News 2.24

Fraunhofer Competence Field Additive Manufacturing

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Editorial

Welcome to Fraunhofer ADDITIV NEWS 2.24, presenting highlights from Fraunhofer's applied research in Additive Manufacturing (AM) and 3D Printing!

Let me specifically introduce you to some of the highlight in this newsletter's articles. Our cover picture shows Fraunhofer IAP's 3D printed pericardial membrane with high elasticity and flexibility to support movements of the human heart while providing reliable protection against external influences, to be applied in future cardiac surgery. Another material innovation is LPBF manufactured SiSiC ceramics from Fraunhofer IKTS, with its first application to be found in gas burners.

Presented AM process innovations encompass Fraunhofer ILT's advanced beam shaping for higher AM process productivity and Fraunhofer IGCV's cold spray forming technology. Innovations in the digital AM workflow come from Fraunhofer IWM with simulation web apps for LPBF of polymers, and from Fraunhofer IAPT with digital twins for optimized AM processes. When it comes to real life AM applications, let me introduce you to Fraunhofer EMI's AM kinetic energy absorbers and to Fraunhofer IFAM's printed batteries and HF filters for satellite communication.

But there is much more to explore in this newsletter, we hope you enjoy reading and encourage you to get in touch, to learn more on the presented topics and how you can envolve with AM and with Fraunhofer ADDITIV!

Dr. Bernhard Mueller
Spokesperson
Fraunhofer Competence Field Additive Manufacturing

Content

Fraunhofer DDMC 2025

The Fraunhofer Competence Field Additive Manufacturing presented the seventh edition of the "Fraunhofer Direct Digital Manufacturing Conference DDMC" in Berlin on March 12 and 13, 2025.

More than 110 participants from 13 countries and 3 continents attended DDMC 2025. The top-class conference program offered over 20 sessions with 67 specialist lectures including a dedicated poster session.

On top, six outstanding keynote speakers from research and industry presented their very personal perspectives on the future of Additive Manufacturing: Prof. Enrico Stoll from TU Berlin (Germany), Prof. Wojciech Matusik from MIT (Cambridge, USA), Ben Hartkopp of Quantica (Berlin, Germany), Prof. Bianca Colosimo from Politecnico di Milano (Italy) and Dr. Sebastian Piegert & Dr. Cynthia Wirth from Siemens Energy (Berlin, Germany).

At the end of DDMC 2025, the awards for Best Paper, Best Poster, and Best Presentation were presented. The Best Presentation Award was won by Ligeia Paletti from German Aerospace Center (DLR) in Hamburg, Germany. The DDMC 2025 Best Poster was awarded to Aron Pfaff, Konstantin Kappe and Markus Linnenberg

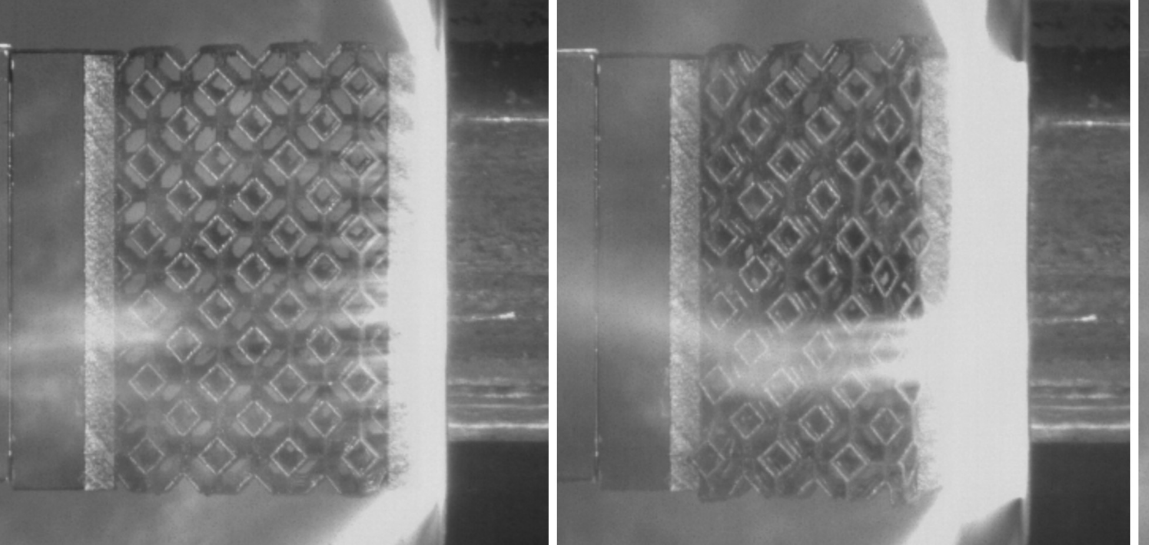
from Fraunhofer EMI in Freiburg, Germany. Winners of DDMC 2025´s Best Paper Award are Eike Tim Koopmann, Tim Jäger, Christoph Kaminsky, and Henning Zeidler from Mercedes-Benz and TU Freiberg, Germany.

Next DDMC will take place in 2027 and again showcase the latest trends in Additive Manufacturing from research and industry worldwide.

Impressions:
https://www.ddmc-fraunhofer.de/en/review-ddmc/impressions.html

PIAM Collection:
https://link.springer.com/collections/aijdadciif

Conference Proceedings:
https://publica.fraunhofer.de/entities/publication/0419f33c-5344-4f0a-b90e-c50c458006a3



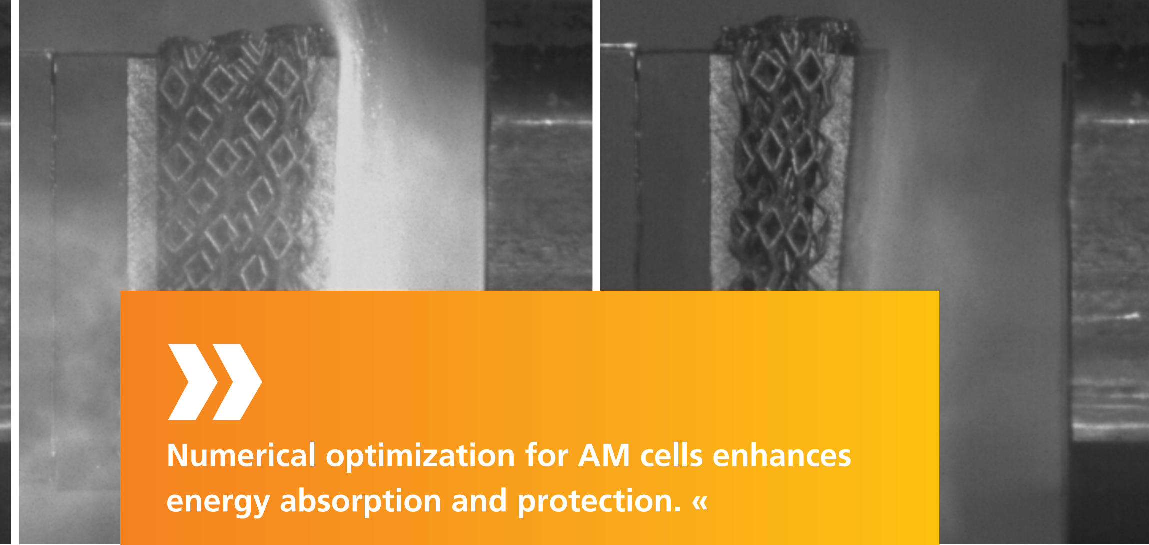
Optimizing Kinetic Energy Absorbers by Additive Manufacturing

