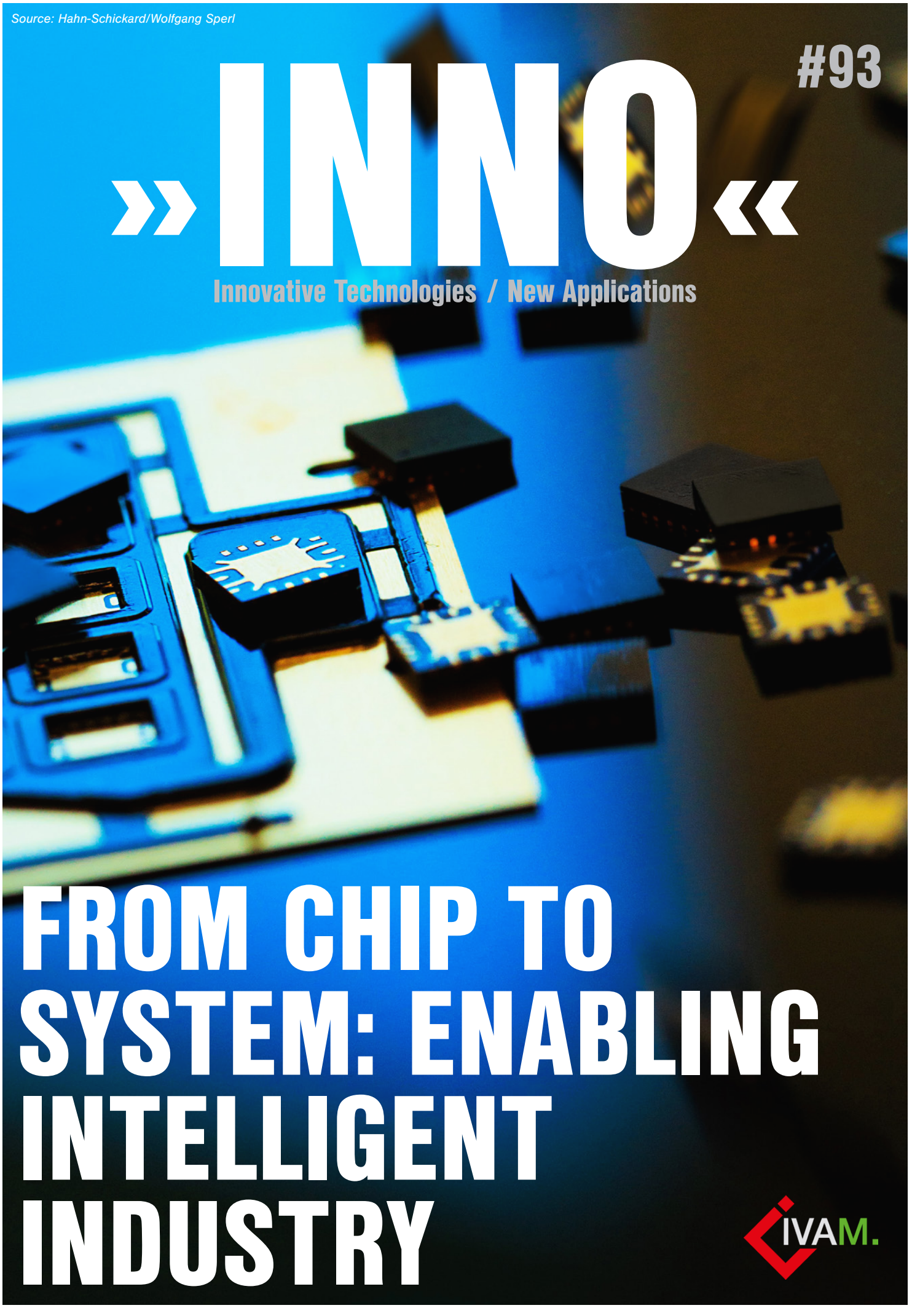

Source: Hahn-Schickard/Wolfgang Sperl

#93

»INNO«

Innovative Technologies / New Applications

FROM CHIP TO SYSTEM: ENABLING INTELLIGENT INDUSTRY

IVAM.

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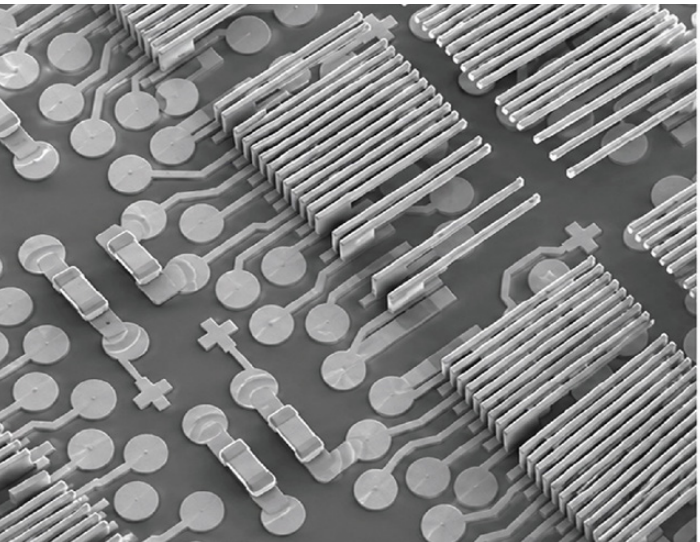

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From vertical probes to MEMS probe: a change of paradigm in the test industry?

As semiconductor devices continue to shrink and move into complex 3D architectures, wafer probing faces new challenges in pitch, density and reliability.

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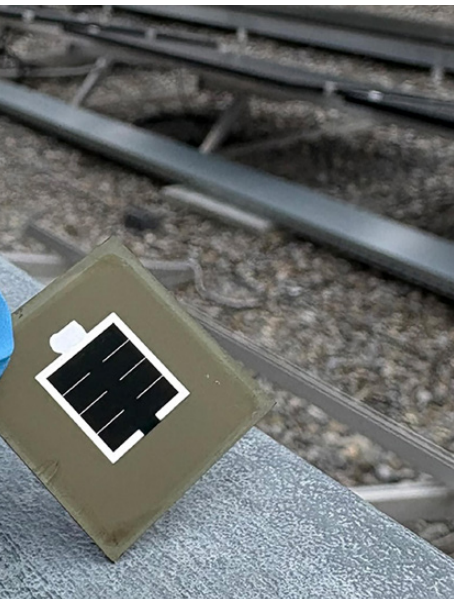

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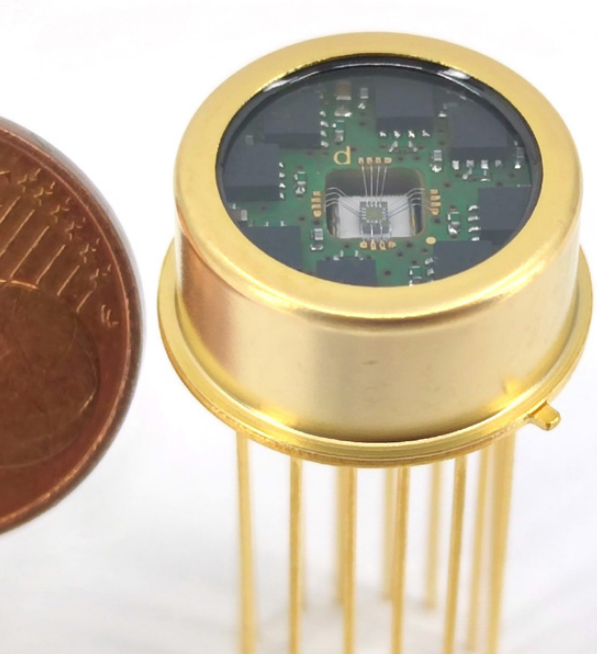
Record Efficiency for Perovskite-Silicon Triple-Junction Solar Cells

EPFL and CSEM researchers have achieved a record 30% efficiency for triple-junction solar cells, which combine two thin-film perovskite cells and one silicon cell on a single device.



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New QKD Receiver Shrunk to Coin-Sized Module

Quantum computers are advancing faster than expected, and conventional encryption faces an uncertain future.

»INNO 93«
From Chip to System: Enabling Intelligent Industry

Welcome to this edition of INNO. The future of industry is being built where the invisible becomes possible: at the micro- and nanoscale. Tiny structures, advanced materials, and groundbreaking semiconductor technologies are redefining how we generate energy, process information, communicate, manufacture, and connect the world around us.

This issue explores the innovations that form the foundation of tomorrow's industrial landscape. From novel wafer probing concepts and wide-bandgap semiconductors to quantum communication, flexible packaging technologies, next-generation solar cells, and intelligent sensor networks, the stories presented here demonstrate how technological excellence is transformed into tangible impact.

