Press Release

“Chips Instead of Virgin Powder”

From Scrap and Used Parts to High-Performance Materials: Fraunhofer IWU Opens New Circular Pathways for Aluminum Foam

Aluminum is a key material for sustainable mobility and resource-efficient products, yet its production requires substantial amounts of energy. Researchers at the Fraunhofer Institute for Machine Tools and Forming Technology IWU have now demonstrated how production scrap, aluminum chips, and end-of-life aluminum foam components can be systematically reintegrated into the manufacturing process. Their findings open up new opportunities for the circular production of aluminum foam and could significantly reduce the need for primary raw materials.

Aluminum foam is one of the lightest structural materials available. Thanks to its low-density, high-energy absorption capacity, and excellent damping properties, it is suitable for applications in automotive engineering, machine structures, construction, and energy-efficient lightweight systems, among others. Today, however, aluminum foam is produced primarily from aluminum alloy powders, which are relatively complex and costly to manufacture.

The Fraunhofer IWU researchers therefore focused on a largely overlooked sustainability lever: the use of circular materials within powder metallurgy foam production. Their work centered on clean, single-alloy aluminum chips, production scrap, and end-of-life materials that can be mechanically processed and reused as feedstock for new aluminum foams.

Processed Chips Instead of Virgin Powder

One particularly promising approach involves partially or completely replacing energy-intensive virgin aluminum alloy powder with processed aluminum chips. The investigations showed that grinding and classifying the chips produces a powder-like feedstock that can be successfully converted into foamable semi-finished products. The resulting foams achieve structures and densities comparable to those of conventionally manufactured aluminum foams.

“Using production waste directly within the material cycle offers substantial environmental and economic potential,” explains Dr.-Ing. Jörg Hohlfeld, Head of the Metal Foam Group at Fraunhofer IWU.

Of particular significance is the fact that producing secondary aluminum requires far less energy than producing primary aluminum. As a result, both material costs and CO_2 emissions can be reduced.

Turning Production Waste Back into Functional Materials

The researchers also investigated the processing of larger aluminum residues such as foils, coils, and wheel-rim material. Through multi-stage mechanical processes including cutting, crushing, grinding, and sieving, they generated defined particle sizes suitable for foam production. End-of-life aluminum foam components can also, in principle, be reintegrated into the material cycle. To achieve this, the team developed suitable strategies for comminution, sorting, and material-specific reprocessing.

A particularly important aspect is that recycling is not limited to simple remelting. Instead, Fraunhofer IWU is pursuing so-called solid-state recycling approaches. In these processes, much of the existing material structure is retained, enabling additional energy savings while minimizing material losses.

New Perspectives for the Circular Economy in Lightweight Engineering

The results show that aluminum scrap in powder form can serve as a technically equivalent alternative to newly produced aluminum alloy powder. This brings a significantly more resource-efficient production of aluminum foams within reach. The researchers see this as an important building block for circular value chains in the metal-processing industry, particularly in sectors with stringent lightweight construction requirements, such as automotive engineering, mechanical engineering, and rail transportation.

The work will now be continued with a view toward industrial implementation. Future research activities will focus in particular on stabilizing material properties despite fluctuations in scrap quality, as well as conducting comprehensive life-cycle assessments. These efforts aim to quantify the environmental benefits of scrap-based foam production and prepare the technology for broad industrial adoption.

Research Partners Sought

Fraunhofer IWU is eager to contribute its findings to follow-up research projects and welcomes partners interested in expanding and validating the scientific and data basis for the recyclability and circularity of aluminum foam.

Background: Aluminum Foam

Aluminum foam is an ultra-lightweight metallic structural material with a density well below 1 g/cm³. Owing to its high stiffness-to-weight ratio, excellent energy absorption, and damping characteristics, it is used in applications such as sandwich structures, crash systems, and lightweight components. For many years, Fraunhofer IWU has been researching resource-efficient manufacturing technologies as well as recycling and circular-economy concepts for this material.

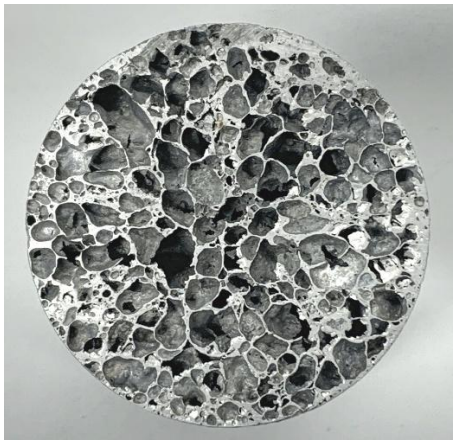

Fig. 1a **Fig. 1b**

Aluminum foam cylinders produced from ground aluminum chips (Fig. 1a): Processed chips can be used to create aluminum foam with a structure comparable to that of foam produced from atomized powder (Fig. 1b), the conventional manufacturing route based on virgin material. © Fraunhofer IWU

Fig.2 Aluminum alloy chips as a feedstock for high-performance lightweight construction materials. © Fraunhofer IWU

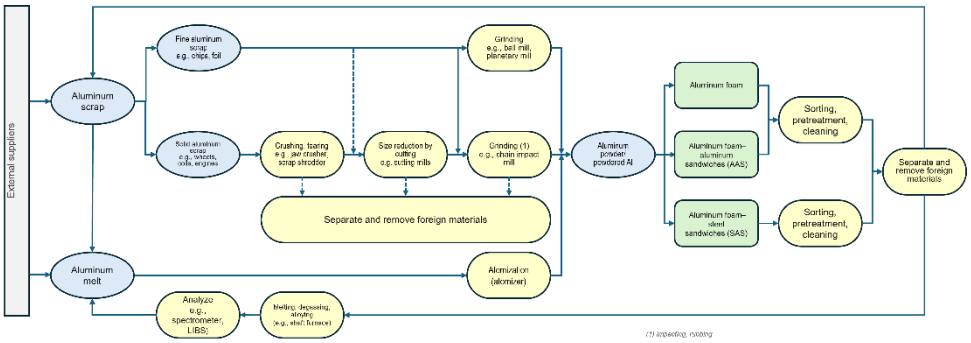

Fig. 3 Circular economy of aluminum foam: production and recycling pathways. © Fraunhofer IWU

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