Cell Structures for Enhanced Blast Protection

The EDA-Cat B project "AMALIA" – Additive Manufacturing (AM) of Metallic Auxetic Structures and Materials for Lightweight Armor – aims to revolutionize blast protection using Laser Powder Bed Fusion (LPBF) to create optimized cellular structures. Alongside intricate cell design, the project addresses manufacturing challenges related to armor steels, ensuring optimal performance under the demanding conditions of blast loading.

Blast and ballistic protection are critical concerns in military vehicle design, with armor often constituting over 50% of a vehicle's total weight. As threats evolve, traditional high-performance protection steel plates can add significant weight, impacting both mobility and efficiency. The AMALIA project seeks to transform this landscape by developing innovative solutions through the additive manufacturing (AM) of auxetic cellular structures using laser powder bed fusion (L-PBF), addressing the critical need for effective blast protection while minimizing overall armor weight.

Auxetic materials possess a unique negative Poisson's ratio, allowing them to expand orthogonally when stretched and contract



» Numerical optimization for AM cells enhances energy absorption and protection. «

Aron Pfaff
Fraunhofer EMI

when compressed. This remarkable property significantly enhances energy absorption during impacts, making these materials denser at impact zones and improving their protective capabilities. Such characteristics are especially vital in military applications, where the ability to absorb and dissipate energy can be the difference between survival and failure on the battlefield.

The primary objective of the AMALIA project is to identify optimal designs for kinetic energy absorbers by examining various cell geometries, arrangements, and dimensions using advanced numerical optimization methods. Additionally, the selection of suitable alloys based on their mechanical properties and microstructures is key to ensuring effectiveness. To enhance the performance of these cellular structures under blast loads, various cell topologies and gradients in relative density are thoroughly analyzed. Advanced simulations are utilized to train a neural network as a surrogate model, facilitating a more streamlined optimization process. The suitability of traditional armor steels for AM is also investigated, while simultaneously exploring the potential of novel alloys,

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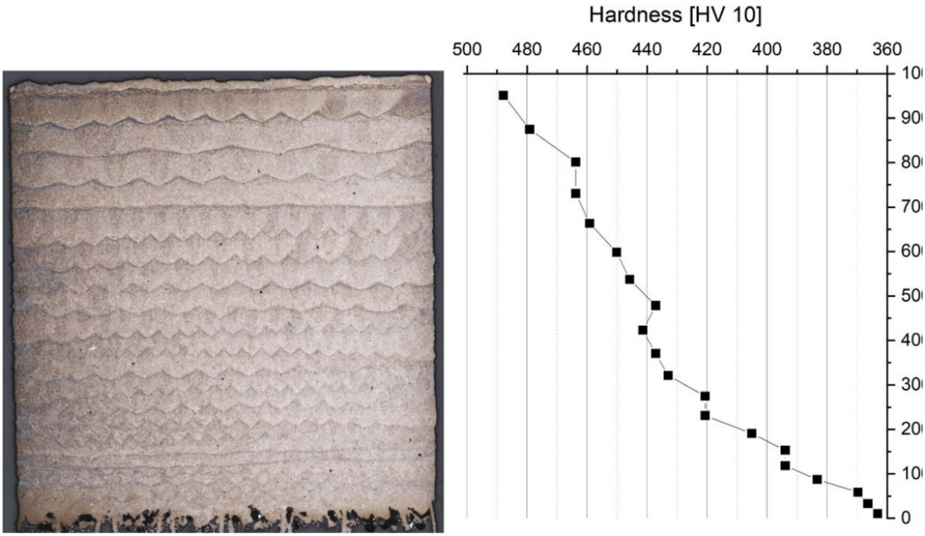


In-situ heat treatment to generate property gradients.

such as High Manganese Steel and 17-4 PH Steel, to withstand blast and ballistic threats while meeting rigorous military standards.Furthermore, process parameter optimization is conducted, with a strong focus on incorporating in-situ thermal treatment during manufacturing to produce functionally graded materials that can offer enhanced performance.

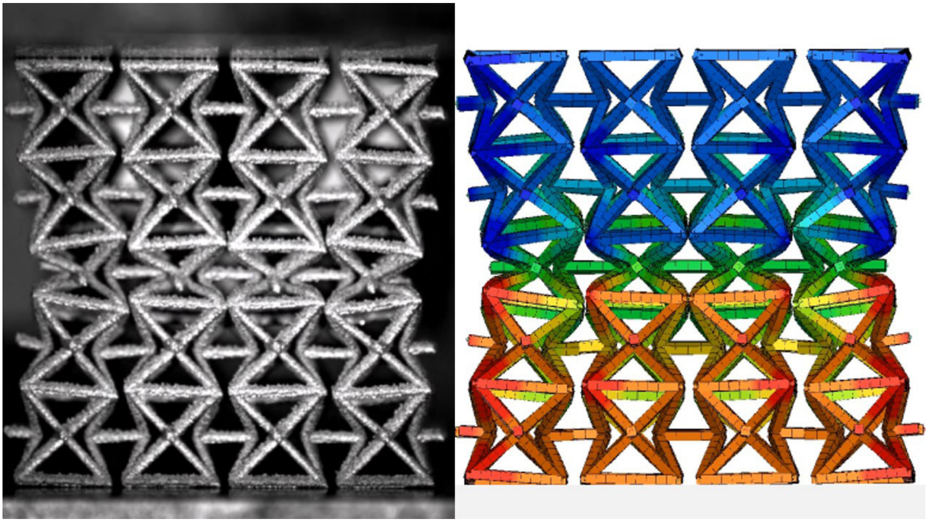
The resulting structures undergo rigorous testing under real-world blast loads to compare experimental results with simulation outcomes. Strong correlations have been observed between experimental data and simulations, validating the effectiveness of our design and manufacturing processes. In conclusion, the combination of numerical optimization techniques with additively manufactured armor steels represents a significant advancement in energy absorption capabilities, enabling the development of highly efficient protective structures tailored to meet stringent performance requirements in defense applications.

