties, optical transmission and temperature resistance. Selecting the right composition allows the substrate to be adapted to silicon, compound semiconductors, metals or polymers in the package.

For advanced packaging, the most relevant attributes are high stiffness, low warp, excellent



Example of a metallized glass interposer, or adapter with copper routing, landing pads and test structures.

flatness and stable dimensions over temperature. These properties support fine-pitch lithography and accurate die placement, especially as package sizes increase. Glass is also an electrical insulator with low dielectric loss, which is beneficial for high-speed and RF signal routing. Its smooth surface enables thin-film metallization and redistribution layers, while optical transparency can simplify alignment and open additional options for photonic integration.

Glass-core substrates as system platforms

When through-glass vias, copper metallization and redistribution layers are added, the glass core

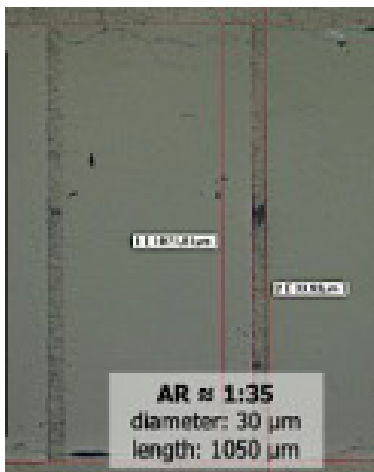
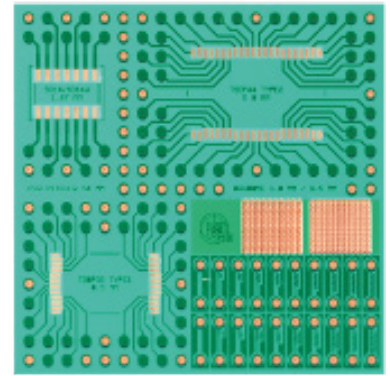
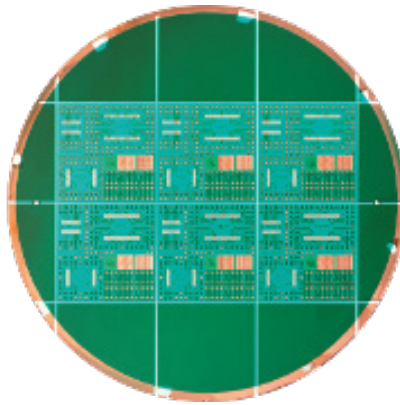
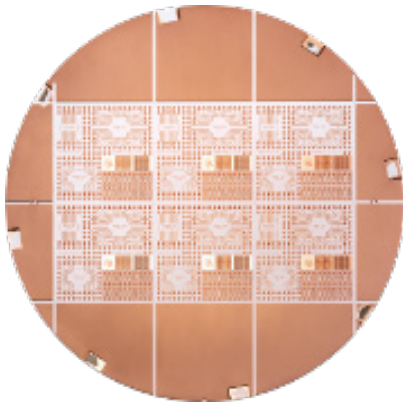
becomes an interposer or package substrate. Vertical vias connect the two sides; fine conductive structures distribute signals and power laterally; pads and solder-mask structures create interfaces to dies, chiplets and the next packaging level. This architecture is attractive for AI and high-performance computing, where multiple logic dies, accelerators and high-bandwidth memory must be integrated within increasingly large packages. Dimensional stability helps control warpage, while fine routing and dense vertical interconnects support short electrical paths and high I/O counts. The same platform can serve RF modules, photonic assemblies and MEMS packages, combining

electrical, mechanical and optical functions in a common substrate.

Industrialization requires the complete process chain

The challenge is not only to form an individual microvia. Industrial implementation requires a stable process chain from material selection and surface preparation through via formation, metallization and lithography to solder mask, dicing and reliability validation. For PLANOPTIK, integrating precision glass processing with microelectronic structuring is what turns a material sample into a manufacturable packaging platform. Glass remains a brittle material and has limited thermal

From patterned glass wafer to metallized wafer and diced interconnect: wafer-level processing turns glass into a functional packaging platform.



conductivity, so handling, edge quality and thermal design must be addressed from the beginning. Via geometry, surface damage, metal adhesion and coverage, build-up materials and thermo-mechanical reliability also have to be considered as one system rather than as isolated process steps. Glass-core development should therefore start as a co-design task

Cross-section of a high-aspect-ratio through-glass microvia. The demonstrated geometry is approximately 30 micrometres in diameter through 1,050 micrometres of glass, corresponding to an aspect ratio of about 1:35.

between material, process and package architecture. When these disciplines are engineered together, specialty glass changes its role: from a passive packaging material to a scalable platform for heterogeneous integration. This transition makes glass a key enabling material for the next generation of semiconductor, photonic and MEMS systems.

