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FRAUNHOFER-INSTITUTE FOR MACHINE TOOLS AND FORMING TECHNOLOGY IWU

METAL FOAMS
METAL FOAM CENTER CHEMNITZ

LIGHTWEIGHT DESIGN
... INSPIRED BY NATURE

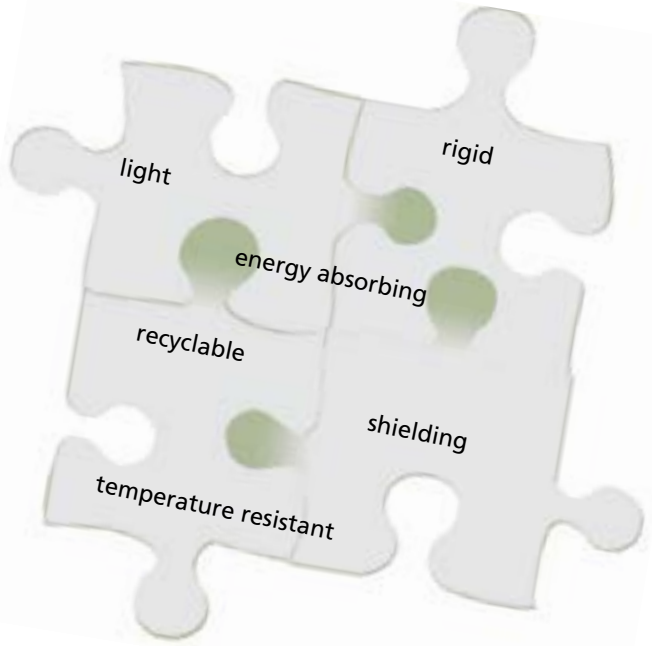
METAL FOAM

This highly porous material is very light, equally to the model of Mother Nature, exemplified by wood and bones. Metal foams excellently absorb energy as vibration, impact and sound due to their cellular structure. Metal foams are, in general, significantly more stable and temperature resistant than plastic foams. Moreover, they are well suited for shielding electromagnetic waves.

The state of the art are foams based on aluminum and zinc which exhibit a density of less than 0.5 g/cm³, depending on the production method.

Metal foam is usually offered compositely with steel and aluminum sheets realized in sandwiches. Sandwiches feature a much higher bending stiffness than massive sheet metal plates with less overall weight. Due to their properties such as high stiffness and crash behavior, metal forms are highly applicable on many working fields.

At the end of their lifetime, metal foams und foam composites can be recycled without any problems.



1 *Aluminum foam*
2 *Car body knot made of aluminum foam*
3 *Y-slide with aluminum foam core*
4 *Slide of a milling machine made of sandwiches with aluminum foam core (serious production part)*
5 *Cross-portal of a milling machine made of sandwiches with aluminum foam core (the world's largest component with aluminum foam)*

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LIGHTWEIGHT DESIGN
... APPLICATION OF METAL FOAM

FIELDS OF APPLICATION

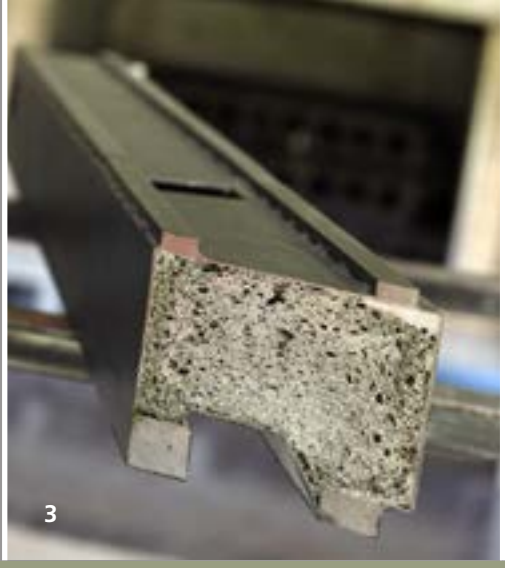
Sandwiches with aluminum foam core und massive cover sheets are excellently suited for lightweight constructions. The light aluminum foam core functions as a rigid core which holds the top layers at a distance. The top layers are responsible for the applied loads. Semi-finished products are significantly lighter than massive plates as the core material exhibits a low density while maintaining the same load carrying capacity.

Due to the high lightweight potential and the very good energy absorption capability the sandwiches are particularly predestinated for machine tools. Due to their lightweight potential, these sandwiches are also highly suitable in the building sector and in the ship building industry as floor, wall and stiffening elements such as ribs.