The European AMALIA project is supported by the German Federal Ministry of Defence (BMVg). Fraunhofer EMI brings invaluable expertise in high-speed dynamics, modeling, simulation, and experimental methods, ensuring the development of effective and reliable protective solutions that can adapt to the ever-evolving landscape of military threats.

AMALIA Project Highlights

- Advanced Manufacturing: Utilizes Laser Powder Bed Fusion (LPBF) for creating lightweight cellular and auxetic structures.
- Generative Design Optimization of Cellular Structures: Using and developing numeric methods in order to optimize cellular structures for blast loads.
- Suitability of AM Armor Steels: Explores both traditional and alternative armor steels for optimized performance.
- Functionally Graded Materials: Incorporates in-situ thermal treatment to achieve tailored mechanical properties for increased material performance.
- High-Speed Dynamics Testing: Employs blast testing to ensure the reliability of protective solutions.

Drop weight test: 17,6 kg, 5 m/s, dynamic equilibrium.



Artificial pericardium

©Fraunhofer IAP,
Photo: Till Budde

Artificial tissue from the 3D printer

Innovative biomimetic materials and magnetically controllable robotics

The PolyKARD project has made significant progress in the field of biomedical materials: The production of an artificial pericardium that biomimetically mimics the properties of the natural pericardium. This was made possible with the help of special biomimetic polymers and an innovative 3D printing process. The resulting material imitates the mechanical and biological properties of the pericardium. It is elastic, biocompatible and durable. The structure and function of the PolyKARD material are strikingly similar to those of the natural pericardium.

The artificial pericardial membrane is elastic and flexible enough to support the movements of the heart, while at the same time providing reliable protection against external influences. These properties make the material a promising candidate for use in cardiac surgery, particularly in the development of implants.

A promising further development, in cooperation with Professor Russell Harris and Dr Silvia Taccola et al. from the UK, is the integration of magnetically responsive nanoparticles. This new variant of the material combines elasticity with magnetic properties and thus enables external control using magnetic fields. This opens up new possibilities for use in robot-assisted surgery or other medical technology applications.

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Web applications to identify optimal PBF-LB/P process parameters

Predictive tools for polymer 3D printing

The laser powder bed fusion process for polymers (PBF-LB/P; also known as selective laser sintering, SLS) involves a multitude of process parameters requiring precise adjustments. To obtain a suitable parameter set for a given polymer time-consuming experimental investigations are typically necessary. To address this challenge, we have developed digital tools designed to assist in selecting the most critical process parameters.

PBF-LB/P process window identifier

This handy web application is an implementation of the theoretical framework derived within the German Research Foundation priority program 2122 "Materials for Additive Manufacturing". The goal is to pinpoint the ideal laser power to thoroughly melt the polymer and fabricate a dense part. This optimal setting should result in optimal mechanical properties of the final product while ensuring that the polymer does not thermally degrade (cf. Figure 1). The application calculates expected process results based on the material properties and process conditions provided by the user.

The theory behind the suggested optimal laser power range is based on the attenuation melt ratio (AMR). The AMR is the ratio of the thermal energy density due to laser irradiation and the thermal energy density required to fully melt the material.

Multilayer PBF-LB/P process simulation

In previous research on particle-based simulations of the PBF-LB/P process, it was found that the relevant physical phenomena can be divided into three distinct temporal phases: laser motion (approximately 100 µs), thermal diffusion (around 100 ms), and viscous flow (about 10 s). Simulations demonstrated that the differences in time scales create temperature and density gradients primarily along the build direction. Recognizing that the build direction is the relevant spatial direction, the idea to discretize a process and material model only along this axis has been developed. This simplification reduces the computational effort dramatically and allows, e.g., to study the influence of inter-layer time – the interval between the deposition of successive powder layers – on the densification process.

Process Window App

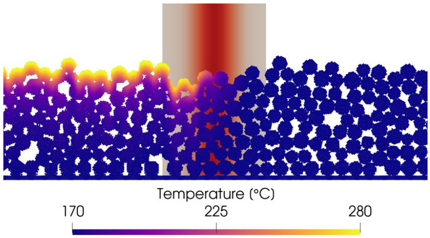

Figure 1: QR code for the process window app (left); underlying PBF-LB/P simulation for polyamide 12 (right).

Process Simulation App

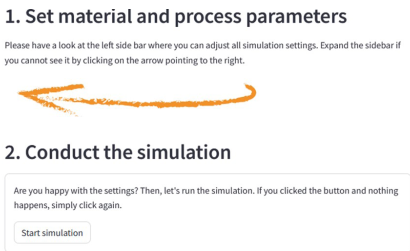

Figure 2: QR code for the process simulation app (left); screenshot from the web application (right).

As a result, a simulation tool for the PBF-LB/P process has been implemented, which discretizes solely in the build direction (cf. Figure 2). This model can accurately predict surface temperature, melt pool depth and part density which has been confirmed through comparisons with experimental data for polyamide 6, polyamide 12 and polyetherketoneketone.

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Screen-printed high-frequency filters in groove gap waveguide architecture for the WR10 band

Generative production of high-frequency filters for satellite communication

Flexible and cost-effective: Production of GGW filters using additive screen printing

Modern communication systems, like satellites and mobile phones, demand higher data rates, leading to an increasing use of millimetre wave frequency bands. Yet, as frequency increases, wavelengths decrease, necessitating smaller components. This miniaturisation requires technologies for efficient, low-loss manufacturing of, e.g., filters, antennas, and diplexers. Conventional processes are also becoming less economical.

Additive screen printing has emerged as an ideal solution for these components. In a joint project with the European Space Agency (ESA) and the University of Kiel, significant advancements in groove-gap waveguide (GGW) technology have been made. This technology effectively produces millimetre wave components. The quality achieved in the project is comparable to conventional milled parts while being more flexible and cost-effective for large-scale production.

Here, screen printing, well-known and widely used in the solar and electronics industries, is enhanced to the third dimension by printing layer on layer. Thus, structures with less than 100 µm fineness and high surface quality are achieved. Not only can complex internal geometries be realised, but quantities of several million units are also possible in a later application. Additionally, the powder metallurgical approach allows for the production of components from a wide range of industrially relevant materials close to the final shape.

