

TALAT Lecture 1410

Aluminium foam

24 pages, 16 figures

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Objectives:

Mainly because of the strong demand of the transport industry for lower operating costs, higher payloads, improved environmental compatibility as well as increased passenger safety and comfort aluminium foams have become more and more important during the last few years. They had been identified as a new class of material of great interest due to their unique combination of properties derived from their cellular structure and metallic behaviour. But not only the automotive industry offers a great potential for the use of aluminium foams. Possibilities for applications of aluminium foams are also to be seen in other areas, for example in building and construction or in engineering. This chapter gives an overview about the possibilities of producing aluminium as a foam, their specific properties and the possibilities for application.

The chapter will cover

- foam production technologies
- processing of aluminium foams
- properties of aluminium foams
- areas of application
- future prospects

Prerequisites:

- General knowledge in materials engineering
- Some knowledge about aluminium powders and solidification of aluminium melts
- Engineering background in manufacturing processes
- Overview about the application areas of aluminium

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1410 Aluminium Foam

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1. Introduction

In the last years the interest in metallic foam has increased considerably. The main reasons for this development are new concepts for light weight cars and other light constructions.

Natively existing porous materials with higher stiffness and low specific weight exist and these examples prompted the development of artificial cellular materials made from polymers, ceramics and glass which have many applications for damping, insulating and cushioning.

It therefore seemed reasonable to make a cellular material out of metals since if this would be possible such a foam could offer interesting perspectives due to the combination of the metallic properties and the special features of a foam.

In the last 40 years many attempts have been made to produce metallic foam structures, they were not successful, because of their relatively high costs. Furthermore, it was not possible to produce a metallic foam with reproducible properties. Problems occurred with a low foamability of the molten metal, the varying size of cellular structures or solidification shrinkage. However, recently these issues have been solved by extensive research that has led to the development of new production technologies. These new foaming technologies allow the production of foam of a significant higher quality. In particular the foaming of aluminium was successful.

Metallic foams, particularly these of aluminium, offer a great potential for applications in the automotive industry. Foams are light weight, energy absorbing and incombustible and have good sound absorbing properties. Other applications are also possible in engineering, building, household goods and the chemical industry.

At the moment there is no serious bulk application of aluminium foam, but many prototypes show their great potential. The foams are still expensive, because they are mostly not produced in an industrial scale. A forecast of the IFAM Bremen indicates that after the year 2000 there will be the first commercial products made out of aluminium foam. It is to be expected that foam products will find wide applications in the future.

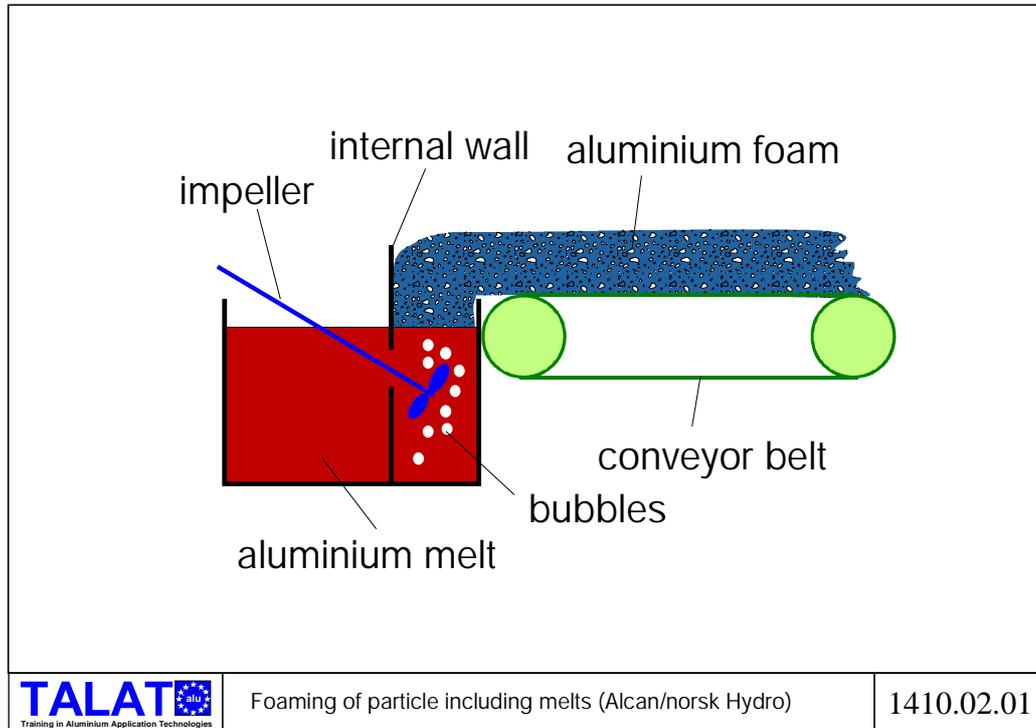
2. Production methods for aluminium foams

During the last ten years several technologies had been developed for the production of metallic foams or similar porous metal structures, but it has to be stressed to be mentioned that only some of these processes will be suited for the production of aluminium foams in an industrial scale. The technologies can be divided into those that start with the liquid metal or with a metal powder.

