PRESS RELEASE

Graded porous structures from the metal 3D printer

How do you make a metal component permeable without drilling it afterwards or equipping it with filters? Researchers at the Fraunhofer Institute for Laser Technology ILT have developed a method which can be used to additively and precisely process metallic materials so that they not only are locally permeable or dense – with graded transitions between the states – but can be manufactured reproducible and in a single production step. Fraunhofer ILT will be showcasing the new LPBF applications at Laser World of Photonics 2025 in Munich from June 24 to 27, 2025.

The newly developed method is based on the proven laser powder bed fusion (LPBF) process, in which metal powder is applied in layers and selectively remelted using a laser. Until now, the focus has been on producing components that are as dense and resilient as possible. "But if we allow porosity locally, for example, by changing the process parameters, we can create controlled permeability," explains Andreas Vogelpoth from the LPBF Process and Systems Engineering group at Fraunhofer ILT.

The result is completely metallic components that are locally permeable – such as to gases or liquids – while still maintaining the required mechanical integrity. The trick is that areas with different densities can be combined within one component thanks to LPBF. The institute can make transitions either with a sharp separation or graded.

Function instead of post-processing

Classic metal foams or fabric structures fulfill similar functions, but usually have to be produced separately and incorporated into components. Not only does this take time, but limits the design freedom and leads to changes in the physical properties of the component due to seams and joints, e.g. an increase in thermal and electrical resistance. The Fraunhofer solution integrates porous zones directly into the component. Thus, post-processing is not necessary. Even complex geometrical shapes with internal structures can be made in this way.

"We are adding new functions to parts made with 3D printing: permeability as a designable feature," explains Vogelpoth. The process is particularly interesting wherever gases or liquids need to be distributed, filtered or channeled in a controlled manner.

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A key area of application is hydrogen technology, specifically for electrolyzers. These consist of complex cell stacks with various functional layers. Fraunhofer ILT is currently investigating whether these layers can be additively manufactured directly, including specific permeable areas. The experts at Fraunhofer ILT aim to reduce the number of individual parts and, thus, improve efficiency while reducing material usage and production costs.

The Fraunhofer ILT team is also already in contact with end users in other areas of applications such as turbomachinery, toolmaking, heat exchangers and filters as well as chemicals. The wide range of possible applications underlines how relevant this development is for high-tech applications.

Exhibit with bubble curtain at the trade fair

At the Laser World of Photonics 2025, Fraunhofer ILT will be showing what such components look like in practice with a concrete demonstrator: A metallic institute logo with integrated porous zones is placed in a transparent water basin. Air flows through the zones at the touch of a button. The permeability can not only be seen, but also experienced.

The porous areas can be reproduced reliably, which the researchers have already demonstrated using computer tomography and cross-sections. They are currently working on the next step as part of a research project: the precise control of permeability via process parameters.

"Our plan is for users to tell us how much permeability is required in which component areas, and we will supply the appropriate design and process parameters," says Vogelpoth.

In contrast to other players who are already investigating similar processes in turbomachinery construction, Fraunhofer ILT is pursuing an open, cross-application approach. It aims to make the process accessible for new fields of application, especially for small and medium-sized companies that previously had no access to such complex manufacturing methods.

The researchers are actively seeking exchange: Anyone who has their own ideas, issues or interest in cooperation is cordially invited to visit the researchers at the Laser World of Photonics from June 24 to 27, 2025 in Munich at the Fraunhofer joint stand (Hall A3, Stand 431) or to contact them directly.

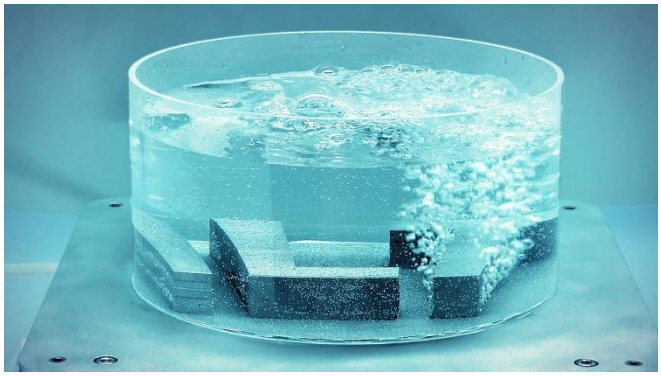

Image 1:
Demonstration of the additive manufacturing of porous structures: The metallic logo of the Fraunhofer ILT illustrates the adjustable permeability through integrated porous zones, controlled at the touch of a button.
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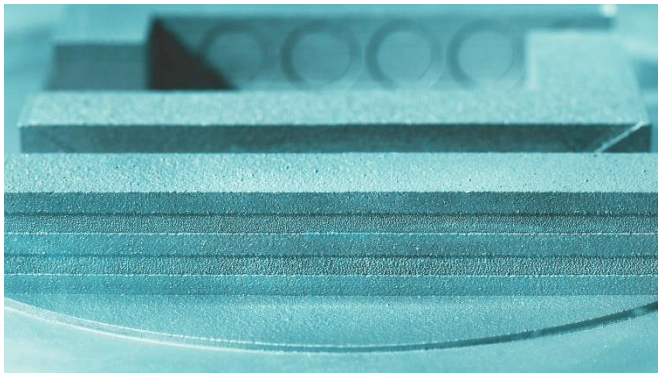

Image 2:
Detailed view of an additively manufactured porous structure illustrating the controlled permeability between dense and permeable areas.
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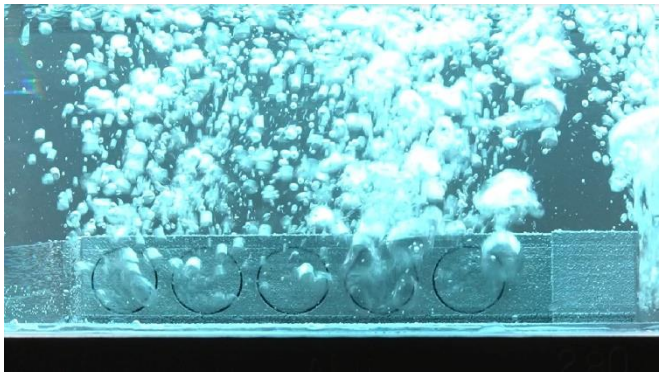

Image 3:
Close-up of the porous zones in an additively manufactured component, demonstrating the targeted control of permeability between dense and permeable areas.
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