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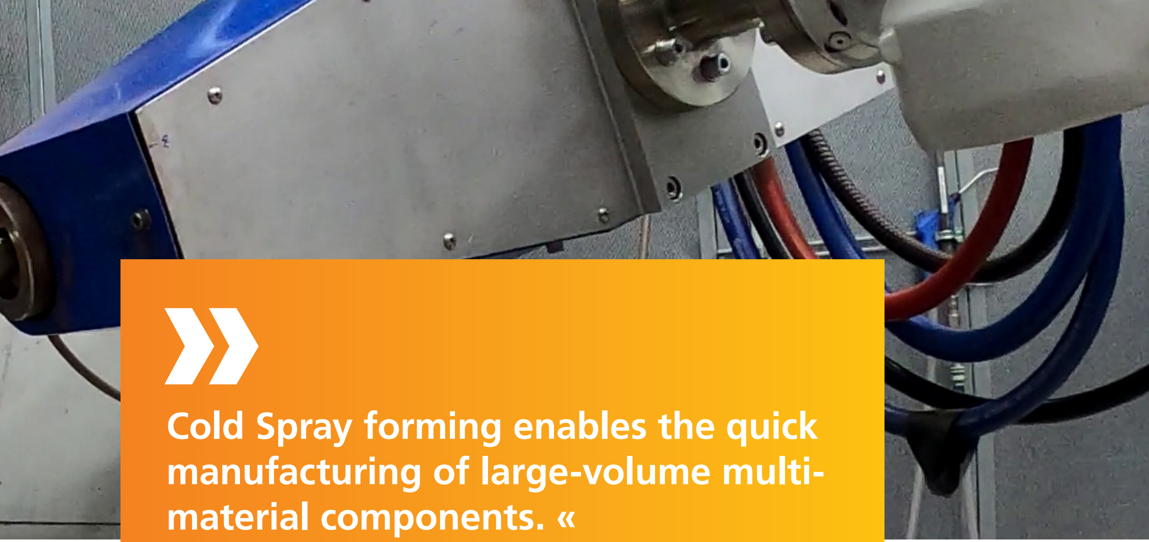
Cold Spray Forming – a new way to manufacture large-volume components

A brief summary of this combinatorial approach

Originally developed in the 1980s as a metal-coating process, Cold spray has recently gained importance as a large-scale additive manufacturing technology. Until now, this required complex path planning or the elaborate production of a mandrel as a shaping substrate.

To enable Cold Spray as an additive manufacturing process, it is necessary to apply a suitable path planning strategy to build geometrically defined shapes with this process, such as rectangular walls. Especially for rotationally symmetrical, mandrels offer a further option. Mandrels are conventionally manufactured base parts that are used as a form-giving substrate. After spraying, they are removed by conventional subtractive processes, like turning.

This process can be simplified and improved by Cold Spray Forming (CSF). For CSF, the mandrel itself is also additively manufactured and can be chemically or thermally dissolved after the process. For the manufacturing, the processing of a thermoplastic material by the Fusion Filament Fabrication (FFF) process is a suitable



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Cold Spray forming enables the quick manufacturing of large-volume multi-material components. «

Dr. Georg Schlick
Fraunhofer IGCV

and cost-efficient method. As Cold Spray is a non-melting process, polymer substrates can be coated with metal. Tests have shown that only thermoplastics that exceed a certain critical hardness can be coated well. Thermosets are generally subject to erosion.

So far, this process works particularly well with the combination PEEK (Polyetheretherketone) and pure copper. However, the sprayed copper only serve as an intermediate layer onto which other materials, such as the nickel-based alloy Inconel®718, can be sprayed. In this way, Multi-material components can be easily produced, and the mandrel can then be thermally dissolved, for example during the necessary heat treatment. Compared to conventional mandrel manufacturing, such as turning from aluminum, this approach offers both cost and time-saving advantages as well as an increased geometrical freedom. In the future, further potential savings can be achieved by identifying more cost-effective suitable polymers.

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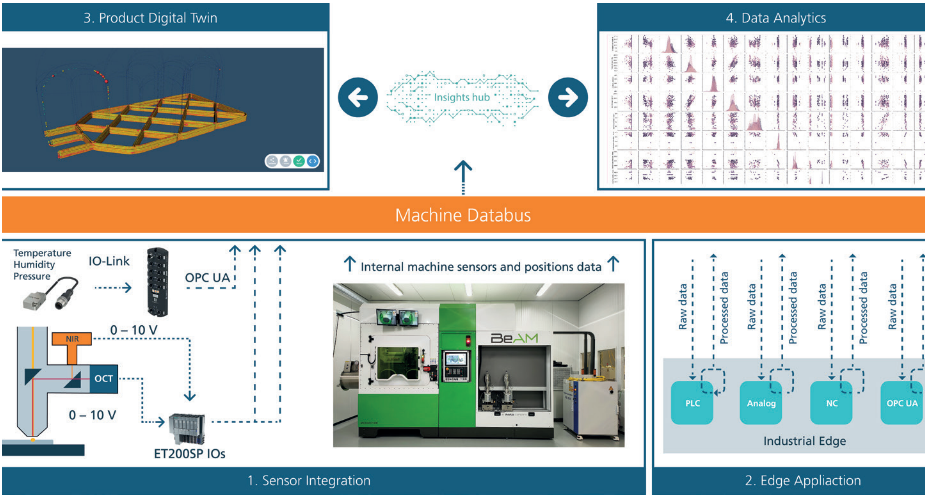
Leveraging Digital Twins to Optimize Additive Manufacturing Processes

The Industry 4.0 initiative has paved the way for extensive digitalization and virtualization in manufacturing processes. In this landscape, the digital twin – a virtual representation – of a system, process, or product can greatly improve both efficiency and product quality. By systematically gathering and analyzing all relevant production data, digital twin models offer a thorough understanding of the entire manufacturing workflow.

In the industry-funded 'BigDataLMD' project, Fraunhofer IAPT has created a data-pipeline infrastructure and accompanying tools and software applications to facilitate the digitalization of a powder-based laser metal deposition system. Utilizing SINUMERIK Edge and in-situ optical sensors like optical coherence tomography and high-speed infrared camera, the system captures all relevant machine parameters and process-related data. A product digital twin is then generated in Siemens Insights Hub® for visualization and analysis of sensor data followed by the identification of key influencing factors. Additionally, the software tool enables users to gather metadata like powder characteristics and also data generated from subsequent quality measurement steps like tensile testing, hardness measurement, etc. From the analyzed data, actionable recommendations are developed to enhance the stability of the powder-laser-DED process.

Traceability of the entire manufacturing process is thereby achieved through digitalization of the process chain. One of the primary benefits of such a digital twin model is the continuous and automated optimization of processes. Through data- and AI-driven simulations and forecasts, end-users can make accurate predictions and detect potential errors early, thereby enhancing the stability and precision of additively manufactured components.
By minimizing waste during the manufacturing process, a much more resource efficient and sustainable process can be achieved.