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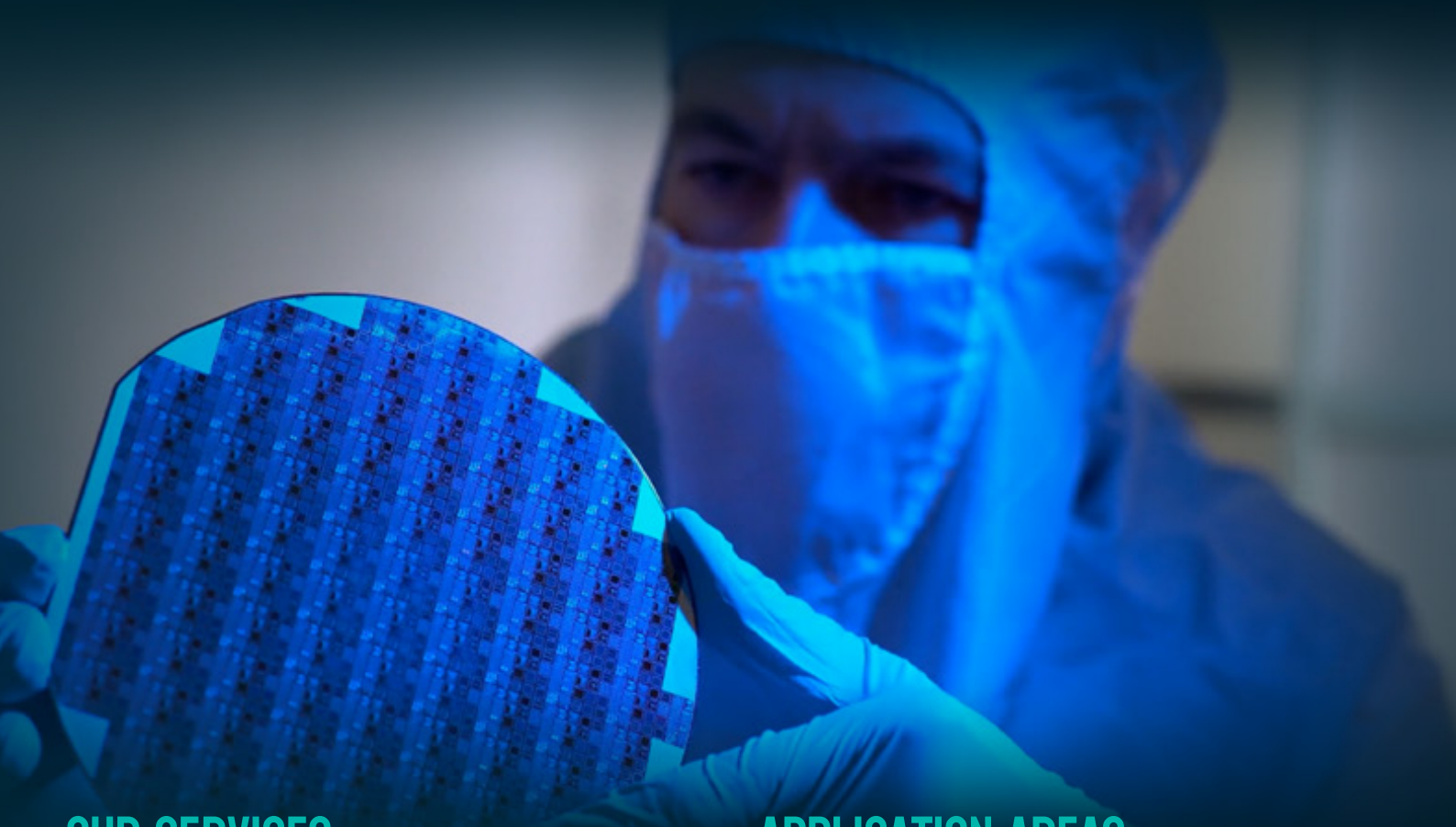
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CONDUCTIVITY RIGHT UP TO THE SURFACE: A GAME-CHANGER FOR PLASTICS WITH EFFECTIVE EMC PROPERTIES

Conductive plastics offer great potential for applications in the field of electromagnetic compatibility (EMC), as they combine the advantages of polymers with electrical conductivity. However, despite good conductivity within the component, the comparatively high surface resistance poses a key challenge. Current research approaches aim to specifically overcome this weakness through innovative material combinations and novel additives.

Plastics offer numerous advantages over metallic materials. These include, in particular, lower manufacturing costs, a significant reduction in weight, and sustainability-related aspects such as an improved carbon footprint, recyclability and comparatively low processing temperatures. With this background in mind, the use of conductive plastics for EMC applications has been the subject of intensive research for many years. Particularly the automotive industry, electronics, mechanical engineering and medical technology, have a growing demand for materials that enable reliable electromagnetic shielding whilst offering a

high degree of design freedom. The electrical conductivity of plastics is usually achieved by adding conductive fillers. Examples include carbon fibres, steel fibres, metal-coated fibres, conductive carbon black or modern carbon nanostructures. If these fillers form a continuous network within the plastic, very good electrical properties can be achieved. However, the challenge often lies not in the core of the component, but on its surface.

The boundary layer as a weak point in EMC shielding

A characteristic multi-layer structure develops, particularly in injection-moulded, fibre-reinforced plastics. During processing, a boundary layer forms on the component's surface, which is predominantly characterised by the electrically insulating polymer matrix. By contrast, the conductive fibres and particles are concentrated more heavily within the component,