What inspires us most is that every innovation featured in this issue represents more than a technical achievement. Each one is a building block for a smarter, greener, and more resilient future. Together, they illustrate how progress emerges when scientific curiosity meets industrial ambition.

We invite you to discover the technologies, trends, and minds that are shaping the next generation of intelligent systems–and, with them, the future of industry.

Enjoy reading.
Mona Okroy-Hellweg

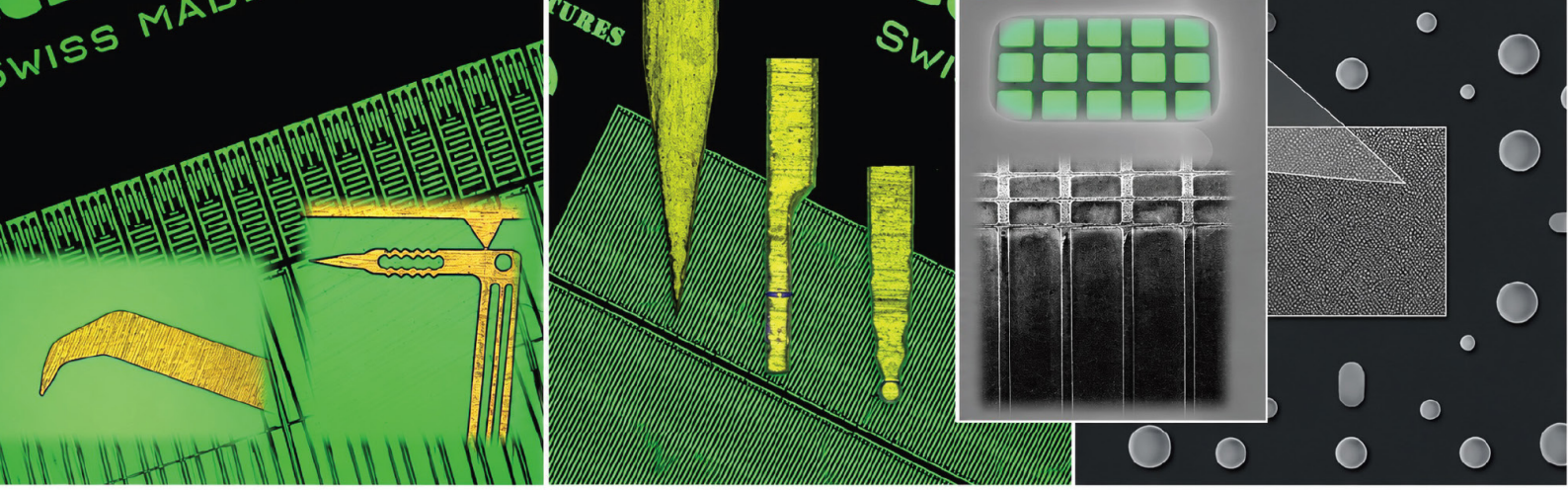


Figure 2: Illustration of probes and guide plates made by 5-axis laser cutting. Left, center: cantilever and vertical probes. Right: ceramic guide plate (vignet: SEM image of square holes with A/R of 1:10).

Samuel Benketaf

FROM VERTICAL PROBES TO MEMS PROBE: A CHANGE OF PARADIGM IN THE TEST INDUSTRY?

Trend and convergences in the semiconductor industry

Compelled by Moor's scaling law, the semiconductor industry shifted toward 3D multi-layer circuits for building system-on-chip. Despite the high degree of sophistication of the latest lithography machinery, fabrication isn't yet without defects. Probing is an essential and crucial step in value generation. The challenge there is threefold: achieving smaller pads, higher density, and longer lifetime of a test system. The wafer probing industry also is mutating to keep up with the growth of the volume and with the changing requirements. This article explains wafer-probing techniques (vertical and MEMs probes) and compares their fabrication processes.

What is wafer probing?

Wafer probing consists of touching contact points with tiny needles (probes) and reading electrical signals with a circuit analyser (ATE). A steady force is maintained on the probes onto the substrate. A fixtureless, flying probe robotic station can do low volume; For greater parallelism, a probe card is deployed. At the core of it is an array of probes. The pad layout is inherent to the design and mode of action of probes (Figure 1). Cantilevers flex under load: the tip "scrubbing" the surface. Vertical probes buckle; therefore, their lateral scrub is shorter, which makes them compatible with array probing contrarily to cantilever probes, which are limited to peripheral rows. Despite its merit, the size is limited due to mechanical considerations. An assembly of precision plates

(usually ceramics)ensures guiding and accurate positioning. The probe card is built by inserting the needles into the tiny holes; a task still often executed by skilled hands. Hence, probes count in the range of “many thousands”. Traditional probes can be cut directly from precious metal alloys by Laser. For that purpose, 5-axis galvo-scanners are fast (several mm per second), and the precise control of the Laser angle of incidence yield straight edges and 2.5 D features (beveled tips). The same can also drill ceramic guide plates at the rate of one second per hole (Figure 2). This versatile tool is a reliable workhorse for probe card makers. The state of this art attains over 150k hole at a pitch of 50 µm or less with process accuracy of ± 2 µm.

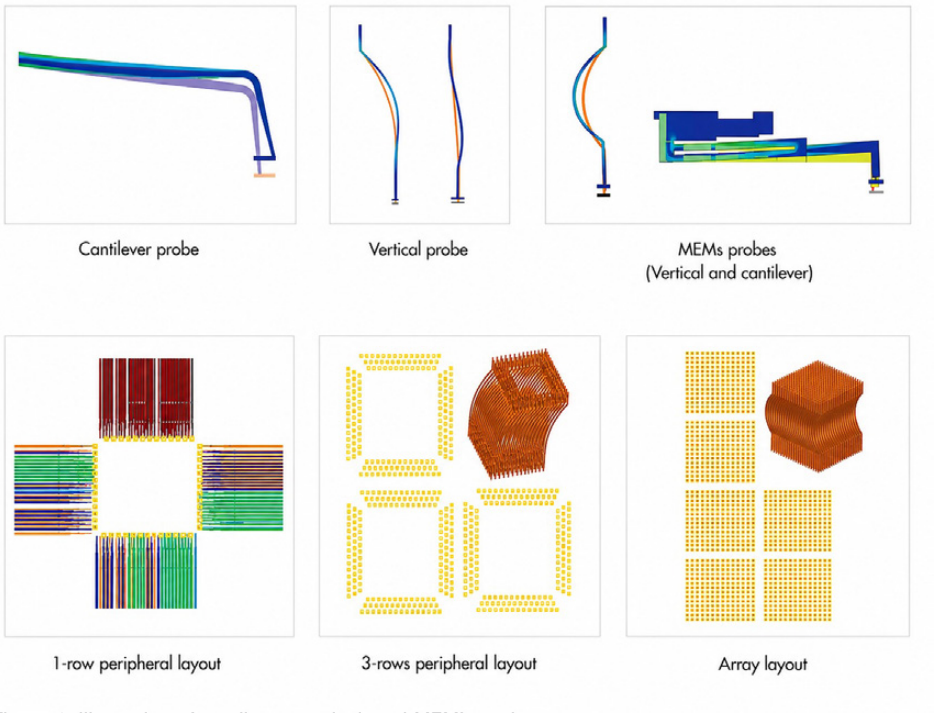


Figure 1: Illustration of cantilever, vertical, and MEM’s probes. Upper row: Deformation under load and lateral scrub. Lower row: pad configurations. Illustrations adapted from Tunaboylu, B., & Soydan, A. M. (2018).

Overcoming the challenge of probing fine-pitch grid arrays

The MEMS probes leverage the lithography process, which offers significant gain in parallelism while making pitch < 30 µm attainable. The wafer-layer depositions and etching generate large batches in a highly reproducible manner. The 3D geometries are written with a resolution of 1 µm by maskless raster-scanning exposure. Moreover, the iterative process and the multi-material capability facilitate the optimization of mechanical and electrical characteristics. Another key advantage of MEMS process is the batch-transfer of the probes to a multilayer substrate (MLS) by the flip-chip method (thermal reflow, followed by the etching-release). Also called a space transformer, this miniature circuit interfaces the tiny probes (on one side) with larger bump connections on the other side. In figure 3, a typical probe-card is shown, where precision interposers and guide-holes finalize the assembly.

Conclusion

The market for wafer-test is likely to continue to grow along with the semi-conductor industry. Traditional vertical probe is a mature art of engineering, mostly sustained by chemical process (etching) or laser cutting machines. MEMS technology enables the mass-replication of probes and quick assembly onto multi-layer carriers by flip-chip bonding. Although the infrastructure is heavier, it is a cost-effective solution for the most demanding test requirements. The next evolution is toward probing of photonics chips, for which the MEMS process is likely to enable innovative solutions.