Data pipeline and system architecture implemented for digitalization of a powder-based laser metal deposition system consisting of four phases: 1. Integration of in-process and on-axis sensors along with the integration of environmental sensors; 2. Industrial edge-based data processing applications; 3. Geo-mapping of sensor data and its visualization; 4. Post-process data analytics using statistical and AI methods

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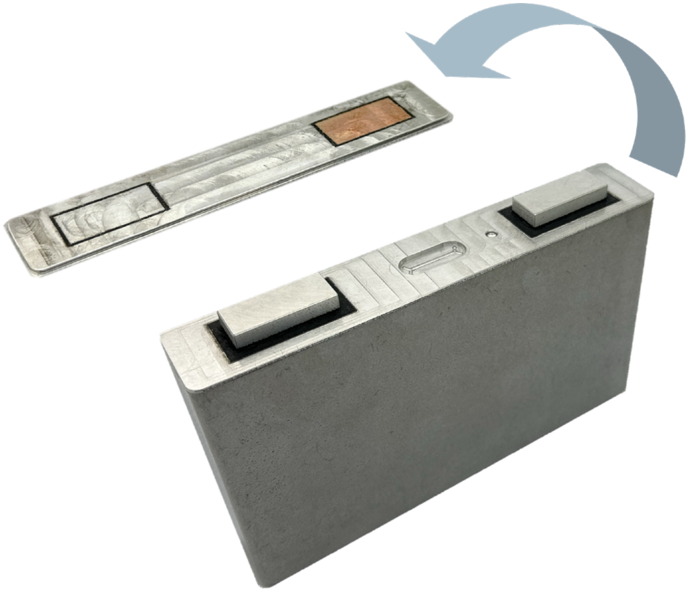
Additively manufactured battery cell housings with three materials

The Fraunhofer Institute for Casting, Composite and Processing Technology IGCV has developed a three-material processing technique using powder bed fusion (PBF), enabling the production of battery cell housings from aluminum, copper, and ceramic in a single manufacturing step. This approach allows for the creation of geometrically complex housings, offering significant flexibility in both design and production. By integrating multiple materials into a single process, the technique simplifies the manufacturing chain by eliminating the need for conventional methods like molding and stamping. Particularly suitable for small-batch production, the method supports rapid design adjustments during early development stages without incurring the costs of new tooling. Such flexibility is essential in the fast-paced development of next-generation battery cells, where quick prototyping and frequent design modifications are crucial. By reducing iteration cycles and lead times, this process facilitates faster transitions from design to market, accelerating the introduction of new battery technologies. A key feature of the technique is its ability to incorporate ceramics as electrical insulation alongside conductive metals in a single powder bed fusion process. High ceramic density is achieved without extensive preheating, ensuring the structural integrity of the final product. Although the process involves longer build times and requires postprocessing through milling, the advantages of design flexibility and supply chain agility present a strong alternative to traditional manufacturing methods. In addition to multi-material battery cell caps, there is significant potential for additive manufacturing of the cell can, too. This component can also be produced using PBF. However, maintaining high geometric accuracy is a current challenge, which can be addressed through specific distortion-minimizing measures. To improve the surface roughness of the manufactured cell can, the Fraunhofer IGCV has introduced a postprocessing step involving vibratory finishing. This ensures that the required surface quality is achieved, meeting the standards for battery cell applications.



Multi-material cell cap assembled together with a pure aluminum cell can.

»A customized manufacturing system, enhanced by an articulated robot, enables additional material deposition through the use of a guided powder nozzle.« – Thomas Bareth, Fraunhofer IGCV

Multi-Material Processing Innovation

- Simplified Manufacturing Chain
- Ideal for Small Batch Sizes
- Conductor-Insulator Integration

Fraunhofer Institute for Casting, Composite and Processing Technology IGCV

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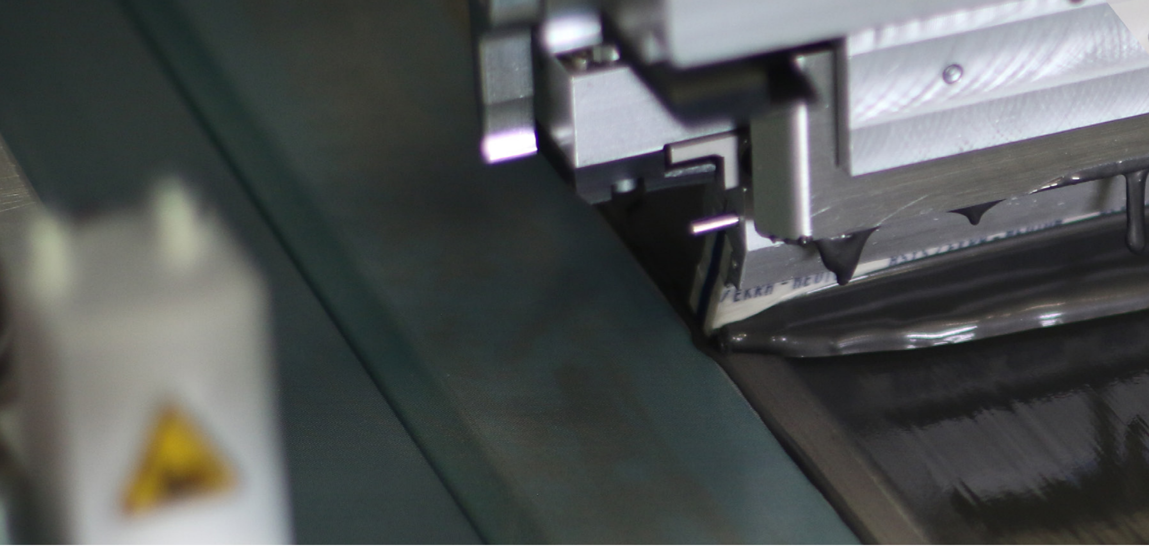

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Battery manufacturing using 2D and 3D printing processes

Cost-effective and flexible battery printing

The development of advanced batteries is crucial for meeting the growing energy demands and addressing environmental challenges in today's world. Fraunhofer IFAM is developing innovative manufacturing processes for the batteries of the future using 2D and 3D printing techniques. The use of the screen printing process allows e.g. higher active material loads and greater design flexibility of electrodes. Fully printed batteries reduce the use of solvents and drying processes. Current challenges in energy storage, such as increasing specific energy density and environmental friendliness through alternative materials, are being addressed.

