Aluminium foam

For the production of foamed aluminium, Al powder is mixed with a product releasing gas at higher temperature and then compacted. This foaming agent is placed into a mold form and heated up until the agent starts to foam. Immediately thereafter the mold is taken out of the furnace and cooled off, so the aluminium foam part is frozen in shape. The outcome of this process is a closed cell aluminium foam showing a thin casting skin on the surface.

Powder Metallurgy

This technology is creating benchmarks. During this process, metal powders are being compacted using extrusion technologies. This represents an additional technology besides existing sinter technologies, especially for components with 2-Dimensional outlines. Material properties can be designed precisely for requirements. Structural parts with high stiffness, thanks to the various possibilities of combining Non-Ferrous powders can be named as example.

Field of Activities

Aluminium foam

Application of Aluminium foam

The combination of top attributes such as high stiffness, low weight and high energy absorption enables Aluminium foam to qualify for specific requirements within the automotive, aviation, railway and engine building industry. Aluminium foam is also qualifying for other high potential applications in the field of Architecture and Design, where electromagnetic shielding, structural damping, flame resistance and a decorative surface structure is required.

Permanent Cooperation with:

- Slovak Academy of Sciences / Bratislava (Protoyping, Process analysis, plant engineering and construction)
- TU Vienna / Institute of Materials Science and Testing / o. Univ. Prof. Dipl. Ing. Dr. techn. H. Peter Degischer
- Neue Materialien Fürth GmbH / Prof. Dr. R. F. Singer
- LKR - Ranshofen (on-road test)
- MIT - Boston (Computation, Simulation)

Contact:

Alulight® International GmbH
Lach 22
A-5282 Ranshofen
Austria
Phone: (+43) (7722) 64564-0
Fax: (+43) (7722) 64564-610
E-mail: office@alulight.com
Internet: www.alulight.com

The data in this application brochure correspond with the current status of our knowledge and experience. We do not assume any guaranty for the information given. We reserve the right to alter any product data as a result of technical progress or further developments in the manufacturing process.
Characteristics

- high stiffness at very low density
- Absorption of high impact energies, regardless of the impact direction
- heat insulation
- highly efficient in sound absorption, electromagnetic shielding and vibration damping
- heat resistant and not inflammable
- fully recyclable

Summary of Results:

- the storage modulus of Alulight® does not depend on resonant frequency – it can be considered as a static value of the modulus
- Alulight®’s modulus of elasticity depends strongly on density. The dependence obeys the power law function with an exponent of about 1.6
- the base alloy composition has no significant influence on the modulus of elasticity of Alulight® (tests with densities up to 1000 kg/m³).

Main Applications:

- stiff structural components with minimized masses – especially beam and membrane-like structures
- as a filling material for hollow structures Alulight® helps to move resonant frequencies outside operating frequency range
- heat resistant structures with high stiffness and low density made at reasonable cost
- isotropic properties, non-combustibility, form stability and simple recycling make it an alternative to wood (Alulight® float on water)
- heat resistant, isotropic and stiff cores for sandwich structure

<table>
<thead>
<tr>
<th>Material</th>
<th>density $p$ [kg/m³]</th>
<th>modulus $E$ [GPa]</th>
<th>$E/p^2$ [$10^{-5}$ GPa.kg²/m⁶]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alulight®</td>
<td>500</td>
<td>5</td>
<td>2,0</td>
</tr>
<tr>
<td>epoxy:</td>
<td>1300</td>
<td>3</td>
<td>0,3</td>
</tr>
<tr>
<td>steel:</td>
<td>7800</td>
<td>210</td>
<td>0,4</td>
</tr>
<tr>
<td>aluminium:</td>
<td>2700</td>
<td>69</td>
<td>1,0</td>
</tr>
<tr>
<td>glass:</td>
<td>2500</td>
<td>70</td>
<td>1,1</td>
</tr>
<tr>
<td>concrete:</td>
<td>2500</td>
<td>50</td>
<td>0,8</td>
</tr>
</tbody>
</table>

The structure modulus elasticity of foam cannot be determined as usual from the slope of the stress strain curve. This is due to plastic deformations in the early stress stages. Elastic vibration loading is therefore the more appropriate method. Alulight® was tested as follows: The rod-shaped sample was vibrated longitudinally with an “impact-hammer”.