POSALUX SA, Biel/Bienne 6, CH
https://www.posalux.com/

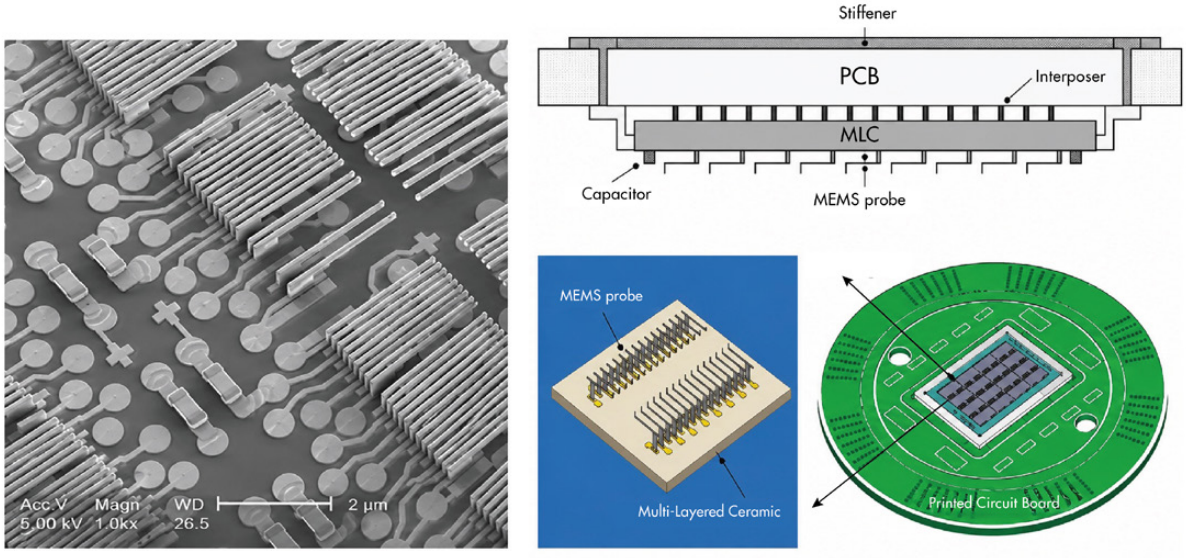


Figure 3:. Illustration of MEMs probes and MLC. Illustration from Kim, B., Kim, J., & Kim, J. (2009).

Sami Suihkonen

NEW GENERATION OF SEMICONDUCTOR TECHNOLOGIES FOR INTERNATIONAL MARKETS

The deployment of new generation Wide Band-Gap (WBG) semiconductors that reduce electricity consumption and carbon dioxide emissions will increase globally with electrification of mobility, renewable energy and industry. The WIBASE project coordinated by VTT has been launched in Finland to develop WBG technologies for power electronics applications. Participants in the project include leading semiconductor and power electronics companies and research organisations.

Benefits of WBG technology for everyday life

WBG semiconductors enable more energy-efficient electric cars, fast charging stations, smart electrical grids, smaller and more efficient everyday devices and more reliable electricity grid solutions. For consumers, this can mean a longer driving range for electric cars, faster charging and more energy efficient household appliances.

WIBASE accelerates development and commercialisation

The WIBASE project is developing WBG material and component processing, prototyping, testing capabilities and life-time modelling. The aim is to accelerate the adoption of WBG technology, improve expertise and the availability of workforce, and facilitate the commercialisation of technology. The project consortium covers the full value chain of WBG power electronics from semiconductor materials and components to end applications. In addition to VTT, Aalto University, LUT University, University of Helsinki, ABB, Applied Materials, Comptek Solutions, Danfoss, Kempower and Okmetic are involved in the project.

"The WIBASE project is building an expertise cluster in Finland to cover the entire value chain from semiconductor materials to end applications. This will improve our self-sufficiency and competitiveness in the global semiconductor and power electronics market. WBG expertise will enable surprising breakthroughs and new business opportunities," states Sami Suihkonen, Senior Scientist at VTT and WIBASE project manager.

“Wide Band Gap (WBG) expertise will enable surprising breakthroughs and new business opportunities.”

Supporting electrification and EU climate goals

Power electronics systems play a key role in the electrification of society in areas like industry, transport and energy storage. WBG semiconductors can significantly reduce the electricity consumption and carbon dioxide emissions of systems, which supports the EU’s Green Deal targets.

New capabilities, innovation and market opportunities

The competencies and testing capabilities developed in the WIBASE project will allow Finnish companies to quickly access rapidly growing international markets. This will simultaneously provide the foundation for new innovations, startups and new workplaces. The project is developing and combining several cutting-edge technologies, such as WBG semiconductor materials, new component structures, packaging and integration technologies, reliability testing and international research collaboration. These solutions are designed to address industry challenges, such as material and component reliability issues, a lack of testing and validation capabilities, and the availability of skilled workforce.

Market outlook and project funding

The first commercial applications for WBG technologies have already been introduced, and wider deployment is expected to begin in 2028-2030. Applications for new Ultra Wide Band-Gap (UWBG) materials are expected to arrive on the market within 5-10 years. The three-year WIBASE project is funded by Business Finland. The total project budget is EUR 11 million.

VTT, Technical Research Centre of Finland
https://www.vttresearch.com/en

Source photos in this article: Microtec Academy I Hug.S photography

Jana Mönner

THE TALENT RACE IN MICROTECH

Insights and Strategic Signals from the MICAFO 2026 Workforce Conference in Dortmund

Micro- and nanotechnology have become foundational technologies of the modern economy. Invisible to most consumers, yet essential to nearly every innovation, microelectronic systems power advances in medical devices, automotive engineering, industrial automation, and next-generation communications. But while the technology continues to evolve at remarkable speed, the industry is facing a challenge that may ultimately define its future competitiveness: the growing shortage of highly qualified talent.

At the MICAFO Workforce Conference 2026 in Dortmund, industry leaders, research institutions, universities, and training organizations came together to address exactly this issue. Over two days, the event evolved into far more than a conventional conference. It became a working platform for shaping the future workforce strategy of Europe's microtechnology ecosystem.

From Operational Challenge to Strategic Priority

One message became unmistakably clear throughout the conference: workforce development is no longer an HR issue alone. It has become a strategic industrial imperative.

As semiconductor and microelectronics technologies become increasingly complex, companies require specialists with interdisciplinary expertise spanning engineering, materials science, automation, AI-supported manufacturing, and digital production systems. At the same time, demographic change, shifting educational pathways, and global competition for talent are shrinking the available workforce pool.

This structural transformation is driving a new approach to talent development across the sector.

At the center of many discussions was the European initiative Skills4Chips (S4C), which aims to establish a resilient talent ecosystem that supports qualification pathways across the entire educational chain – from early career orientation to advanced professional training.

Prof. Dr.-Ing. Patrick Scheele, Scientific Managing Director of the Ferdinand-Braun-Institut (FBH), summarized the ambition succinctly:

"Our goal is to strengthen Germany's microelectronics ecosystem sustainably. The Microtec Academy is creating a unique network that brings together all relevant stakeholders."

The emphasis is shifting from isolated educational programs toward interconnected, modular, and highly collaborative qualification structures that can adapt to rapidly evolving industry requirements.

Reinventing Technical Education for the Semiconductor Era

One of the most forward-looking discussions at MICAFO focused on the future of technical education itself.

The planned modernization of the German "Microtechnologist" vocational profile reflects how deeply manufacturing environments are changing. But the transformation extends far beyond curriculum updates. New technologies are fundamentally reshaping how technical expertise is transferred and acquired.

Virtual reality simulations, digital learning platforms, and blended learning concepts are increasingly being integrated into industrial qualification models. These technologies allow complex semiconductor and microfabrication processes to become more accessible, visual, and scalable – independent of location and increasingly aligned with real industrial workflows.

The conference repeatedly highlighted a critical realization: traditional training models alone

> **“The growing demand for skilled workers can only be met through new qualification pathways across the entire educational chain”**

will not be sufficient to meet future demand. As one recurring theme throughout the workshops stated: “The growing demand for skilled workers can only be met through new qualification pathways across the entire educational chain.”

Collaboration as an Innovation Infrastructure

Another key takeaway from Dortmund was that workforce development cannot succeed in isolation.

The newly established Microtec Academy represents a strategic attempt to institutionalize collaboration across industry, academia, and research organizations. Its mission is to create scalable educational frameworks, foster knowledge transfer, and accelerate the development of future talent pipelines.

The initiative is supported by a broad consortium of organizations representing the entire value chain of the microtechnology sector, including:

- Ferdinand-Braun-Institut (FBH
- IVAM Microtechnology Network
- microTEC Südwest e. V.
- Otto-von-Guericke University Magdeburg
- Kaiserslautern University of Applied Sciences
- Technical University of Braunschweig
- RBZ Steinburg

This cross-sector diversity is particularly significant because it

enables direct transfer between research, industrial practice, and educational implementation – a prerequisite for maintaining innovation speed in semiconductor-related industries.

