

PRESS INFORMATION

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Microstructure on Demand for Additive Manufacturing ICON Project “UltraGRAIN” Demonstrates Local Microstructure Control with Potential for Tailored Products

(Dresden, 02/27/2026) UltraGRAIN controls the grain structure of metallic components directly within the additive process. The international ICON research project of the Fraunhofer-Gesellschaft, conducted with Australian partners, has shown that microstructures can be adjusted locally and in a targeted manner during laser-based metal deposition. The project involved Fraunhofer Institute for Material and Beam Technology IWS, Fraunhofer Institute for Additive Manufacturing Technologies IAPT, and RMIT University in Melbourne. Funded through the Fraunhofer ICON program and by Australian partners, the consortium developed a scalable approach for industrial applications. The project concluded on February 25, 2026, with a final partner meeting in Dresden.

At the heart of UltraGRAIN lay a central question in additive manufacturing: How can components be produced so that their internal structure matches the intended function? The project demonstrates a practical path to no longer leaving microstructures to the process itself but instead defining them precisely where strength, service life, or load-bearing capacity matter most. For industrial users, this opens new degrees of freedom in the design of additively manufactured metal components. Professor Christoph Leyens, Director of Fraunhofer IWS, explains: “UltraGRAIN shows how Fraunhofer IWS develops new manufacturing technologies consistently from concept to industrial application. The results offer significant scientific insight and provide an excellent foundation for future industrial transfer.”

A Step Change in Process Control

UltraGRAIN first used ultrasound to influence grain formation, then shifted to pulsed-laser excitation. This method operates without contact, works with any geometry, and suits industrial environments. Pulsed laser-induced direct melt-pool excitation can be integrated into existing systems for laser-based directed energy deposition (DED-LB). It scales far better than conventional ultrasonic methods and remains stable even for complex geometries. In demonstrator components, the project achieved a reduction in the size of up to 75 percent. This capability enables, for the first time, the direct creation of microstructurally and functionally optimized zones during the manufacturing process. “We deliberately chose a solution that works in industry,”

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explains Jacob-Florian Mätje, main contact for the project and research assistant at Fraunhofer IWS. “Laser-based excitation allows us to set microstructures precisely where they make a real difference to component performance.”

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Added Value through an Integrated Competence Chain

A key distinguishing feature of UltraGRAIN lies in the close integration of laser processing, simulation, design methodology, and materials development. Fraunhofer IWS integrated pulsed laser-induced melt pool excitation into real DED-LB systems and validated the technology under industry-relevant conditions. Fraunhofer IAPT developed methods for segmentation, path planning, and parameter assignment for components with locally varying microstructures. RMIT University complemented the project with multiscale modeling, simulation-based process design, and optimization concepts in the sense of integrated computational materials engineering. Dr. Andrey Molotnikov, Professor and Director of the Centre for Additive Manufacturing at RMIT University, emphasizes: “Active collaboration among the project partners was a key highlight of the ICON project.” UltraGRAIN connects digital models and real manufacturing into a continuous approach. The close coupling of simulation-based process design and additive manufacturing accelerates transfer into industrial applications and strengthens international collaboration in advanced manufacturing.

Practical Relevance for Industry and Research

UltraGRAIN’s results are relevant for industries that demand high mechanical performance and long component service life. These include mechanical engineering, aerospace, energy technology, turbomachinery, automotive manufacturing, and tool and mold making. Companies benefit from components whose microstructure aligns precisely with load and function. This approach reduces material use, extends service life and improves the overall property profile of the component. UltraGRAIN has demonstrated that the build process can enable precise adjustment of this microstructure.

International Collaboration with Strategic Impact

The project partners presented UltraGRAIN’s results at international conferences and trade fairs, including ICALEO, ICAM, APICAM, and EUROMAT. The collaboration extends beyond the project itself. In December 2025, the institute director of Fraunhofer IWS signed memoranda of understanding with RMIT University and Swinburne University of Technology in Melbourne to prepare transfer activities and follow-up projects. These agreements strengthen long-term international innovation structures in advanced manufacturing. From RMIT University’s perspective, UltraGRAIN highlights the added value of simulation-driven process design and international collaboration for industrial additive manufacturing.

Info Box

UltraGRAIN

UltraGRAIN is an international research project focused on the targeted control of grain structure in metallic components produced by additive manufacturing. The project focused on laser-based directed energy deposition (DED-LB). This process feeds metallic filler material directly into a locally generated melt pool and builds components layer by layer.

The project aimed to locally tailor microstructures during the build process according to specific requirements. UltraGRAIN addresses a central challenge in additive manufacturing: the frequent formation of columnar grain structures and their adverse effects on fatigue strength and component service life. UltraGRAIN addresses a central challenge in additive manufacturing: the frequently occurring columnar grain structure and its negative effects on fatigue strength and component service life.