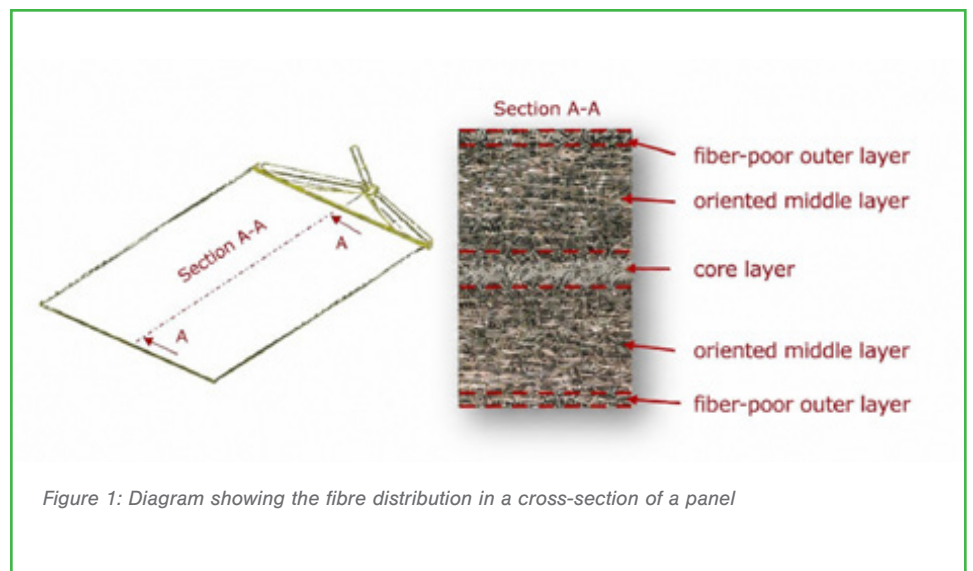
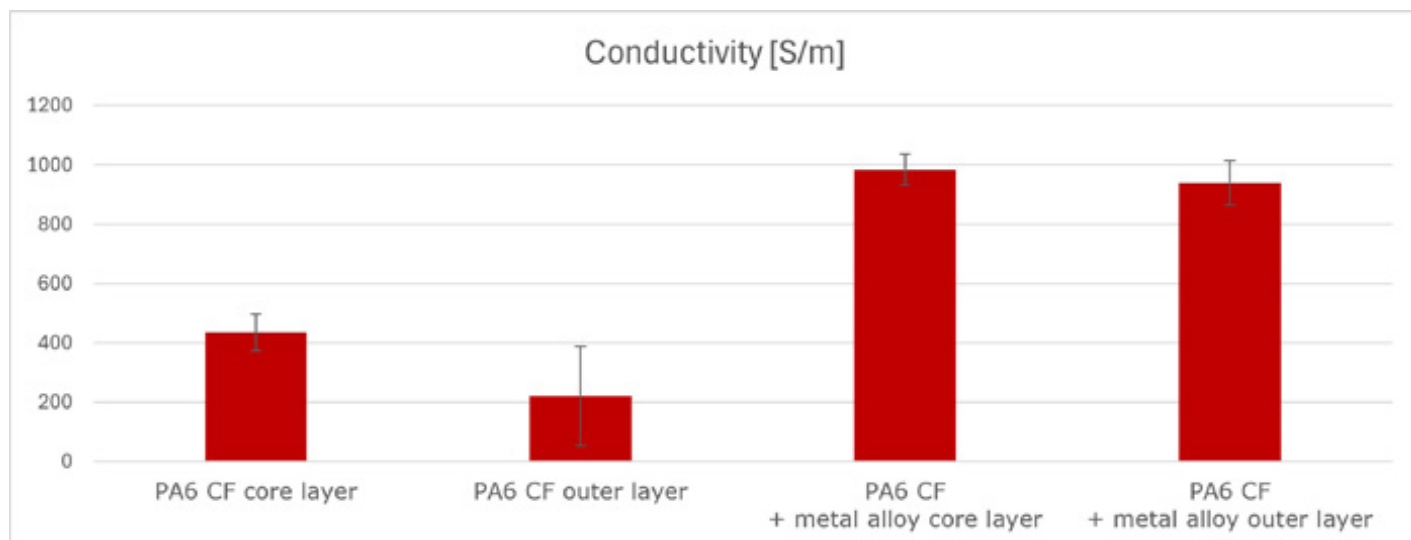


Figure 2: Difference in conductivity resulting from the use of a metal alloy in the edge and centre layers



where they form an effective conductive network (Figure 1). This results in a significant inhomogeneity in the electrical properties across the component's cross-section.

For many EMC applications, this uneven distribution of conductivity presents a critical barrier. The shielding effectiveness of an enclosure depends not only on the conductivity within the component, but in particular on good electrical contact at the surfaces and joints. If, for example, the lid and base of an enclosure are joined together, the reduced surface conductivity can lead to so-called EMC leakage. Electromagnetic waves then penetrate the contact areas almost unhindered, despite the material's good overall conductivity. This can impair the functioning of sensitive electronics and make it difficult to comply with regulatory requirements.

In order to better understand these challenges and develop suitable solutions, different material systems were investigated as part of three collaborative projects. Various thermoplastics were used in combination with conductive fibres made of steel, carbon and nickel-plated carbon fibres. In addition, additives such as conductive carbon black, carbon nanostructures and copper-silver hybrid particles were employed. The results consistently

showed high electrical conductivity within the components. At the same time, however, it was demonstrated that the less conductive boundary layer has a dominant influence on the overall electrical behaviour, regardless of the material combination.