Test sample: Alulight® rod-shaped specimens (diameter of 17 mm, min. length of 300 mm) with varying densities and base alloy compositions were used for the tests.
Characteristics of Panels

One has the choice between pure aluminium foam and additionally reinforced panels with densities ranging from 0.4–0.6 kg/dm³. Expanded metal may be embedded within the aluminium foam in order to improve bending stiffness.

Alulight®-sandwiches can also be produced with plain or shaped aluminium cover sheets either on one or both sides, if higher bending strength or specific surface quality is required. Pre-cut panels with outlines after customer requirements are available on request.

Alulight®-panels can be nailed, screwed, bolted joint, using connection elements built in the foamed structure or mounted using variety of standard tools for wall, ceiling and floor mounting.

Alulight® panels are available with casting skin in various dimensions. Our panels can be machined as easily as wood, using conventional techniques like sawing, drilling, turning, etc.

Care should be taken, as the very thin surface skin can be removed by machining, thus revealing the inner pore structure.

### Deflection of Alulight®-panels and sandwiches:

![Deflection chart]

### Material

<table>
<thead>
<tr>
<th></th>
<th>AlSi</th>
<th>AlMgSi0,6</th>
<th>AlMgSi0,6+T6</th>
</tr>
</thead>
<tbody>
<tr>
<td>E-modulus:</td>
<td>GPa</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>min. plastic collapse stress:</td>
<td>MPa</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>min. bending stiffness:</td>
<td>MPa</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>bending stiffness:</td>
<td>%</td>
<td>210</td>
<td>210</td>
</tr>
<tr>
<td>(Al-sheet, same weight)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>heat conductivity at 20°C:</td>
<td>W/m.K</td>
<td>6–15</td>
<td>6–15</td>
</tr>
<tr>
<td>electrical conductivity:</td>
<td>10⁸ S/m</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>energy absorption:</td>
<td>MJ/m³</td>
<td>4,5</td>
<td>4,5</td>
</tr>
<tr>
<td>loss factor:</td>
<td></td>
<td>0,003</td>
<td>0,003</td>
</tr>
</tbody>
</table>

Density: 500–550 kg/m³.

Data were based on a closed geometry 50x50mm with a wall thickness by 7mm.

Contact:
Alulight® International GmbH
Lach 22
A-5282 Ranshofen
Austria
Phone: (+43) (7722) 64564-0
Fax: (+43) (7722) 64564-610
E-mail: office@alulight.com
Internet: www.alulight.com

The data in this application brochure correspond with the current status of our knowledge and experience. We do not assume any guaranty for the information given. We reserve the right to alter any product data as a result of technical progress or further developments in the manufacturing process.
Impact absorbers protect passengers and fragile devices from the effects of sudden impact. This is achieved by converting the impact energy into plastic deformation energy, keeping the peak force acting on the protected object below the level which could cause damage. The material must also provide a long deformation path to sufficiently reduce the deceleration of the protected object.

The energy absorption properties can be adjusted through foam density respectively pore size and may be optimized through further heat treatment. Because of those excellent absorption properties Alulight® aluminium foams are already used as serial part for crash absorption by leading automotive manufactures.

Summary of Results:
- Alulight®'s cell walls start to buckle (wrought alloys) and fracture (cast alloys) at low stresses allowing for extensive compression with an adequate deceleration path

Main Applications:
- deformable car body parts for protection of passengers from crash (also side protection)
- safety pads for lifting and conveying systems
- protective covers for high speed rotating machines

Contact:
Alulight® International GmbH
Lach 22
A-5282 Ranshofen
Austria
Phone: (+43) (7722) 64564-0
Fax: (+43) (7722) 64564-610
E-mail: office@alulight.com
Internet: www.alulight.com

The data in this application brochure correspond with the current status of our knowledge and experience. We do not assume any guaranty for the information given. We reserve the right to alter any product data as a result of technical progress or further developments in the manufacturing process.
Design and architecture:

A process of design and modelling which also takes into consideration the aesthetic aspects. Intuitive creation of buildings and objects to raise emotions through individual beauty.