Or as several participants summarized during the event: "Skilled professionals are not developed in isolation – they emerge through the interaction of companies, education, and networks."

The Visibility Problem: Winning the Next Generation

Beyond qualification, another issue emerged as increasingly urgent: visibility.

Despite its enormous relevance for future technologies, micro- and nanotechnology remain largely invisible to many young professionals and career changers. The industry suffers from a perception gap – not from a lack of technological relevance, but from insufficient public awareness.

Initiatives such as beHighTech.de aim to address this challenge by making career opportunities within the sector more tangible and accessible. By highlighting real career paths, educational opportunities, and industry applications, the platform seeks to connect the next generation with one of Europe's most strategically important industries.

A statement repeated throughout the conference captured the urgency of the issue: "We must make technology tangible – otherwise we will not reach the next generation."

Looking Ahead: MICAFO 2027

The organizers emphasized that MICAFO 2026 should be understood not as a conclusion, but as the beginning of a longer-term transformation process. The next conference is already scheduled for March 3–4, 2027, in Freiburg, where stakeholders will continue working on scalable workforce strategies, educational innovation, and long-term ecosystem development.

Human Capital as the Defining Competitive Factor

Europe's microtechnology industry is technologically strong. But its future leadership will not be determined solely in laboratories, fabs, or cleanrooms. It will be determined by the industry's ability to attract, educate, qualify, and connect people.

MICAFO 2026 demonstrated that the sector has recognized the scale of the challenge – and that it is increasingly willing to rethink traditional structures in response.

> **"We must make technology tangible – otherwise we will not reach the next generation."**

In the end, the conference delivered one central insight: The future of microelectronics will not be shaped by technology alone – but by the people capable of creating it.

Microtec Academy, Berlin, DE
https://microtec-academy.de
IVAM Microtechnology Network
https://www.ivam.de

The researchers tested various interconnection pitches to evaluate the reliability of NPG for different chip sizes and contact pad geometries of the GaN chips. Source: Fraunhofer IZM | Volker Mai

GALLIUM NITRIDE PLAYS A KEY ROLE IN GREENER ELECTRONICS

Anove A significant reduction in energy consumption and CO_2 emissions through modular and easy-to-integrate GaN power semiconductors - this is the objective of the EU-funded All2GaN project. Forty-five partners from twelve countries are collaborating to unlock the energy-saving potential of gallium nitride (GaN) semiconductors for a broad range of industrial applications. Fraunhofer IZM plays a key role across the value chain: leveraging its internationally recognized expertise in packaging technologies, the institute is developing innovative assembly solutions that are essential for the performance, miniaturization, and sustainability of next-generation GaN electronics.

The researchers tested various interconnection pitches to evaluate the reliability of NPG for different chip sizes and contact pad geometries of the GaN chips Gallium nitride is regarded as one of the most promising semiconductor materials for future electronic systems. Compared to silicon, GaN enables higher power densities, lower switching losses, and higher operating frequencies - providing decisive advantages for applications in telecommunications, data centers, e-mobility, renewable energy, and smart grid technologies.

The components developed within the All2GaN project ("Affordable smart GaN IC solutions for greener applications") are being evaluated in eleven industrial use-case demonstrators to systematically assess their efficiency potential. Across all use cases, the researchers expect to achieve an average reduction in power losses of around 30 percent. In addition, the project aims to establish an integration toolbox that will pave the way for a new generation of modular, easy-to-integrate GaN power semiconductors.

The development of suitable interconnection technologies for printed circuit boards is essential to fully exploit the advantages of gallium nitride in real-world applications. While other project partners are investigating conventional soldering approaches and sintering technologies, the scientists at Fraunhofer IZM are focusing on thermocompression - a process particularly well suited for fine-pitch applications with dimensions below 10 µm.

Nanoporous gold as a game-changer for fine structures and reliable interconnections

A central role is played by the nanoporous gold (NPG) developed at Fraunhofer IZM. It consists of a three-dimensional network of nanoscale gold ligaments created through the selective dissolution of silver from a gold-silver alloy. As the miniaturization of microelectronic systems continues to advance, NPG is increasingly attracting attention as a promising material for next-generation assembly technologies.

NPG is considered a highly promising alternative to conventional joining methods, opening up new possibilities for reliable assembly technologies. It enables solder-free interconnection for direct chip attachment on organic printed circuit boards and, thanks to its sponge-like structure, provides a significantly broader process window than traditional soldering approaches. Its unique deformation behavior allows for highly precise and dependable connections even within extremely confined spaces. At the same time, the porous structure efficiently compensates for relatively large topographical variations between the joining partners. Another major advantage lies in the material's exceptionally large specific surface area, which enables material-bonded interconnections at comparatively low temperatures. This considerably reduces thermal stress on sensitive components.

As a result, nanoporous gold is emerging as a forward-looking material for high-precision applications, particularly in areas where conventional soldering

> **"Semiconductor technologies for energy-efficient gallium nitride electronics"**

technologies are approaching their physical and technological limitations

Greater efficiency and sustainability through innovative material and system approaches

In addition to technological innovation, sustainability is a central focus of the project. All2GaN forms part of the European strategy to support the objectives of the Green Deal by developing energy-efficient and resource-saving technologies.

GaN-based circuits can make a direct contribution to reducing energy consumption by minimizing power losses. At the same time, advanced packaging approaches - such as the use of nanoporous gold - enable more material-efficient integration while also extending component lifetime.

The projected energy-saving potential is substantial: with the widespread adoption of GaN-based circuits, around 86 TWh of energy could be saved annually within the EU alone over the long term. This corresponds to approximately 43 megatons of CO_2 emissions per year. On a global scale, the savings potential could reach 218 megatons of CO_2 annually - roughly equivalent to the yearly emissions of a medium-sized industrialized nation such as Spain.

Fraunhofer Institute for Reliability and Microintegration IZM

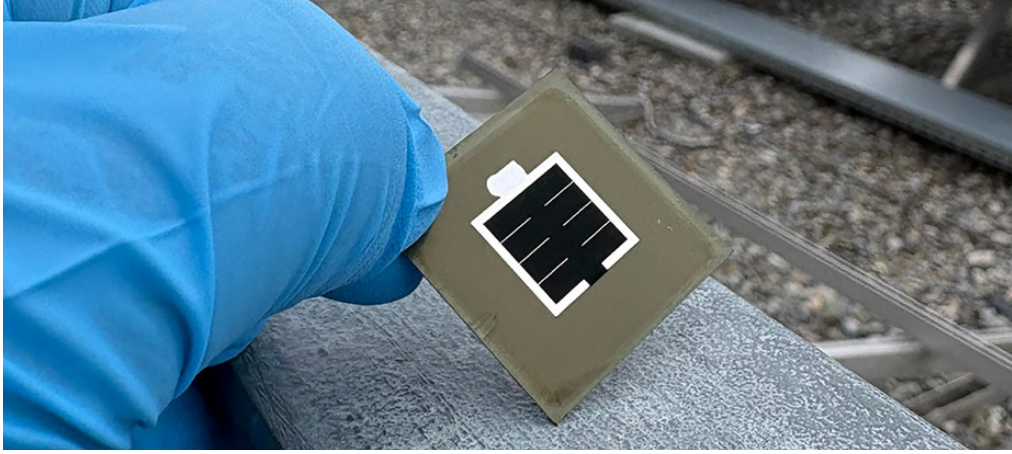
http://www.izm.fraunhofer.de

The triple-junction solar cell (54 cm²). © Kerem Artuk

Celia Luterbacher

RECORD EFFICIENCY FOR PEROVSKITE-SILICON TRIPLE-JUNCTION SOLAR CELLS

EPFL and CSEM researchers have achieved a record 30% efficiency for triple-junction solar cells, which combine two thin-film perovskite cells and one silicon cell on a single device. The milestone could advance affordable next-generation solar technologies for space and terrestrial applications.



The triple-junction solar cell (1 cm²). © Kerem Artuk

Researchers from the Photovoltaics and Thin-Film Electronics Laboratory (PV-Lab) in EPFL's School of Engineering and CSEM have developed a new solar cell that combines exceptional voltage, high efficiency, and scalable manufacturing. The triple-junction device is composed of a silicon bottom cell, onto which middle and top cells made of semiconductors called perovskites are deposited as thin films. The new device, according to the paper published in Nature, achieves an independently certified efficiency of 30.02%, surpassing the previous certified record of 27.1%.

First author Kerem Artuk, an EPFL PhD graduate now working at CSEM, says the achievement demonstrates how advanced materials and optical engineering can yield efficiencies and voltages on a par with the solar cells used in space applications – but potentially at a fraction of their cost.

"We show that with clever design and processing, we can approach performance levels traditionally reserved for the most expensive III-V multi-junction solar cells used in space, which are composed of multiple semiconductor layers. These can reach up to 37% efficiency, and cost around 1,000 times more than terrestrial cells per watt. Our approach opens the door to a new generation of industrially viable, high-efficiency multi-junction photovoltaics."