The additive manufacturing of electrodes offers advantages regardless of the battery cell system whether Lithium, Zinc or Sodium and whether liquid or solid-state battery. Screen printing processes enables the production of thicker electrodes, allowing for higher energy densities. Other advantages include a high degree of design freedom, so cells can be designed to fit perfectly into the construction space and is produced in the final shape, so no cutting is needed and no waste is generated. Additionally, environmentally friendly water based printing pastes were developed. Being able to significantly reduce the solvent content in the printing pastes helps to

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Battery production of the future, more environmentally friendly and cheaper through printing. «

Jonas Deitschun
Fraunhofer IFAM

reduce process costs significantly, which in battery production are mainly determined by the energy consumption during drying.

Additive manufacturing also offers considerable advantages for the production of next-generation batteries. For example, composite electrodes consisting of active material and solid-state electrolyte can be printed in a single process step.

The final vision of these developments is a fully printed cell, including current collectors, separators and housing, which can be individually adapted to the application needs. Therefore, an innovative battery production line for printed Na-Ion solid-state batteries, which covers the entire production process from paste preparation to printing and cell assembly, has already been put into operation. A further printing line for pilot series is currently under construction to bring the technology into application.

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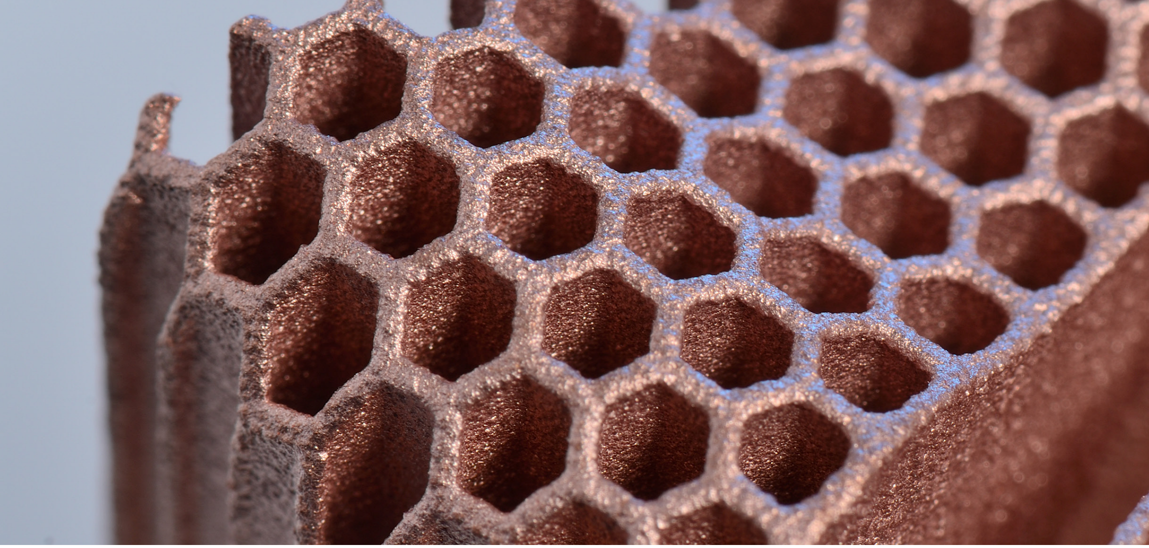

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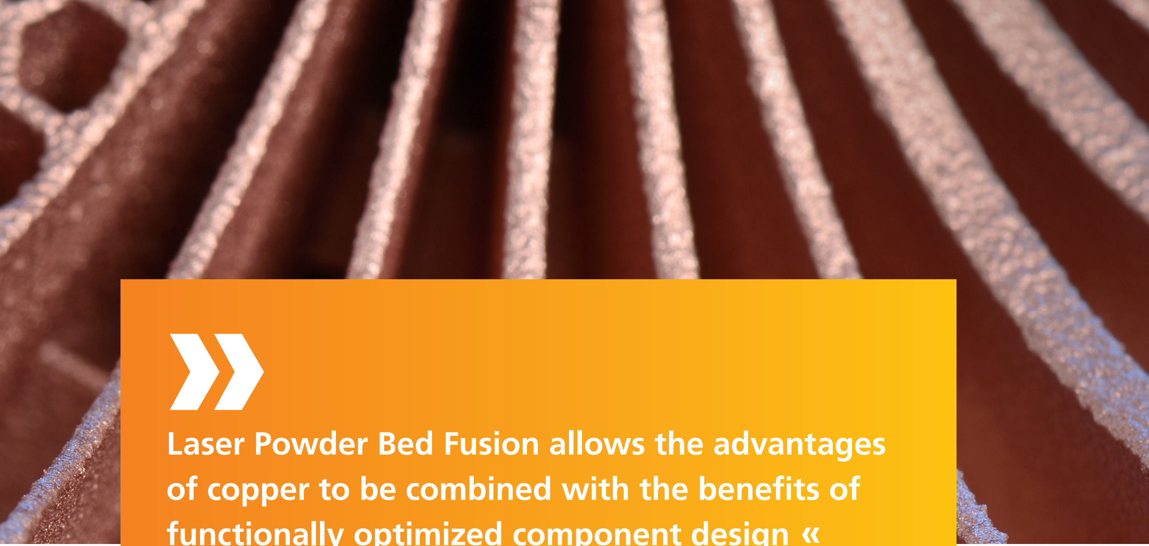
LPBF of copper materials for applications in energy and aerospace sector

Combustion chambers in rocket engines and inner structures of a fusion reactor have to withstand extremely high temperatures. In addition to the high thermal load, there are further requirements regarding heat transfer, strength and corrosion resistance of the material. Copper materials are particularly suitable for this requirement profile due to their excellent conductivity. Used as a functional material to dissipate heat, they make a decisive contribution to the functionality of components subjected to high thermal loads.

Fraunhofer Institute for Laser Technology ILT has many years of experience in the processing of copper materials using LPBF. In recent years, ILT has significantly improved process technology for the LPBF of copper materials using infrared and green laser radiation. By processing GRCop42 (CuCrNb) with the aid of green laser radiation, process limits in LPBF to manufacture dense components could be extended. This has enabled further optimization along the manufacturing process chain.



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Laser Powder Bed Fusion allows the advantages of copper to be combined with the benefits of functionally optimized component design «

Daniel Heußen
Fraunhofer ILT

Additive manufacturing of copper materials using laser powder bed fusion (PBF-LB/M or LPBF) allows the advantages of the material to be combined with the benefits of functionally optimized component design. For example, thin walled flow- and heat-transition-optimized internal channels improve the dissipation of heat in very high temperature ranges. However, with respect to thermal cycling and mechanical loads, process development for the manufacturing of thin walled components is quite challenging.

Fraunhofer ILT takes these requirements into account and endeavors to transfer them into different applications. Current development is focused on the processing of copper and tungsten in material composites in order to manufacture thin-walled and high-temperature resistant heat sinks and heat exchangers. These are used, among other things, in the field of nuclear fusion but also in other highly stressed components.