New metal additives improve surface conductivity

In the current collaborative project 'EMV 4', the project group is therefore pursuing an innovative approach. This involves incorporating low-melting-point metal alloys as additives into the compounding process. These metals melt at temperatures as low as 190 °C and subsequently exhibit almost Newtonian flow behaviour. Due to their high fluidity, they can be distributed much more evenly throughout the plastic melt during the injection moulding process than conventional solid particles. The key advantage of this concept is that the metal phase is able to reach the previously critical boundary layer to a greater extent. There, it contributes to the formation of additional electrical contact points and, ultimately, a continuous conductive network. This results in a homogeneously conductive hybrid compound whose electrical properties are distributed much more uniformly across the entire cross-section of the component. Initial investigations have yielded

extremely promising results. In the case of a carbon-fibre-reinforced polyamide compound, the conductivity of the surface layer was increased by a factor of five. At the same time, the conductivity remained virtually constant from the edge right into the core (Figure 2). This represents a significant step forward in the development of EMC-effective plastic components and opens up new possibilities for the use of conductive plastics in demanding shielding applications. As the project progresses, additional fibre materials and plastic systems will be investigated for their suitability. Furthermore, the project group is addressing design-related issues, such as the integration of EMC seals using direct metal injection moulding. The aim is to further improve electrical contact whilst developing assembly-friendly solutions. The results to date show that high conductivity right up to the surface is a crucial factor for the next generation of EMC-effective plastics. If surface conductivity can be increased in various material combinations, conductive plastics could replace traditional metal solutions in many applications. Interested companies are invited to join the project group and play an active role in shaping the further development of this promising technology.

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DNA ORIGAMI

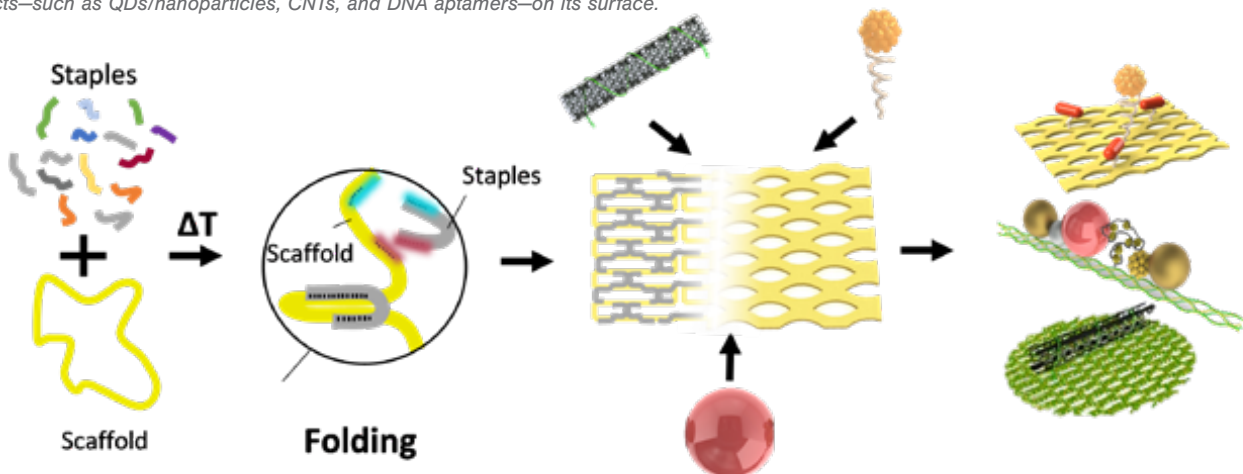
A PLATFORM FOR NANOSCALE INTEGRATION

As technological systems become smaller and more complex, their performance increasingly depends on the precise spatial arrangement of individual components. In nanoelectronics, photonics, quantum technologies and biosensing, distances of only a few nanometers can influence electrical transport, optical coupling, energy transfer or molecular recognition. Controlling matter at this scale is therefore becoming an important requirement for highly integrated functional devices. Conventional

top-down fabrication remains indispensable for micro- and nanoscale manufacturing. However, heterogeneous systems in which nanoparticles, molecules or biomolecular components must be positioned with nanometer-scale accuracy pose a different challenge: functional elements must not only be miniaturized, but also placed, oriented and connected in a controlled manner. Bottom-up self-assembly offers a complementary route, and DNA origami is one of its most versatile tools.

In the classical DNA origami approach, a long single-stranded DNA scaffold is folded by hundreds of short, sequence-designed “staple” strands into predefined two- or three-dimensional structures. (1-4, see Nature [2006](#) / [2009](#) and Science [2009](#) / [2011](#)) Beyond structural diversity, the key advantage of DNA origami is its molecular addressability. Selected staple strands can be extended with sequences that act as defined attachment sites, enabling functional components to be positioned at

Figure 1: Schematic representation of DNA origami folding based on the complementary binding of scaffold and staple strands, followed by functionalization with various heterogeneous objects—such as QDs/nanoparticles, CNTs, and DNA aptamers—on its surface.