"Our first demonstration in 2018 had only 13% efficiency, so reaching over 30% efficiency today in a triple-junction device is a remarkable achievement," adds PV-Lab head Christophe Ballif. "Triple-junction solar cells have an even higher efficiency potential compared to single junction and tandem – well above 40%."

A barrier-breaking architecture

The team addressed two limitations of triple-junction solar cells: low voltage in the top perovskite cell and low current generation in the middle cell. They solved these challenges with three novel tweaks to their device's material and optical design. First, they added a molecule that guides perovskite crystal formation and eliminates defects, enabling the top cell to create a higher voltage (1.4V) under sunlight. Second, they developed a new three-step method to fabricate a middle cell that improves light absorption in the near-infrared part of the solar spectrum. Finally, they added nanoparticles between the bottom silicon cell and the middle perovskite cell that reflect additional sunlight back into the middle cell, further boosting its current.

Toward affordable high-efficiency solar energy

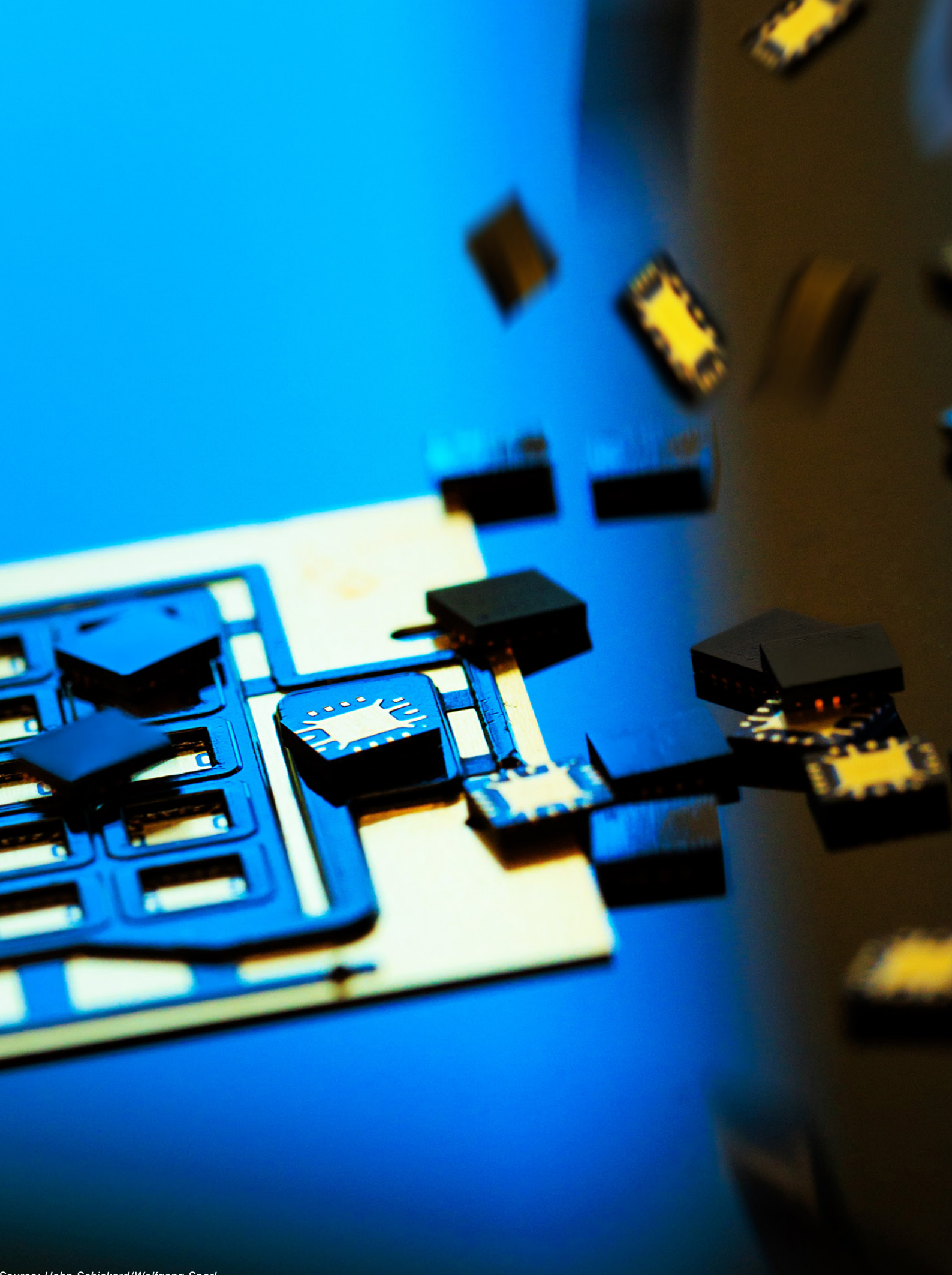
Both perovskite and silicon are cheaper to manufacture than the most efficient III-V semiconductor solar cells available today, which are based on expensive materials and are mostly used to power satellites. Developing solar cells that can reach this level of efficiency at a much lower cost could enable the development of next-generation solar technologies for use at the utility and residential scale, or for space applications.

EPFL team leader Christian Wolff says that they'll continue to explore scale-up strategies for manufacturing with partner CSEM, as well as durability testing and integration into future commercial products. "This project illustrates the power of combining fundamental science with Swiss engineering know-how," he says. "By demonstrating that low-cost perovskite materials can approach the performance of the most advanced space-grade photovoltaics, this research sets a new benchmark for multi-junction photovoltaics."

CSEM Centre Suisse d'Electronique et de Microtechnique SA

https://www.csem.ch/en

"Triple-junction solar cells have an even higher efficiency potential compared to single junction and tandem – well above 40%."