Over the course of the project, the consortium developed an approach to influence grain formation through pulsed, laser-induced excitation of the melt pool. The method operates without contact, remains independent of component geometry, and integrates into industrial DED-LB systems. The work ranged from process and system development to simulation-based design and the fabrication and analysis of demonstrator components.

UltraGRAIN ran from June 2021 to December 2025 with support from the Fraunhofer ICON program and Australian partners, marking the move from feasibility to industrial application.

More information: <https://s.fhg.de/ultragrain-en>

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About the Project Partners

Fraunhofer Institute for Material and Beam Technology IWS, Dresden, develops technologies and systems for laser-based materials processing, additive manufacturing, surface and coating technologies, and functionally integrated materials. In UltraGRAIN, the institute led process and system development for laser-based Direct Energy Deposition, integrated pulsed laser excitation, implemented in situ diagnostics, and fabricated demonstrator components.

More information: <https://www.iws.fraunhofer.de/en.html>

Fraunhofer Institute for Additive Manufacturing Technologies IAPT, Hamburg, researches and develops digital process chains for additive production. Its focus includes design methods, simulation, data models, and production strategies. In UltraGRAIN, the institute developed methods for segmenting and planning the paths of components with locally varying microstructures and derived suitable process parameters.

More information: <https://www.iapt.fraunhofer.de/en.html>

RMIT Centre for Additive Manufacturing (RCAM), Melbourne, Australia, consolidates research expertise in metal additive manufacturing with a focus on modeling, simulation, and process optimization. In UltraGRAIN, the center contributed multiscale modeling approaches, coupled flow-and-grain-growth simulations, and optimization frameworks for process design.

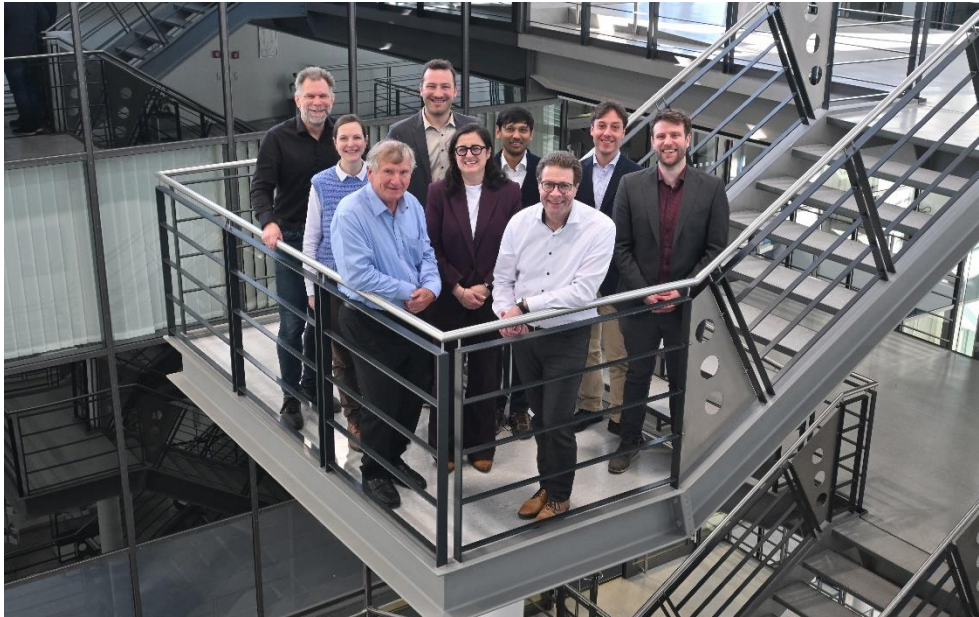
More information: <https://www.rmit.edu.au/research/centres-collaborations/centre-for-additive-manufacturing>

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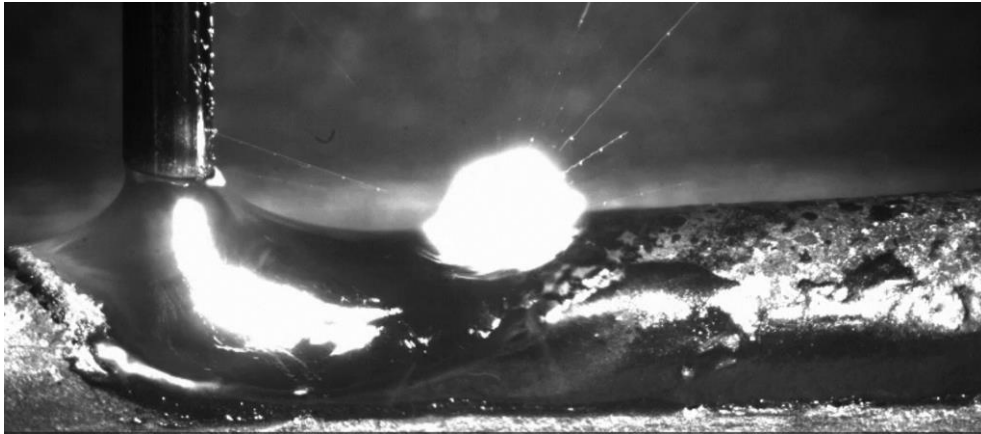
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The international research project UltraGRAIN of the Fraunhofer-Gesellschaft, conducted with Australian partners, concluded on February 25, 2026, with a final partners' meeting in Dresden, Germany.