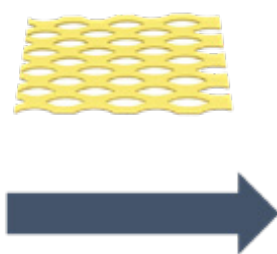
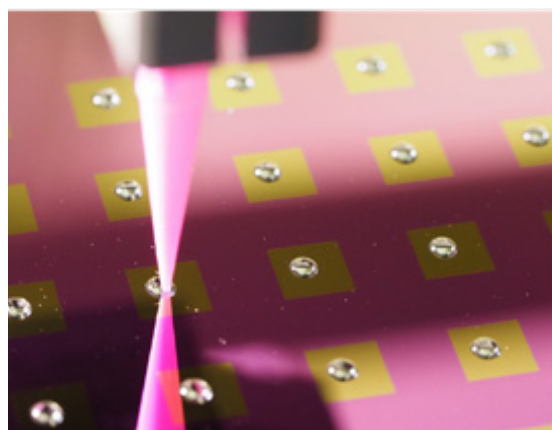
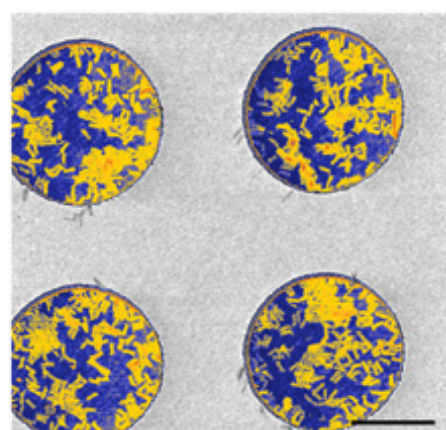


Figure 2: Controlled surface integration of DNA origami on chip and water level. AFM topography image on the right side shows selective immobilized DNA origami in SiO₂ cavities in nanostructured CF polymer (scale bar 4 μ m).



distances of only a few nanometers. (see Figure 1). Metal nanoparticles, quantum dots, aptamers, carbon nanotubes and conducting polymers have all been organized on DNA-origami templates [6-12]. DNA origami can therefore serve as a programmable nano-breadboard for combining different materials and functions. This capability is particularly attractive for linking bottom-up assembly with established top-down fabrication. DNA origami structures can first organize molecular or nanoscale components and can then be positioned and oriented on patterned substrates. Previous work has demonstrated selective placement on chemically or lithographically structured surfaces and the integration of gold nanoparticles and optical emitters into larger device architectures [13-17]. DNA origami thus provides an intermediate level of organization that can transfer molecular-scale precision into micro- and nanoscale systems.

A Programmable Biosensor Platform - DeDNAed

DNA origami also offers opportunities for biosensing by combining biological recognition with nanoscale optical signal

enhancement. In the European research project DeDNAed, DNA origami serves as a programmable platform on which recognition elements and metallic nanostructures can be arranged with high precision. Their defined organization enables the formation of plasmonic hotspots for surface-enhanced Raman spectroscopy (SERS), providing a route towards sensitive and rapid detection of biological target molecules [16]. Because the binding sites can be programmed, the same basic architecture can potentially be adapted to different biomarkers and sensing tasks [18,19].

Deterministic Single-Photon Sources - GREENER

Another application field is optics and quantum technology. By defining the number and position of binding sites, DNA origami can control the attachment of individual optical emitters. This makes it possible, for example, to position single colloidal quantum dots within a multilayer device architecture. In the EU project GREENER, this concept is being pursued to develop an electrically driven single-photon source. A single quantum dot is locally positioned in a cavity inside an insulating layer, which

is embedded in a system consisting of a top electrode, a hole injection (HIL) and transport layer (HTL) on the one side and an electron transport layer (ETL), an electrode, and an additional micro-optical element in the form of a Fresnel lens on the other side. [20]. The resulting compact light source is intended as a key component of a novel spectrometer for detecting very low concentrations of hormones in water. For DNA origami to move beyond laboratory-scale demonstrations, however, reproducible and scalable manufacturing processes are essential. At the Center of Micro-Nanotechnology (ZfM) microfluidic approaches are being developed to transfer conventional batch-based folding and purification into continuous and automated workflows. A modular process design makes it possible to optimize folding and cleaning independently of one another and to adapt or scale individual process steps within one microfluidic system. These developments illustrate the broader potential of DNA origami as a programmable material platform for integrating molecular components into functional high-tech systems. By combining bottom-up precision and material versatility with top-down fabrication, DNA origami could become an important enabling technology for future photonic, quantum and biosensing devices.

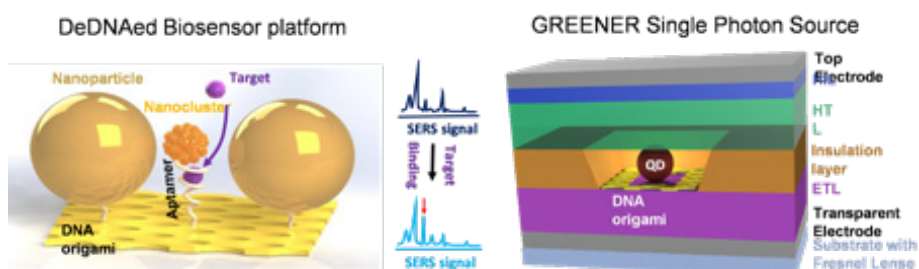


Figure 3: left: DeDNAed approach of analyte detection by surface enhanced raman spectroscopy; right: Layer system of the GREENER single photon source with colloidal quantum dot integrated by DNA origami.