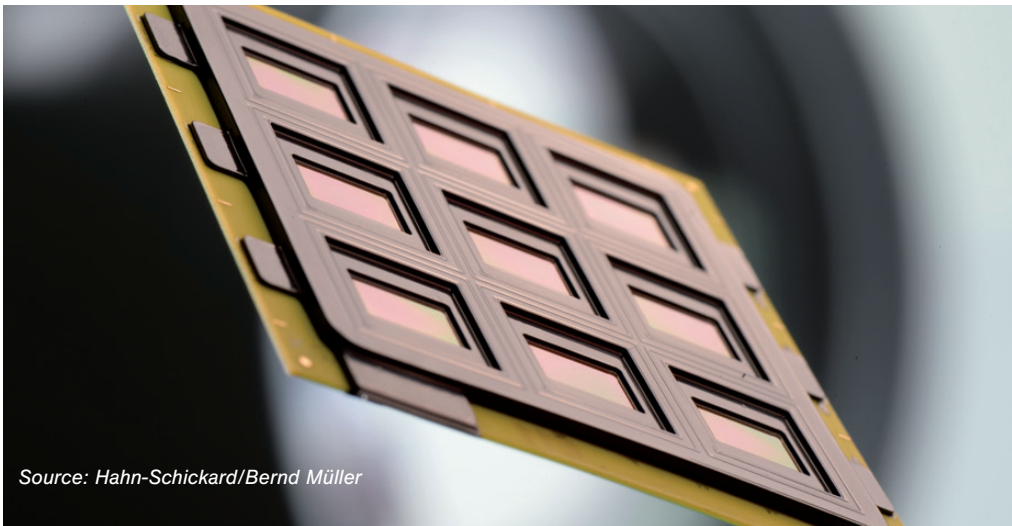
Source: Hahn-Schickard/Wolfgang Sperl

Maximilian Barth

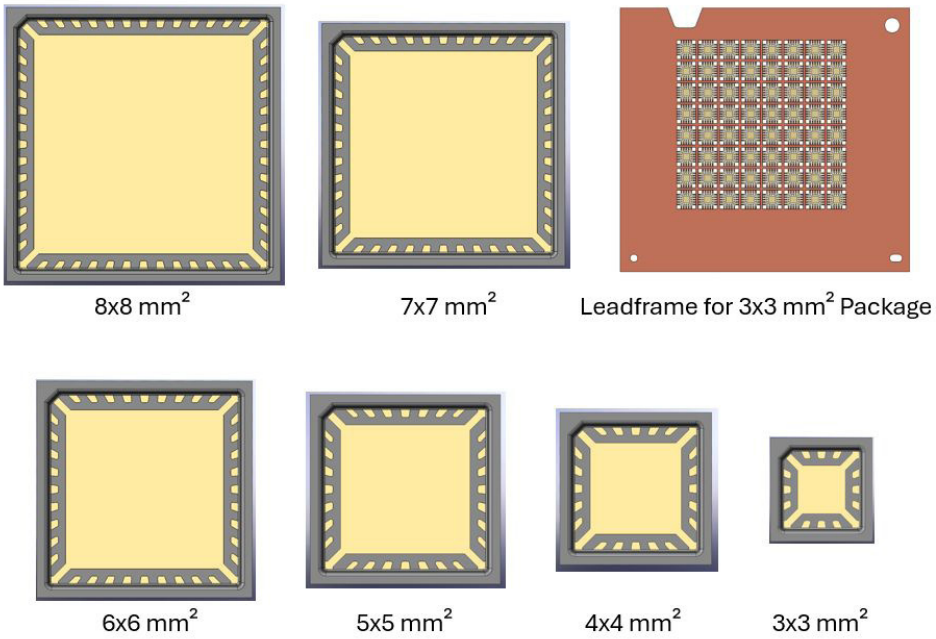
FLEXIBLE CHIP PACKAGING PLATFORM BASED ON FILM-ASSISTED TRANSFER MOLDING

Packaging is a key aspect of the manufacturing process chain of every component based on microelectronics, micro electro-mechanical systems or optoelectronics. While there are offerings for high volume production in Asia which offer affordable and technologically advanced solutions for packaging, this is often not the case for businesses having small to medium volume applications up to 100k pieces or who are on a tight schedule. For fast turnaround packaging solutions with the possibility to include customer specific designs or features, Film Assisted Transfer Molding (FAM) represents a packaging solution for a wide range of applications. Standard quad-flat-no-lead (QFN) footprints with or without air cavity, as well as custom individual designs with specific technical requirements can be realized and locally sourced only if there is an established process chain available which often includes the following steps:

- Leadframe manufacturing
- Transfer molding
- Plating finish
- Die attach
- Wire bonding
- Lid assembly
- Package dicing



Source: Hahn-Schickard/Bernd Müller



High frequency applications

For packaging MMIC devices and other high frequency components, careful design of the interface between die, package and substrate leads to minimal signal loss and high performance of the assembly. Customer specific air cavity packages are an effective solution to create a smooth transition from chip level to board level while also minimizing loss related to the active area of the chip itself. The AQFN platform offered by Hahn-Schickard provides standard QFN sizes between 3x3 mm² and 8x8 mm² in combination with individual leadframe designs without the need for expensive re-tooling. These packages enable low signal losses and design freedom for applications with high operating frequencies up to 40-70 GHz as well as economic feasibility for low to medium volumes.

To achieve the low inductance necessary for high frequency applications, special wire bonding geometries are used. Feasible designs include multiple short wire bonds connected to a single pad combined with low loop height. Compared to off-the-shelf packaging solutions, an individual design with the possibility to geometrically adapt the package to the exact positions and requirements of RF interfaces on the chip enables even higher operating frequencies.

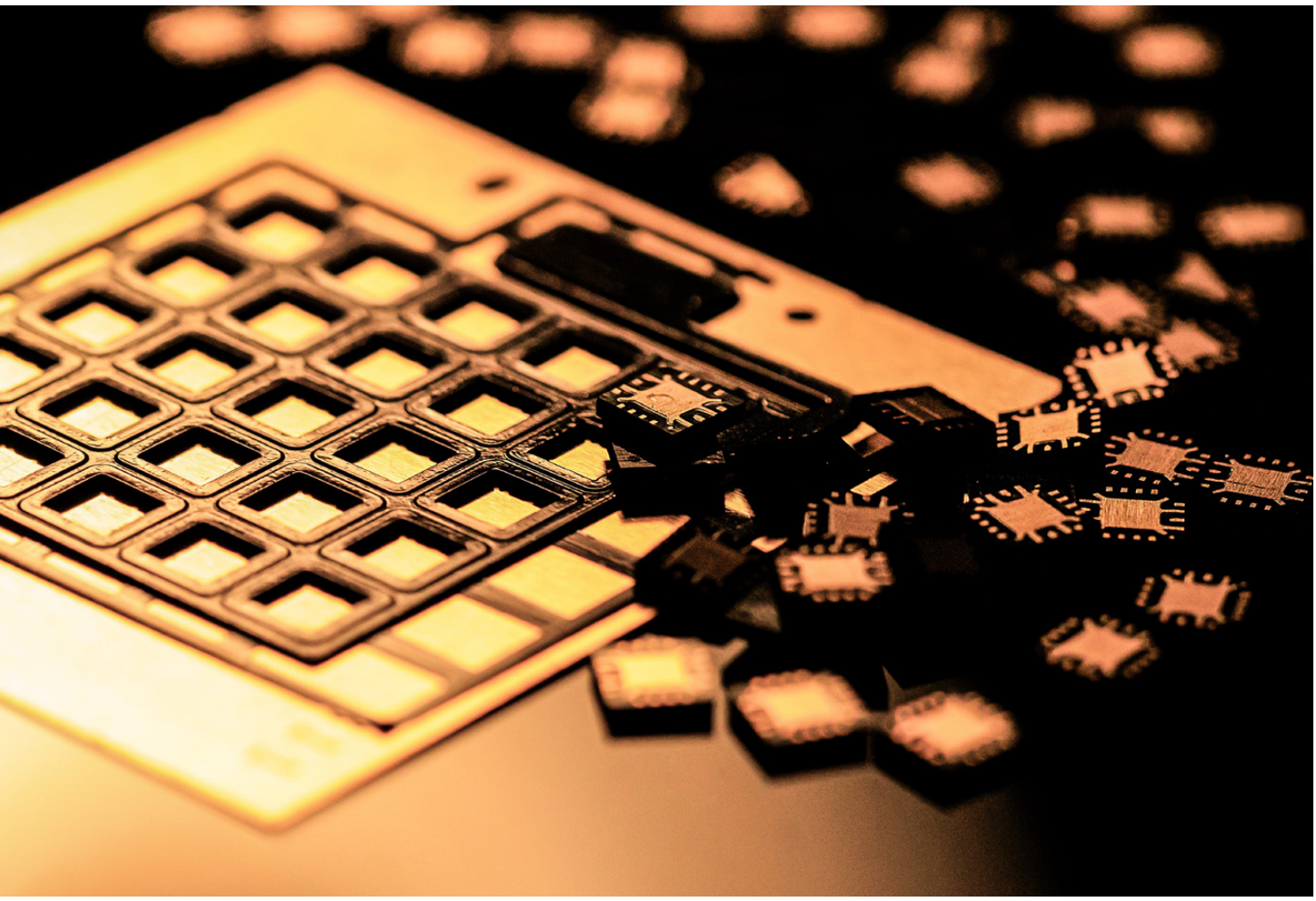
The use of a solid copper leadframe in the area of die attach enables high power density when compared with laminate-based approaches for packaging. For example, in devices like amplifiers the individual chip can have multiple watts in a very small footprint of a few millimeters. Combining a 0.2 mm thick copper leadframe with a thin bond line and a high-performance adhesive for die attach, the AQFN platform is very close to the optimum.