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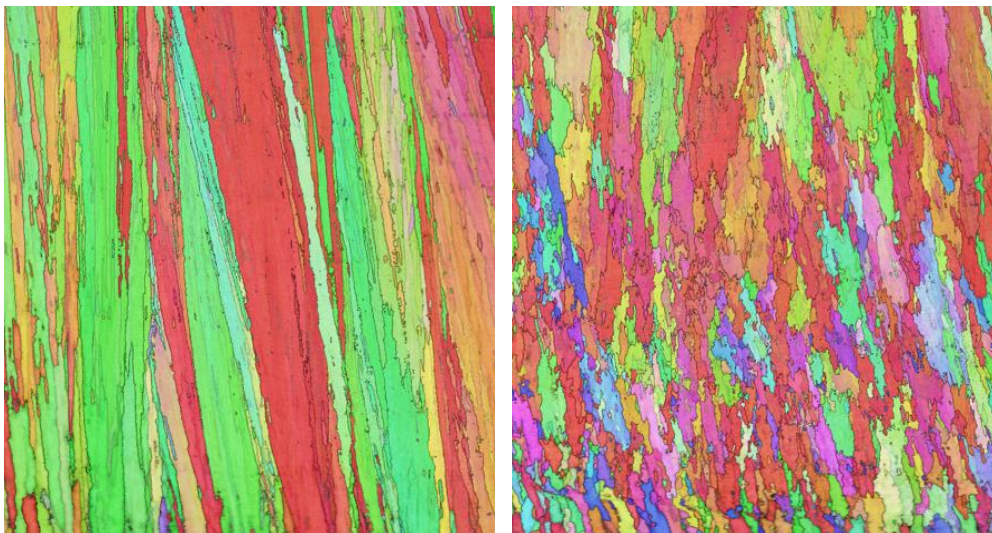
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High-speed imaging captures the laser wire-directed energy deposition (DED-LB) process, with pulsed-laser-induced plasma, which contributed to the success of UltraGRAIN.

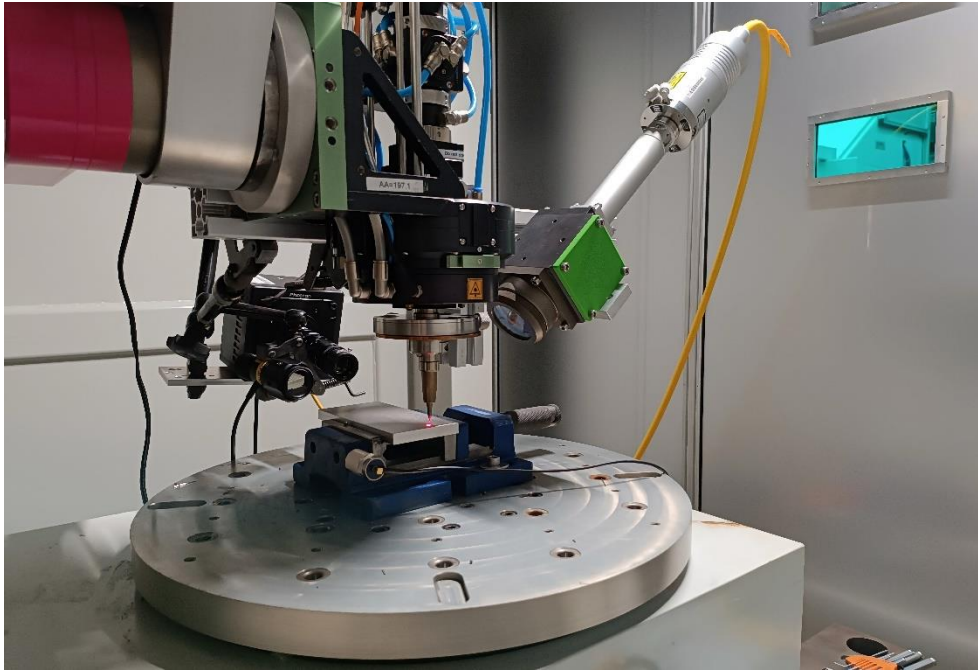
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The international research project demonstrated that microstructures and grain structures can be adjusted locally and in a targeted manner during laser-based directed energy deposition. Electron backscatter diffraction (EBSD) orientation maps show the differences between (left) without and (right) with pulsed-laser-induced melt pool excitation.

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In demonstrator components, the UltraGRAIN project reduced the grain area-weighted average grain size by up to approximately 75 percent in defined areas.

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