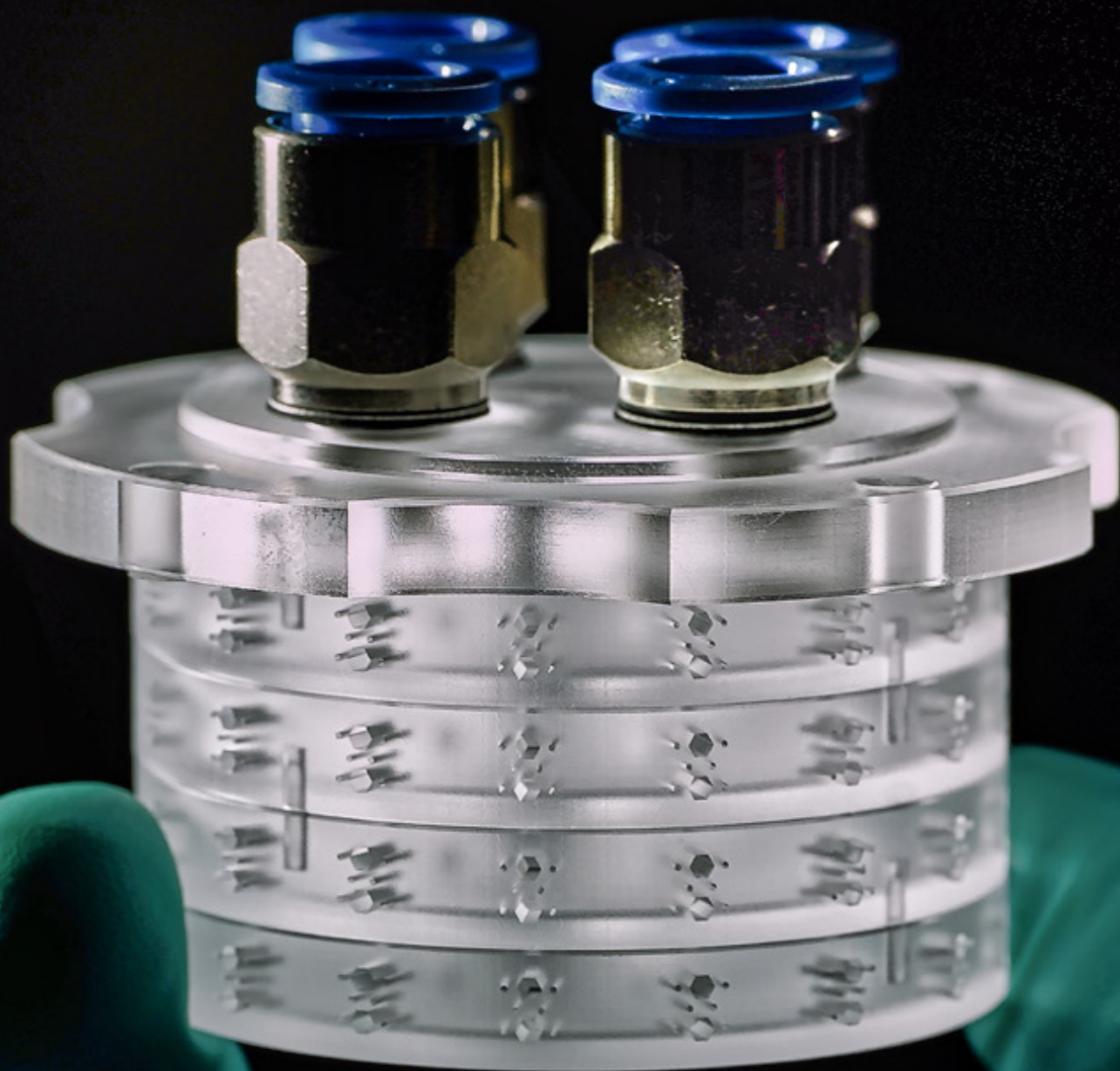
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Sebastian Büsche

FUSED SILICA AS A PLATFORM FOR HIGH-TECH DESIGN

When conventional materials or isolated manufacturing methods reach their limits, the challenge is often not the original idea but turning it into a reliable component. Quartz glass, also known as fused silica, offers an unusual combination of properties: very low thermal expansion, chemical resistance, thermal stability, optical transparency and electrical insulation. It is also suitable for ultra-clean and contamination-sensitive environments. Together, these characteristics allow one material to take on roles that would otherwise require several materials, interfaces or separately assembled parts.

One material - multiple scales

Modern systems frequently combine very different dimensional requirements. A carrier or process compo-

nent may need to be mechanically stable, flat and precisely finished over a large area, while its decisive functions are defined by micrometre-scale cavities, channels, bores or positioning features. Fused silica can bridge these scales when the manufacturing concept is considered as a whole. Available capabilities include mechanical polishing, CNC machining of large components up to approximately one metre, CO₂ laser cutting, thermal processing and hot working, laser welding and ultra-precise laser-based 3D structuring. The innovation does not lie in naming one process as the solution. It lies in selecting and combining suitable technologies so that the geometry, surface quality and functional details support the same technical objective.