With Alulight®, a new, ageless material is available to transfer theory and philosophy of sensual perception into practice.

Due to the moulding capabilities of Alulight® there is also the possibility to produce 3 dimensional shapes.

If required aluminium foam can be finished, coated or also gummed. If a particular smooth surface is desired the aluminium foam has to be primed before lacquering to clear the roughness of the textile like casting skin.

We are pleased to assist you by searching for special lacquers, coatings or surface treatments.

Aesthetic with Attributes:

- 4 to 5 times lighter than bulk aluminium, stiffer than solid aluminium at the same weight
- each surface is individual
- flame resistant
- 100% recyclable
- good magnetic fields and electromagnetic waves shielding efficiency
- lower thermal conductivity than solid aluminium

Application potentials:

- furniture
- lay construction
- adornment for desks or chairs
- cladding constructions
- ceiling plates
- signboards with embossed text, letters or company logos.
- fire protection / defence applications
Resonance Decrease:

Structural damping is the effect of internal friction within changing a material vibration energy into heat. This reduces excessive noise and vibration by converting them into heat to be expelled into the surrounding area.

Vibration energy in cellular structures is dissipated by the slight plastic deformation of the thin walls separating the pores. It can also be reduced by friction between the surfaces of cracks appearing in the pore walls.

Summary of Results:
- The loss factor of Alulight® is significantly higher than the loss factor of Aluminium
- The damping ability of aluminium foam allows to reduce the noise induced by vibrations
- damping ability of Alulight® depends significantly on resonant frequency

Main Applications:
- structural material for various cases gear boxes or covers which suffer from mechanical vibrations
- damping material to fill hollow parts or profiles

Contact:
Alulight® International GmbH
Lach 22
A-5282 Ranshofen
Austria
Phone: (+43) (7722) 64564-0
Fax: (+43) (7722) 64564-610
E-mail: office@alulight.com
Internet: www.alulight.com

The data in this application brochure correspond with the current status of our knowledge and experience. We do not assume any guaranty for the information given. We reserve the right to alter any product data as a result of technical progress or further developments in the manufacturing process.
Electromagnetic waves can cause malfunctions in various electronic devices. Negative influence on human health is also being investigated. Electromagnetic wave shielding should be used to protect electronic devices and rooms interiors from electromagnetic waves.

The material for this purpose should possess good electric conductivity to minimize the penetration of waves into the material and low magnetic permeability to convert magnetic energy into heat.

Preliminary Results:
- **Alulight®** possesses very good magnetic field shielding effectiveness.
- Electric shielding effectiveness of **Alulight®** is comparable with the one of silicon steel for frequencies up to 10 MHz. **Alulight®** is superior for higher frequencies.
- Electromagnetic shield effectiveness of **Alulight®** depends significantly on the frequency.

Main Applications:
- cover boxes for electronic devices
- wall and ceiling plates for protection of rooms against entering or releasing of electromagnetic waves within the frequency range of 0.1 to 1000 MHz
Conductivity
thermal / electric

Only a small portion of Alulight®’s cross section is conductive. These are the pore walls with the conductivity value of the base alloy. The pore walls are continiously covered with non-conductive alumina. The main part of the cross section is formed by the pores filled with air which is non-conductive. Alulight® is therefore far less conductive than bulk aluminium.

Summary of Results / Electrical Conductivity:
- electric conductivity decreases with density of Alulight®
- electric conductivity of Alulight® is a non-linear function of density and obeys the power-law dependence with an exponent of 1.5

Summary of Results / Thermal Conductivity:
- Thermal conductivity of Alulight® is only 1/10 of that of base aluminium

Main Applications:
- recyclable heat shields
- boxes for electronic devices, where also electromagnetic shielding or crash energy absorption are important