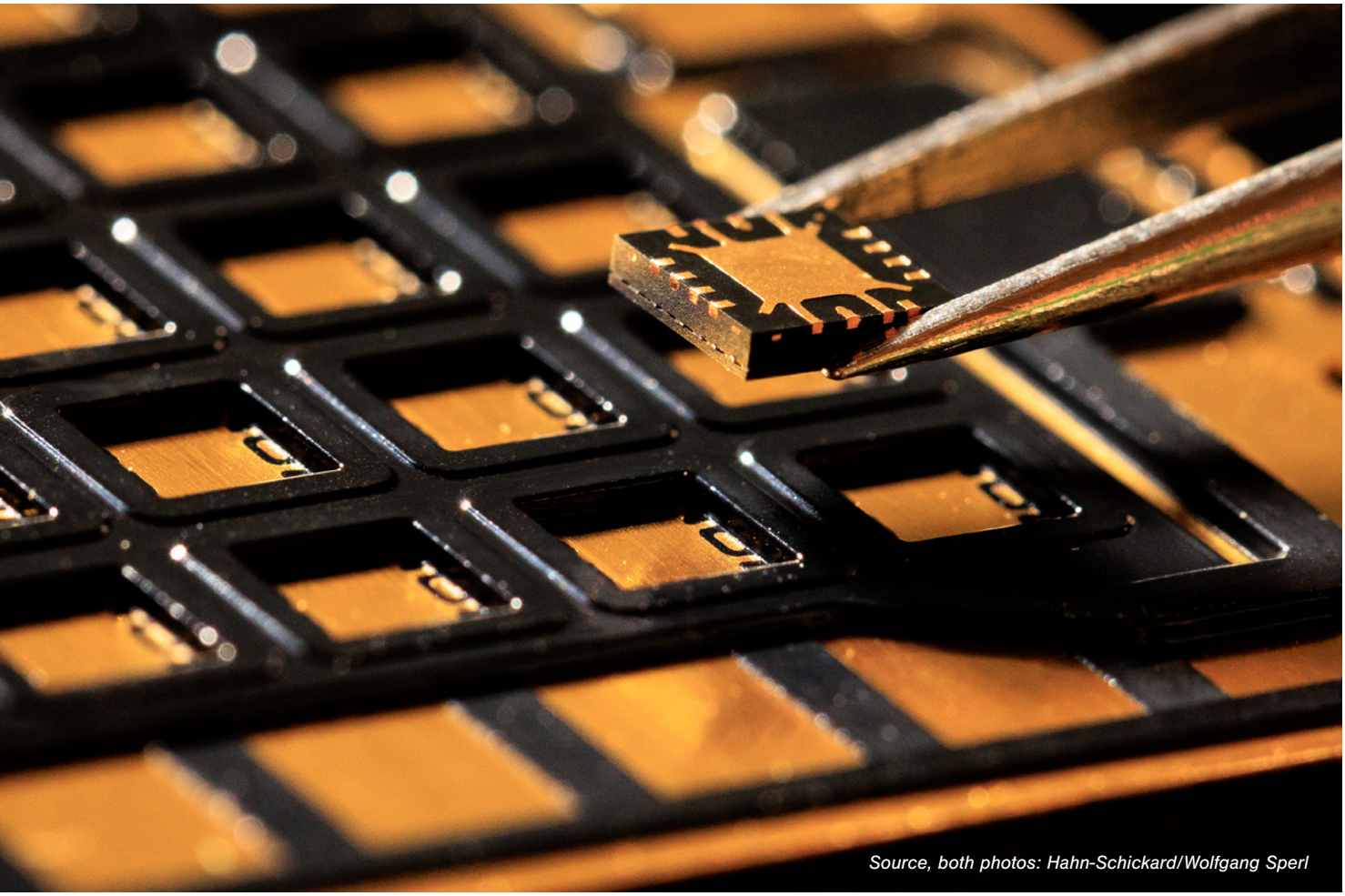
Power electronics

Mold modules offer high potential for integrating packaging solutions for intelligent power electronics and represent a promising alternative to conventional frame-based power modules. One of their key advantages is the integration of functionality directly into the power package. For example, embedding IC drivers enables additional functionality such as EMI-safe control, overload protection, and can contribute to reduce the overall size of an inverter.

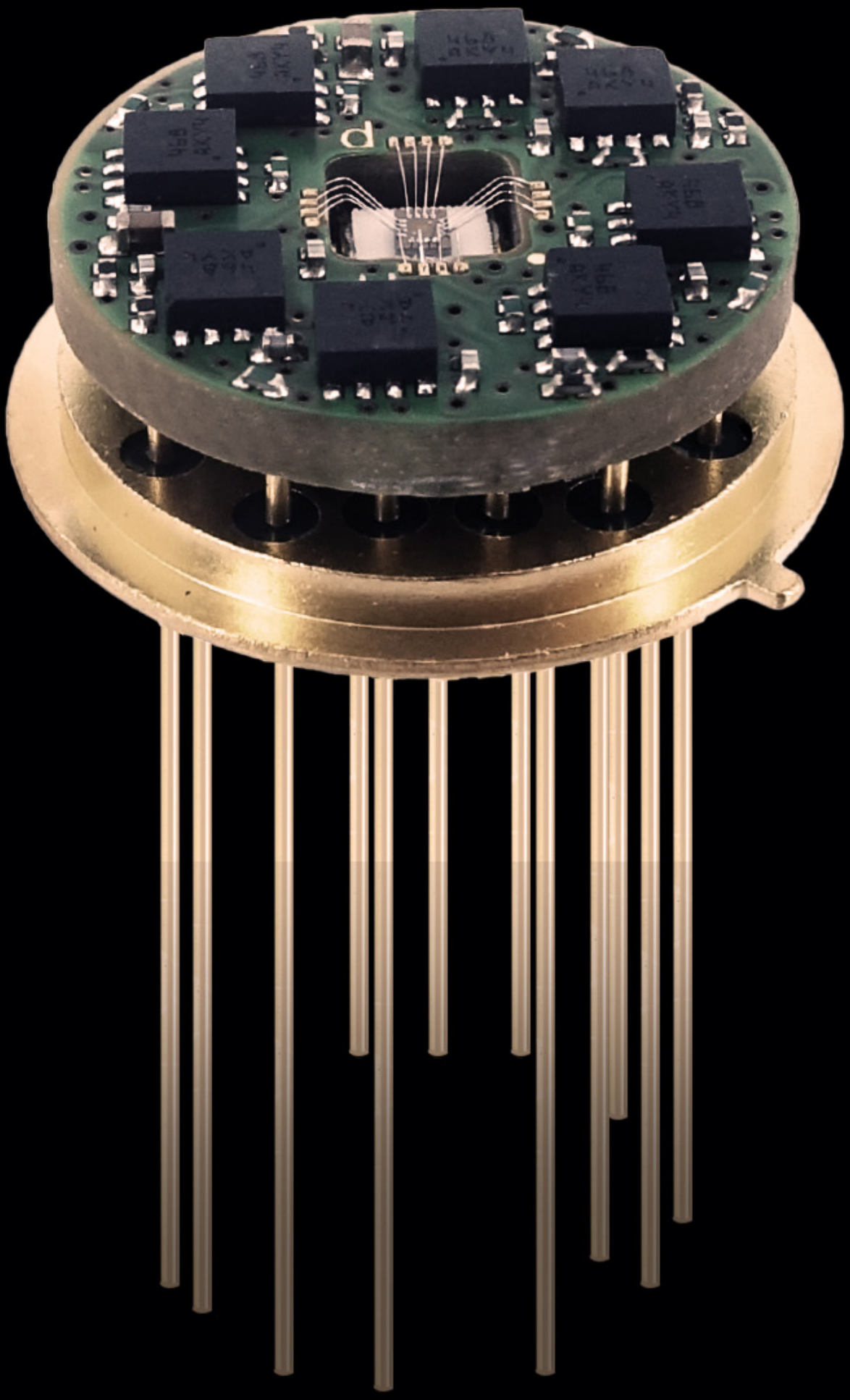
However, this approach comes with increased effort in packaging and tool design, as well as challenges with warpage of substrates like AMB (Active Metals Brazing) and DBC (Direct Bonded Copper). In this context, FAM enables advantages, including lower tooling requirements and improved compensation of tolerances. In combination with new substrate materials such as anodized aluminum, molded power modules represent a strong alternative to traditional solutions, delivering improved system-level performance through double-sided or integrated cooling, further miniaturization, and minimized parasitic paths.

Hahn-Schickard-Gesellschaft für angewandte Forschung e.V.
https://www.hahn-schickard.de





Source, both photos: Hahn-Schickard/Wolfgang Sperl



Michael Hahn I Laura Turck-Hahn

NEW QKD RECEIVER SHRUNK TO COIN-SIZED MODULE

Quantum computers are advancing faster than expected, and conventional encryption faces an uncertain future. Quantum Key Distribution offers a physically secure alternative: if a photon is intercepted or measured in transit, its quantum state changes and the listening attempt becomes detectable. The technology has been researched over the past years with a few players in the market. Sensors for single photon counting require to reach further degree of miniaturization to enable industrial scale. duotec GmbH addresses this directly with a highly miniaturized QKD sensor that combines a four channels single-photon avalanche diode (SPAD) with integrated polarization filters, thermal management, and a fast analog-digital front end in a TO-8 package - roughly the size of a one-cent coin.

Why size is a functional parameter

Single-photon detection generates extremely short electrical pulses. These pulses must travel from the SPAD to the signal-conditioning electronics with minimal distortion. Long interconnects introduce parasitic inductance and capacitance into the signal path, which can broaden, attenuate, or shift pulses in time. In QKD, such effects are critical: secure key distribution depends on precise detection, accurate timing, and reliable evaluation of polarization states. By placing SPADs, polarization analysis, cooling, and the analog-digital front end in close proximity within one assembly, duotec reduces these parasitic effects and directly supports signal integrity. Here, miniaturization is not only a mechanical advantage, it is a functional requirement.