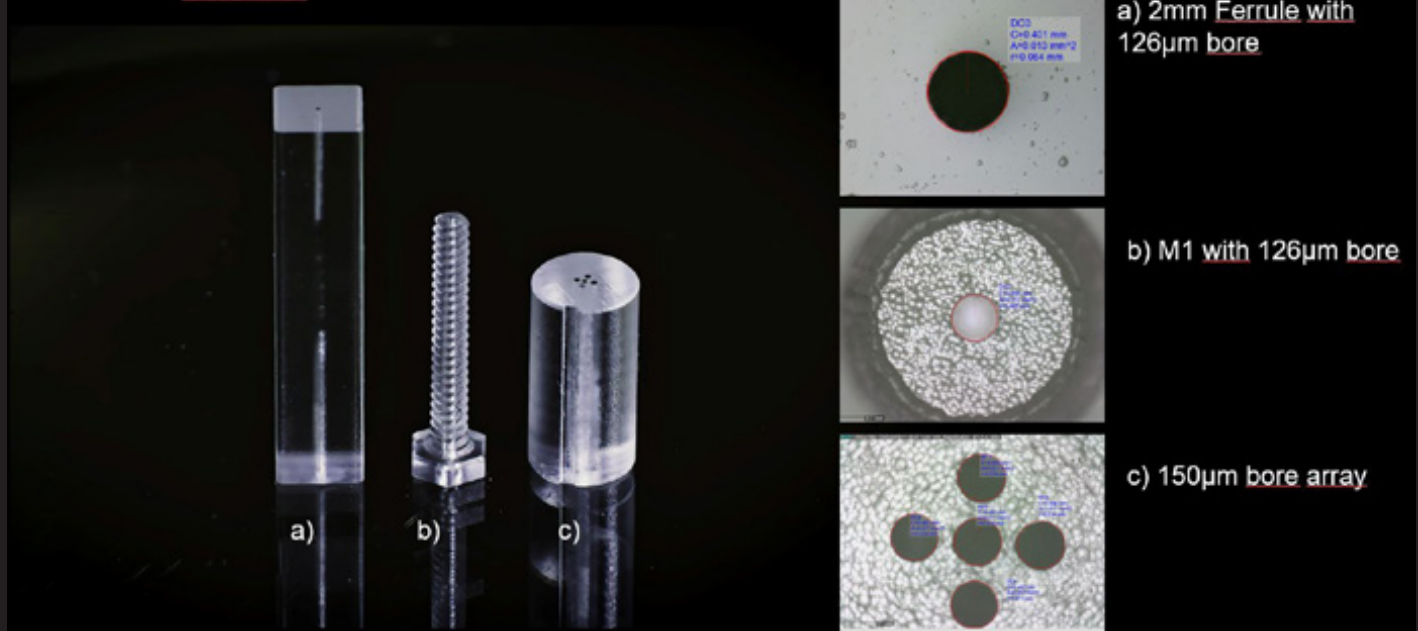
This approach creates freedom at system level. Optical access can be combined with electrical insulation;

chemically resistant media paths can be integrated into a dimensionally stable body; and precision interfaces can become part of the component rather than separate add-ons. Fewer interfaces can reduce alignment effort, simplify assembly and support a more reproducible transition from prototype to production.

Designed integration instead of added complexity

Advanced electronics and optics packaging illustrates this principle. Three-dimensional cavities, pockets, via structures and bore arrays can be formed directly in a glass substrate. The material provides electrical isolation while remaining compatible with optical and fluidic functions. Instead of using glass only as a passive carrier, designers can use its volume to position and connect functions in three

3D Fiber ferrules



dimensions.

The practical benefit is not simply a smaller package. A more integrated architecture can reduce the number of individual parts, shorten tolerance chains and create defined interfaces for subsequent assembly steps. This is particularly relevant where optical, electronic and fluidic elements must coexist within a stable platform.

A related concept applies to coating and distribution heads for gases or liquids. Internal media routing, distribution features and defined outlet geometries can be combined in a compact component. Chemical and thermal stability support operation in demanding process environments, while the transparency of the material can assist inspection or optical monitoring where the application allows it. Such components are relevant for coating equipment, semiconductor technology and other high-purity processes in which controlled distribution and clean material selection are essential.

Precision interfaces for optical systems

Fiber ferrules and fiber arrays demonstrate how mechanical alignment and optical functionality can be brought together. Precision bores, positioning structures, microthreads and customer-specific geometries can guide fibers within a stable glass interface. This can reduce later adjustment work and

enable more compact assemblies with reproducible coupling positions.

The same design philosophy also supports combinations of photonics, fluidics and process monitoring. Fibers, channels and mechanical references can be treated as parts of one component concept instead of independent elements that must be aligned after production. The resulting interface is not merely a holder; it becomes an engineered link between optical signals, media paths and the surrounding system.

From passive material to system component

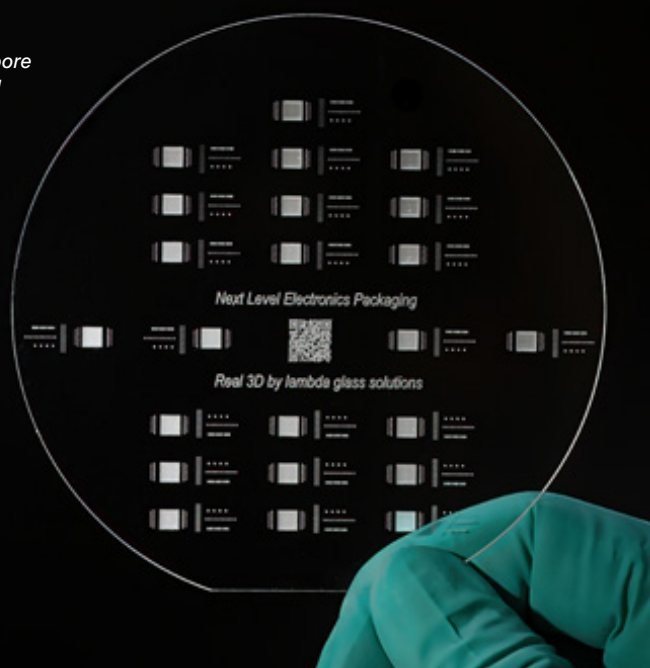
The future potential of fused silica comes from the interaction of its

material properties with a broad processing spectrum. Large-scale machining and polishing create stable foundations. Laser cutting, hot working and welding support shaping and assembly. Precision 3D structuring adds local features where they create technical value.