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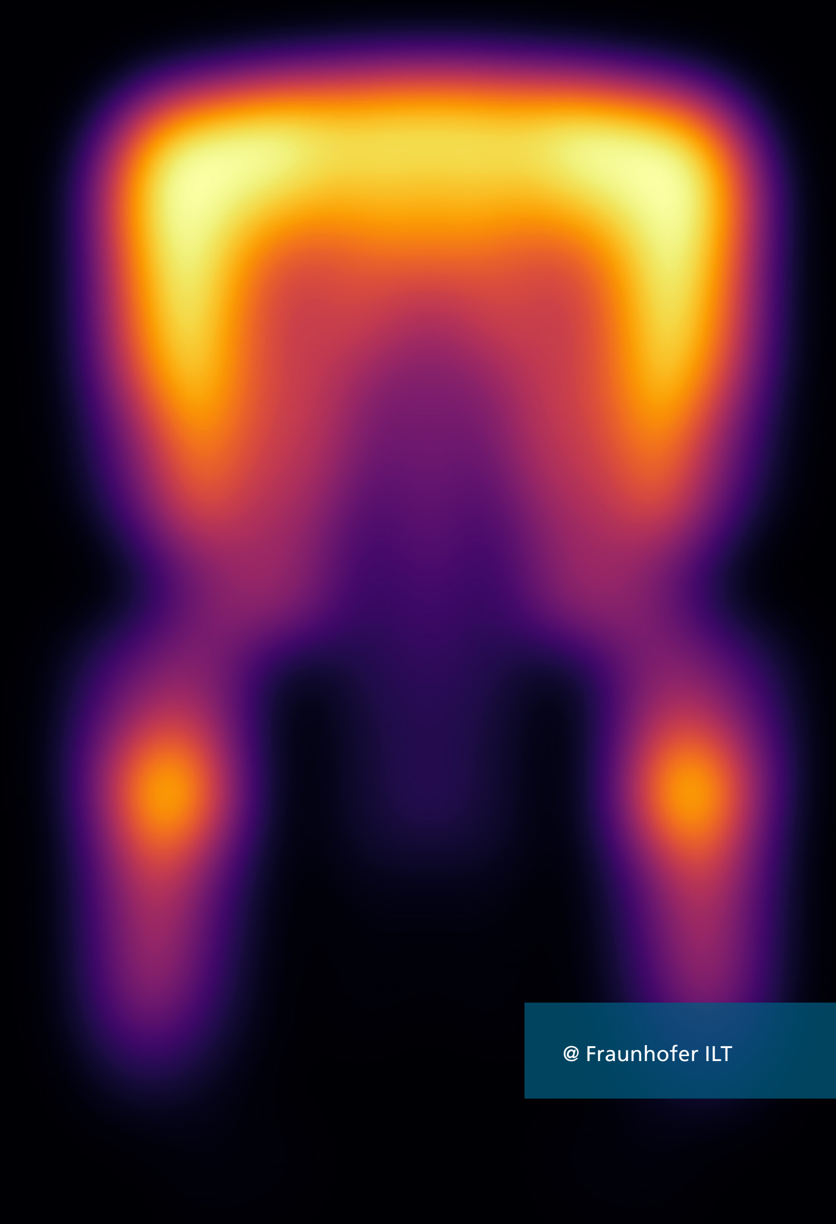

@ Fraunhofer ILT

Transforming Metal Additive Manufacturing with Advanced Beam Shaping

Innovative Spatial Light Modulators enabling higher productivity, efficiency, and scalability

With laser beam shaping, we stand at the beginning of a revolution in the Laser Powder Bed Fusion (PBF-LB/M or LPBF) process. The conventional single-beam approach is often hindered by low productivity and limited scalability due to process instabilities, such as humping and spattering. Consequently, the full potential of available laser power remains untapped when using singlemode lasers. Until now, scaling the process required multiple laser-optical systems, resulting in linear costs increase.

Improving the productivity and efficiency of the single-beam process is therefore a key objective. Recent developments in basic beam shaping techniques—such as ring shapes, dual Gaussian arrays, and Bessel beams—have demonstrated a significant influence of intensity distribution on melt pool stability and the geometry of the resulting melt track. Previously, the potential effects of a fully customizable intensity distribution were only theoretical. However, this is now becoming a reality with the emergence of Liquid Crystal on Silicon Spatial Light Modulators (LCoS-SLMs) in the 1 kW range. These SLMs enable pixel-level precision in curving the laser beam's wavefront, allowing for flexible fine adjustments to the intensity distribution. Fraunhofer ILT has one of the world's first PBF-LB/M laboratory setups with 2 kW laser power and LCoS-SLMs for identifying the most advantageous beam shape for typical objectives (productivity, crack-prevention, etc.).

The ongoing experiments are paving the way for faster, more cost-effective, and highly efficient metal additive manufacturing.

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Laser Powder Bed Fusion for the production of complex SiSiC ceramics

Background Information

Laser powder bed fusion (PBF-LB or LPBF) is an established AM process in the field of plastics and metal printing. In PBF-LB, materials as powders melt by a laser in a powder bed. By adapting the process, Fraunhofer IKTS has succeeded in making the shaping method usable to produce silicon infiltrated silicon carbide ceramics (SiSiC). PBF-LB has not yet found any technical application to produce silicon carbide ceramics (SiC), as SiC is not fusible and forms passivating oxide layers at high temperatures.To address this issue, together with the project partner ESK-SIC GmbH, SiC powders were developed, which have a high flowability due to their roundness and are ideally suited for powder bed-based manufacturing processes. The SiC powders were then coated with a special Novolak. This resin can be melted thermoplastically and can also be converted into a duromer.

Additive Manufacturing of SiSiC via PBF-LB

SiC powders prepared in this way can be processed using inexpensive systems designed for polymer printing with diode lasers (power less than 5 W), CO_2-lasers or

» Almost as easy as with plastic. «

Christian Berger
Fraunhofer IKTS

fiber-lasers. The temperatures during the process only soften the plastic and therefore bond the individual coated SiC grains together. Oxidation of the SiC surface does not take place and the process can be operated without costly inert atmosphere. To produce densest possible green bodies, parameters were optimized for PBF-LB. The energy density, hatch spacing and the assembly temperature used during shaping are the main process-related influencing factors for increasing the green density. By optimizing the process, it was possible to produce polymer bonded SiC green bodies with a density of > 1.3 g/cm³, which have sufficient stability for the subsequent processing steps. After additive shaping, components produced in this way can be converted into silicon carbide by carrying out conventional pyrolysis and siliconization.

First applications in gas burners

PBF-LB is particularly suitable for manufacturing delicate components with tight tolerances. Using this process, the first open-cell SiSiC components were produced at IKTS for application tests at Promeos GmbH.

