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1 *Polymer preform and open porous aluminum foam.*

OPEN POROUS ALUMINUM FOAMS AND METAL-POLYMER HYBRID STRUCTURES

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Motivation

Modern lightweight construction requires materials with low density and high specific strength to reach the increased technical requirements for value creation. Furthermore innovative and economical production processes as well as the appropriate functional integration into design units are very important. Open-porous aluminum foams offer the combination of exclusive functional characteristics e. g. a very good permeability and an effective sound absorption, and they exhibit a considerable resistance to elevated temperatures and present superior heat conductivity.
From the viewpoint of the designer various applications, e. g. as heat exchangers, filter elements, transportation elements for liquid or gaseous media and component for sound proofing are in the focus of current developments. Metal-polymer hybrid compounds offer the advantages of both materials in one component. The polymers exhibit special functional characteristics, the aluminum foam represents the basic structure. These materials give the chance for the development of new lightweight components.

Manufacturing

At Fraunhofer IFAM Bremen open porous aluminum foams are produced by infiltration of aluminum melts into polymer structures using a high-pressure-die-casting process. At first, a porous near-net-shape compact from a polymer will be formed. This compact represents the later pore structure, it is the negative form for the final open-porous metal foam. The high solidification rate of the casting process inhibits the melting of the polymer

granules. They will be removed by thermal pyrolysis after the melt infiltration. Thus the pores are direct replications of the polymer granules, therefore elongated pores or graded pore structures can be obtained by proper choice of the granules. The process results in a homogeneous pore structure with reproducible open porosities between 60 and 80 percent. The components can be manufactured in various geometries, e. g. cylindrical shape with a maximum diameter of 100 mm and a length of 100 mm or with rectangular geometry with 100 mm x 80 mm x 18 mm. The melt infiltration of polymers in the high-pressure-die-casting process is also suitable for the production of metal-polymer hybrid structures. In this case the polymer remains in the component and contributes to specific properties like tribology or damping. Both micro as well as macro components can be infiltrated with melts. The manufacturing of open-porous and hybrid materials using the high-pressure-die-casting process is very cost effective and in many cases allows to save expensive assembly steps. The melt infiltration process is possible for aluminum-, magnesium and zinc casting alloys.

Applications

Open-porous aluminum foams are used for heat exchangers, offering the required permeability for fluids or gases. An additional advantage for this application is the high heat conductivity of the aluminum matrix. If a metallic bonding of the sponge with solid aluminum is required, sandwich structures can be realized. With an extra coating of the high inner surface of the aluminum sponge components for adsorption heat pumps or filter elements exhibiting an antibacterial effect can be produced. With a suitable combination of the open porosity and the flow resistance the sponges can also be effective sound absorbers. The hybrid metal compounds offer a high potential for functional applications. According to the choice of the infiltrated material, developments of regenerators and bearings are possible. Additional functions are added via the integration of sensors into the polymer preforms. After the melt infiltration they remain in the hybrid compound.

Our offer

At Fraunhofer IFAM Bremen we offer our expertise for the development and testing of prototypes made from open porous foams and/or metal-polymer hybrid structures. Moreover, we provide

- Feasibility studies and development of components
- Manufacturing of prototypes
- Characterisation of open porous foams
- Coating of open porous foams
- Training, workshops, know-how transfer

2 *Examples of cylindrical components.*

3 *Rectangular hybrid structures.*