2.1 Foams made from metallic melts (LM foams)

All these methods start with the melting of the metal that will be foamed.

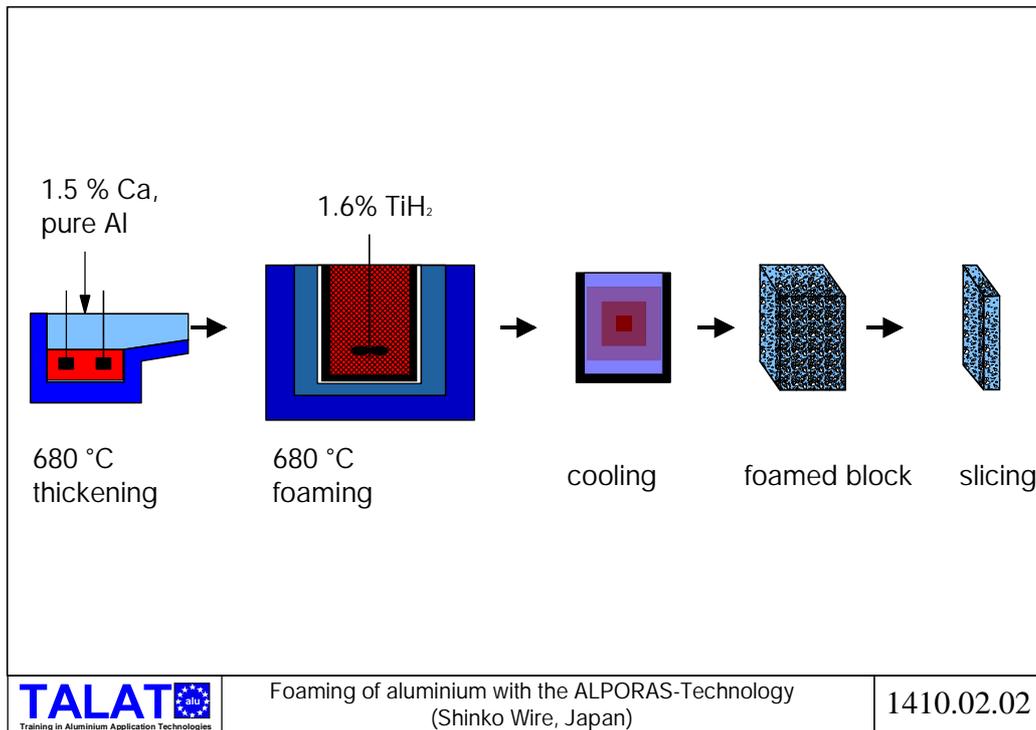
a) Alcan/Norsk Hydro process



The first method is to foam directly by injecting gases into the liquid metal. The **Alcan/Norsk Hydro** process is shown in [Figure 1410.02.01](#). It includes an addition of SiC or Al₂O₃ (10 to 15%) to the melt to increase its viscosity. After this a gas (air, nitrogen or argon) is injected into the melt using a rotating impeller. Then the floating foam is continuously pulled off from the surface of the melt. Foam slabs of considerable size (e.g. 0.1 x 1 x 10 m) can be produced by this way. The product of this technology is a porous sheet material with porosities ranging from 80% to 97%

b) Alporas process

Shinko Wire Co. Ltd. (Osaka, Japan) has developed another method, known as the Alporas process ([Figure 1410.02.02](#)), Japan. This technology includes an addition of 1.5% calcium to the aluminium melt for adjusting the viscosity. Calcium is introduced to the molten aluminium at 680°C and stirred for 6 minutes in an ambient atmosphere. The thickened aluminium melt is poured into a casting mould and stirred with an addition of powdered TiH₂ (foaming agent) by using a rotating impeller. If a sufficient amount of the hydride is added (usually 1.6%) the foaming agent decomposes under the influence of heat and releases hydrogen gas. Thereby, the foam is expanding and fills up the mould within 15 minutes. It is cooled down by fans in the mould and solidifies as a block with porosity between 89% and 93%. A cast Alporas block is 450 x 2050 x 650 mm and weighs 160 kg. The blocks are cut into sheets of the required thickness.