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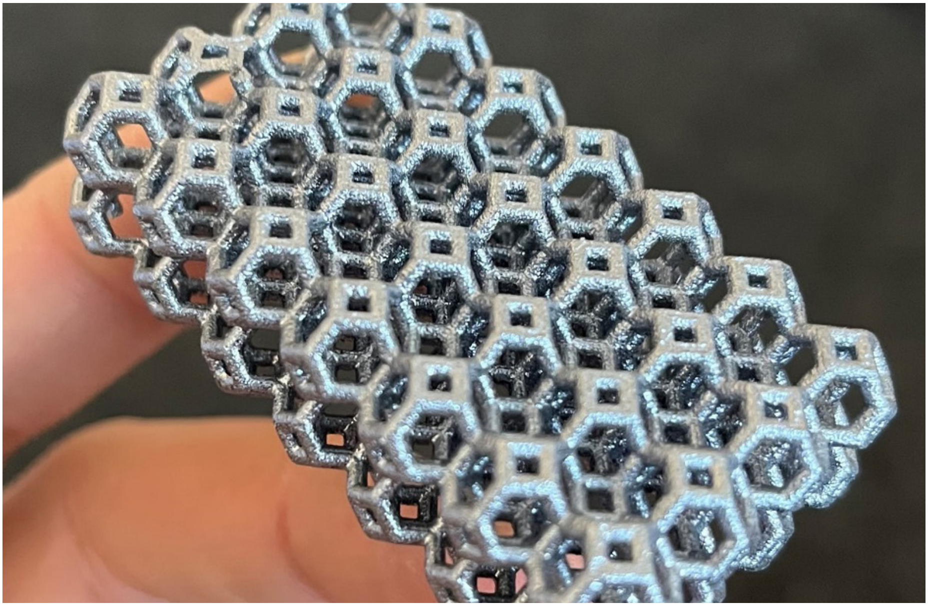


SiSiC gas burner

These components homogenize the thermal radiation pattern in gas burners and increase the emission of infrared radiation, which enhances the efficiency of drying processes. In terms of oxidation stability, there were no differences to conventionally SiSiC. Due to the high Weibull strength of up to 266 MPa achieved with a Weibull modulus of 21, the process is also suitable for addressing structural ceramic applications in the future.

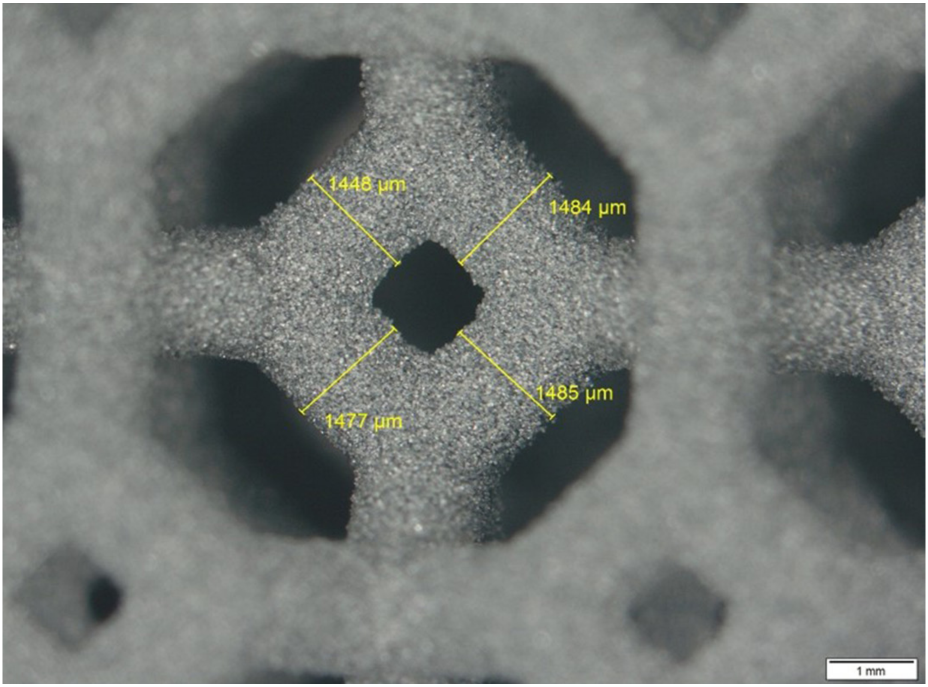
The technology is currently being transferred to other material systems in R&D projects. In addition to reaction-bonded boron carbide, the development focus is on silicon infiltrated diamond-silicon carbide composites. In addition to their excellent tribological properties, these material composites also have unique thermal characteristics. At over 500 W/mK, these composites achieve better thermal conductivity than silver (429 W/mK). At the same time, silicon infiltrated diamond-silicon carbide composites have a thermal expansion of 4.5 x 10^6 1/K, which is very close to that of silicon. This highlights the material's appeal for heat exchangers and heat pipes in microelectronics applications.

Key Facts

device type	KIT (or others)
manufacturer	Sintratec
build volume	90 x 90 x 90 mm³
layer thickness	100-200 µm
minimum wall thickness	< 1mm
build speed	< 240 cm³/h
special features	polymer laser system

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung

Detailed picture of a printed gas burner structure



Fraunhofer Competence Field Additive Manufacturing

With 20 Fraunhofer Institutes throughout Germany, the Fraunhofer Competence Field Additive Manufacturing is Europe's largest player in AM research. This network covers the entire process chain - from developing new materials and creating efficient production processes to ensuring product quality and further developing simulation tools.

With a focus on increasing productivity, improving quality and sustainability, the "Additive Manufacturing" field of expertise supports the industry in implementing innovative solutions through: multi-material solutions, Robust processes and standards, Automation and user-friendly processes, Extensive materials research.

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EMI	High-Speed Dynamics, Ernst-Mach-Institut
IAO	Industrial Engineering
IAP	Applied Polymer Research
IAPT	Additive Manufacturing Technologies
IFAM	Manufacturing Technology and Advanced Materials
IGB	Interfacial Engineering and Biotechnology
IGCV	Casting, Composite and Processing Technology
IGD	Computer Graphics Research
IKTS	Ceramic Technologies and Systems
ILT	Laser Technology
IMTE	Individualized and Cell-Based Medical Engineering
IPA	Manufacturing Engineering and Automation
IPK	Production Systems and Design Technology
IPT	Production Technology
ISC	Silicat Research
IST	Surface Engineering and Thin Films
IWKS	Materials Recycling and Resource Strategies
IWM	Mechanics of Materials
IWS	Material and Beam Technology
IWU	Machine Tools and Forming Technology