Used in this way, fused silica is no longer limited to windows, wafers or laboratoryware. It becomes a platform for components that combine structural, optical, electrical and fluidic tasks. The decisive step is to design the material and the manufacturing possibilities together - from the first concept through to a robust and manufacturable product.

Lambda Glass Solutions GmbH & Co. KG
www.lambda-glass.de

Fused-silica wafer with precision cavities and bore structures for advanced electronics and optics packaging



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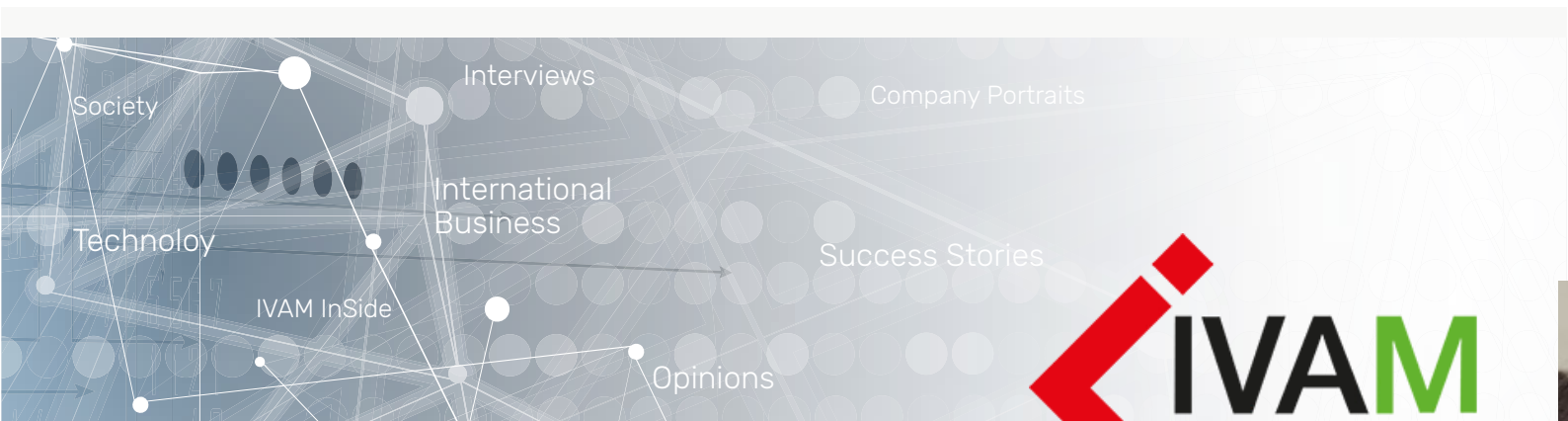
EXPLORE NEW BUSINESS OPPORTUNITIES IN KOREAS NANOTECHNOLOGY MARKET WITH IVAM

Following the successful premiere in 2026, IVAM is organizing another joint booth at NANO KOREA. From July 7 to 9, 2027, companies will have the opportunity to present their technologies and products to an international specialist audience at KINTEX in Goyang and establish valuable contacts in the Korean market. NANO KOREA is one of Asia's leading international exhibitions and conferences for nanotechnology and nano-convergence. Its broad spectrum covers nanomaterials, micro- and nanoelectronics, semiconductors, MEMS and sensors, photonics, manufacturing, packaging and

metrology, as well as nanobiotechnology, medical technology, energy and battery technologies. Several specialized high-tech exhibitions taking place in parallel offer additional cross-industry networking opportunities. Building on the experience gained during the premiere, IVAM has

significantly expanded its full-service package for 2027. Exhibitors also benefit from complimentary conference registration and financial support for selected travel-related services. Company visits ahead of the exhibition are also being planned.

<https://www.ivam.de/events/nano-korea-2027>



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NEW FORMATS CONNECT TECHNOLOGIES AT COMPAMED 2026

IVAM is expanding its activities at COMPAMED 2026 with new formats designed to connect technology providers, medical device manufacturers and users more directly.

A key addition is the new series of application-oriented Technical Tours. Starting from the IVAM joint pavilion, the curated tours will guide trade visitors to selected exhibitors and demonstrate how microtechnologies enable advances in diagnostics, continuous health monitoring, minimally invasive procedures and intelligent drug-delivery systems.

The established Hands-on Session on Microfluidics will continue at COMPAMED and will also be offered in an adapted format at the concurrently held MEDICA. This creates an additional link between suppliers of components and manufacturing technologies, medical device manufacturers and healthcare users.

Together with the international joint pavilion and the COMPAMED HIGH-TECH FORUM by IVAM, these formats make technologies easier to explore, compare and discuss with the relevant experts. Around 50 exhibitors and partners from twelve countries will present their solutions across approximately 700 square meters in Hall 8a from November 16 to 19, 2026.

<https://www.ivam.de/events/compamed-2026>



GET TO KNOW IVAM MICROTECHNOLOGY NETWORK - BOOK A Q&A SESSION

Have you ever thought about whether your company could benefit from a membership in a network? Perhaps an IVAM membership may be the right solution for current challenges in your microtech-, biotech- oder deeptech-company! We cordially invite you to get to know the network better. You are welcome to bring specific questions, which we will then answer personally. Additionally you have the possibility to arrange an individual appointment.

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