Four channels in a standard package

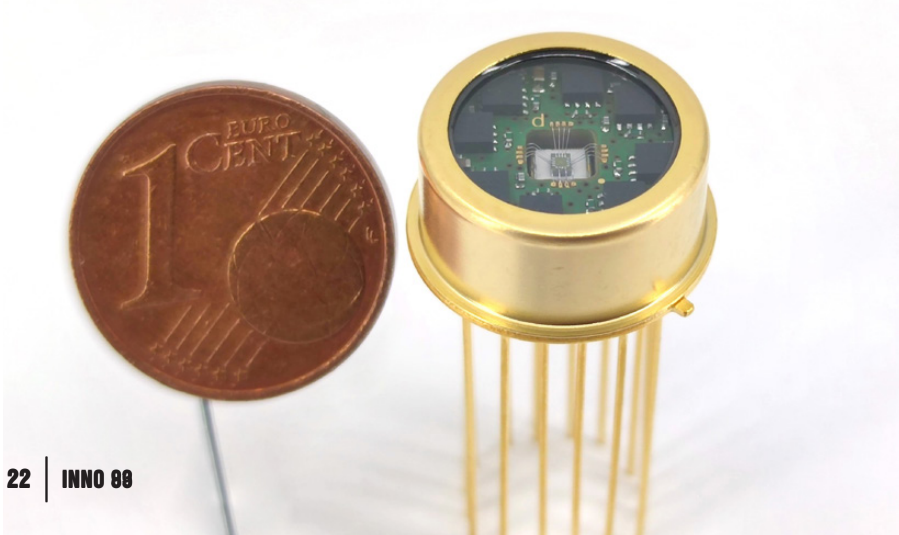
The TO-8 format shows the degree of miniaturization possible already today. It brings together photonics, sensor technology, thermal management, and electronics in a form factor familiar to optoelectronic manufacturing. Four channels address the different polarization states used in common QKD protocols, without the need for separate receiver modules. An integrated two-stage Peltier element stabilizes the thermal operating point of the SPADs, supporting low dark-count rates. A fast four-channel amplifier/comparator converts detector pulses into standardized LVDS output signals, simplifying integration with downstream electronics, FPGA logic, or QKD system controllers and reducing both interface effort and integration risk.

From laboratory instrument to system component

Conventional single-channel SPAD detectors occupy housings of around 133 x 95 x 95 mm. The duotec assembly consolidates four detector channels and all functional periphery into the TO-8 size class, a fundamentally different integration approach that shifts QKD hardware from stand-alone laboratory instruments to embeddable components. Target applications include quantum-secured telecommunications, critical infrastructure, finance, government communication, and aerospace, as well as secure exchange of sensitive patient data in medical environments. For European system integrators, the compact and standardized design also supports series production, supply-chain control, and reduced wiring effort.

A building block for industrial quantum communication

The QKD sensor is part of duotec's Single Photon Counting Platform. As quantum-safe communication moves from research programs into real-world deployment, components at this scale help bridge the gap between laboratory demonstration and market-ready products. For device developers, the combination of four integrated channels, thermal stabilization, and standardized digital outputs reduces system complexity and brings the transition from experimental quantum optics to manufacturable, certifiable hardware a step closer.



duotec GmbH develops and manufactures customized electronics and mechatronic assemblies. With its Single Photon Counting Platform, the company targets applications in secure communications, medical technology, and critical infrastructure by combining optoelectronic integration, miniaturization, and production-compatible packaging.

duotec GmbH
https://duotec.com

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SENSOR NETWORK SYMPOSIUM 2026: DISCOVER CROSS-INDUSTRY SENSOR INNOVATION

On October 1, 2026, IVAM, together with the regional networks detect and OpTecBB, invites technology experts, developers, and researchers to the Sensor Network Symposium 2026 in Berlin-Adlershof. An informal networking event on September 30 offers the perfect opportunity to make first connections ahead of the symposium.

The event focuses on current trends and practical applications in sensor technology, with special sessions on quantum sensing, civil security and dual-use applications, aerospace sensing, environmental monitoring, and sensor solutions for harsh environments. In addition to keynote presentations and expert discussions, the hands-on session "Sensor Technology Up Close" will showcase innovative sensor solutions and provide direct access to the developers behind them.

Save the Date: October 1, 2026 | Berlin-Adlershof, Berlin

https://www.ivam.de/events/sensor-network-symposium-2026

FUNDED MARKET ENTRY TO JAPAN FOR SEMICONDUCTOR COMPANIES

European semiconductor companies planning to expand to Japan are invited to a free online webinar on 15 July 2026 (12:30 CET). The session presents the funded EU Business Hub @ Semicon Japan 2026 mission in Tokyo, offering SMEs and startups financial support for exhibition costs, accommodation, matchmaking and market entry services. The business mission will take place from 7-11 December 2026 during SEMICON Japan 2026. Application deadline: 11 September 2026.

REGISTRATION FOR FREE

AIXTRON R&D-SYSTEM SELECTED AS CENTERPIECE OF PENN STATE'S NEW ADVANCED SEMICONDUCTOR LABORATORY

p AIXTRON SE (FSE: AIXA) has announced that its Close Coupled Showerhead™ (CCS) R&D system will serve as the centerpiece of a new advanced semiconductor research facility at Penn State's Materials Research Institute (MRI).

The new laboratory, located in the Millennium Science Complex at University Park, is being established through $4.3 million in funding and in-kind support provided via the Midwest Microelectronics Consortium (MMEC) under the U.S. CHIPS Act. It will expand Penn State's capabilities in next-generation semiconductor materials and device research. At the core of the facility is AIXTRON's CCS deposition system, an epitaxial growth platform capable of producing ultra-high-quality semiconductor layers on substrates up to 100 mm in diameter. The system is configured for both gallium nitride (GaN) materials, used in high-performance power electronics, and two-dimensional (2D) materials with applications in logic, optoelectronics and neuromorphic computing.

"We are proud to see our technology play a central role in advancing Penn State's semiconductor R&D infrastructure," said Dr. Felix Grawert, CEO of AIXTRON SE. The facility will also serve as a national user platform for training students and early-career researchers while supporting collaboration between academia and industry. Its scalability will enable researchers to move from fundamental materials studies to prototype device fabrication, accelerating innovation in areas such as electric mobility, renewable energy and high-performance computing.

https://www.aixtron.com

LAST EXHIBITION SPACES AVAILABLE AT COMPAMED

COMPAMED 2026, the world's leading trade fair for medical technology suppliers, will once again bring together international experts, innovators, and decision-makers in Düsseldorf from 16-19 November 2026. As the ideal complement to MEDICA, the event offers a unique platform for showcasing advanced technologies, establishing new partnerships, and connecting with a global audience from the medical device industry.

A key destination within the exhibition is the IVAM Product Market "High-tech for Medical Devices" in Hall 8a. Covering more than 700 m², the joint pavilion presents cutting-edge solutions in microtechnology, nanotechnology, photonics, advanced materials, electronics, and sensor systems. Every year, international companies and research institutions use the IVAM platform to demonstrate their innovations and engage directly with OEMs, developers, and purchasing professionals from around the world.

Only a few exhibition spaces remain available for COMPAMED 2026. Companies looking to position themselves at the forefront of medical technology innovation are encouraged to secure their stand now. Exhibitors benefit from a fully serviced participation package, including stand construction, catering, marketing support, a presentation slot at the COMPAMED HIGH-TECH FORUM, networking events, and comprehensive on-site support by the IVAM team.

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

GET TO KNOW IVAM MICROTECHNOLOGY NETWORK - JOIN 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.

membership@ivam.de

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EVENTS

22-23 June 26

IVAM HIGHTECH SUMMIT 2026

Annual Microtechnology Conference “Inside Life - Engineering our Future”, Leiden NL

15 July 26

MID-WEEK COFFEE BREAK - BKB PRECISION GROUP@

Virtual technology talk between IVAM Members

15 July 26

INFORMATION WEBINAR: EU BUSINESS HUB @ SEMICON JAPAN 2026

Funded Business Mission to Japan’s Semiconductor Market

9-11 Sep 26

MEDICAL MANUFACTURING ASIA 2026

Manufacturing Processes for Medical Technology: IVAM joint booth and IVAM Marketing Award Asia Singapore SG

16 Sep 26

MID-WEEK COFFEE BREAK - MEMETIS GMBH@

Virtual technology talk between IVAM Members

23-24 Sep 26

W3+ FAIR JENA 2026

IVAM Focus Group Session at W3+ Fair in Jena

01 Oct 26

SENSOR NETWORK SYMPOSIUM 2026

From Hype to Reality: Discover Cross-Industry Sensor Innovation

21 Oct 26

MID-WEEK COFFEE BREAK - FEMTOPRINT SA@

Virtual technology talk between IVAM Members

16-19 Nov 26

COMPAMED 2026

Product Market “High-tech for Medical Devices”: A hub for high-tech solutions and medical innovations.

16-19 Nov 26

COMPAMED HIGH-TECH FORUM 2026 BY IVAM

Trade Fair Forum in Hall 8a, G40, Düsseldorf, DE

18 Nov 26

EUROPE MEETS NORTH AMERICA AT COMPAMED

Connecting High-tech for Medical Devices in hall 8a, booth G40, Düsseldorf, DE

9-17 Feb 27

MD&M WEST 2027

Medical Design & Manufacturing - IVAM presents Micro Nanotech Area in Hall C, Anaheim, CA, US

3-5 March 27

ASIA PHOTONICS EXPO 2027

Special exhibition area Photonics+ Europe powered by IVAM, EPIC and W3+, Singapore, SG

16-18 March 27

XPONENTIAL EUROPE 2027

Leading European trade fair for autonomous technologies & robotics. New IVAM joint stand. Düsseldorf, DE

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