Complex 3D-components can also be made of aluminum foam. Metal foam can be used as a very good crash absorber in the automotive industry for example, owing to its cellular structure.

The foam formation is associated with a high expansion. The material serves like an adhesive as the foam can bridge very big gaps and creates a metallurgical bonding with metals.

Field of application	**Range of use**
Automotive industry	car body knots, longitudinal beams, crash absorbers
Engineering	fast moving vibrating devices
Building industry	light floor- and wall elements with integrated comfort function, e.g. heat storage and fire protection
Shipbuilding industry	hatches, doors, ribs, superstructures
Railway vehicles	paving tiles, crash absorbers, complete front modules
Design	partitions, adornments, decoration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LIGHTWEIGHT DESIGN
... REALIZED BY FRAUNHOFER IWU

MACHINES CAN LOOSE WEIGHT TOO

In order to create a high level of dynamics animated machine building components need to be light. The less weight needs to be accelerated, the less energy is required. As a result, direction changes can be realized with less effort and in shorter times. Due to the mass reduction, however, the devices become more susceptible to vibrations.

This problem can be solved by using lightweight structures and lightweight material designs in combination, e.g. structures like sandwiches with a low-density core material such as aluminum foam, instead of massive steel elements. Sandwiches possess a much higher flexural rigidity than mass equivalent steel plates. The main reason is the much higher moment of inertia.

A sandwich with a 14 mm aluminum foam core covered by 1 mm steel sheets has the flexural rigidity of a 10 mm steel plate – at only one third of the weight of a steel plate! The combination of lightweight design and the damping of mechanical vibrations predestines aluminum foam sandwiches for the machine tool building industry. Numerous prototypes prove the applicability. Since 2004, the Fraunhofer IWU has mass-produced machine slides of a milling machine out of steel aluminum foam sandwiches for the Chemnitz-based company NILES-SIMMONS Industrieanlagen GmbH.

Despite having the same stiffness, these machine slides are 28 percent lighter than conventional slides made of grey cast iron. Even higher speeds and acceleration rates can be implemented for the processing operation owing to this weight saving.

The current world's largest devices made of steel aluminum foam sandwiches are the two mobile cross-portals of a milling machine for the tool and mold making industry. A large majority of the portal walls and inner supports have been realized in sandwich design. The prefabricated and tailored sandwiches have been joint by welding into a device of approx. 5,900 x 1,400 x 940 mm^3. Measurement tests verify that the portals show a deflection of only 14 µm due to its net weight of approx. 6 t and damping values of the flexural vibrations in x- and z-direction show 2.3 or 2.9 percent.

The above examples prove that semi-finished aluminum products like sandwiches can be joint to very large assemblies with hardly any size restriction. On the one hand, the use of semi-finished products helps to facilitate the production process and then again to reduce development periods and costs.

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FROM CONCEPT TO FINISHED COMPONENT
... EVERYTHING UNDER ONE ROOF

WHAT WE OFFER

You wish to reengineer an assembly or even develop a completely new one? We are prepared to give you our outmost support in the further development of ideas and designs. We simulate your assemblies statically, dynamically and thermally with the help of the Finite Element Method (FEM) so that weak spots can already be recognized and eliminated in this early stage of development. The calculation of several alternatives and a relative comparison to the original construction is already taken into account.

We design foamed parts and units according to your demands. These include conceptual, component and assembly drawings as well as part lists. The construction is performed in close cooperation with your production. If you want to start with a given design, we can offer you consultation on foam-friendly construction of the components.

All production facilities in order to produce aluminum and zinc foam are available at the Metal Foam Center of Fraunhofer IWU. Pure foam and composite parts made of aluminum foam in combination with steel or aluminum can be produced. We generally offer metallurgical connected steel cover sheets – aluminum foam combinations. The overall dimensions of the sandwiches are 1,500 mm x 1,000 mm. Considerably larger dimensions are available upon request.

The processing of these semi-finished products is possible with common processes like sawing and abrasive water jet cutting. Suitable methods for joining are gluing, screwing and welding. We will be pleased to advise you regarding the processing of the semi-finishes products!

Is the aluminum foam not offering the desired effects? In that case, we advise you with the selection of other materials and offer comparative material studies.

Your unit needs stress relief annealing or do you have to conduct technological tests? In case of need, we will gladly supply you with our production equipment consisting of e.g. chamber furnace, continuous furnace and extrusion press.

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