c) Other processes

- The GASAR process is based on the varying solubility of hydrogen depending on the pressure. The metal is melted in an autoclave and then brought under a high pressure, that allows solving of a high amount of hydrogen. This saturated melt is poured into a mould within the autoclave. This is followed by a directional solidification of the melt under reduced pressure, which causes a precipitation of the hydrogen gas at the solidification front. The maximum porosities are low (5 – 75%).
- Other technologies are basing on the well-known investment casting process. To build a mould these technologies (Duocel and Cellmet) are working with a reticulated PU-foam, that is filled with a slurry of heat resistant material. After drying the polymer is removed and the molten metal is cast into the resulting mould. Then the mould material is then removed by pressurised water. A metallic foam is obtained that represents exactly the foam structure of the original PU-foam. Porosities typically range from 80% to 97%. This process differs from those describe above in that it produces a foam with open cells.
- The making of foams by pouring the melt over a bulk of a filler material in the form of inorganic granules or hollows spheres is also possible.
- Electro-galvanic deposition is not used with aluminium.

2.2 Foams made from metal powders (PM foams)

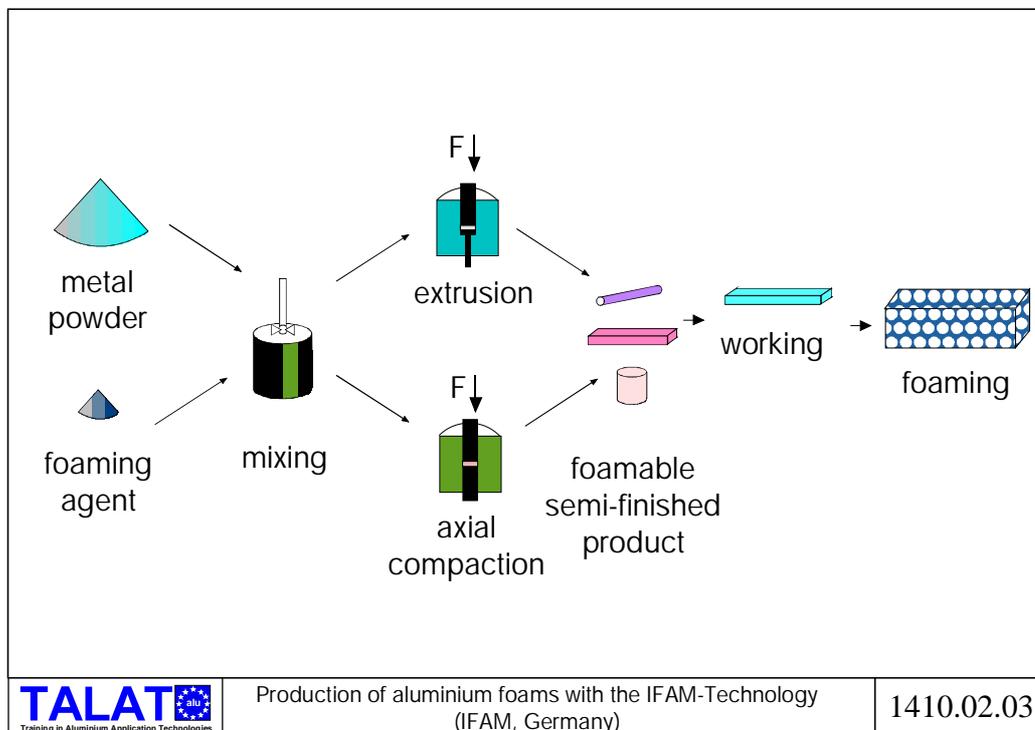
Among these technologies the processes are of great importance for the production of aluminium foams, that are basing on the use of a foaming agent. Instead of foaming agents inert gases can be directly entrapped in the precursor.

a) Expansion with a gas released by a foaming agent (IFAM, MEPURA)

Technologies basing on the use of foaming agents (**Figure 1410.02.03**) start with the mixing of the metal powders (pure metal, alloy or powder blend) with a foaming agent (for aluminium and its alloys usually 0.4 – 0.6 wt.-% TiH_2). The most common alloys for foaming are wrought alloys of the series 1xxx (pure aluminium), 2xxx (Al-Cu) and 6xxx (Al-Mg-Si) or cast alloys, e.g. AlSi7 and AlSi12. The last have an excellent foamability due to their low melting point and their good foaming properties.

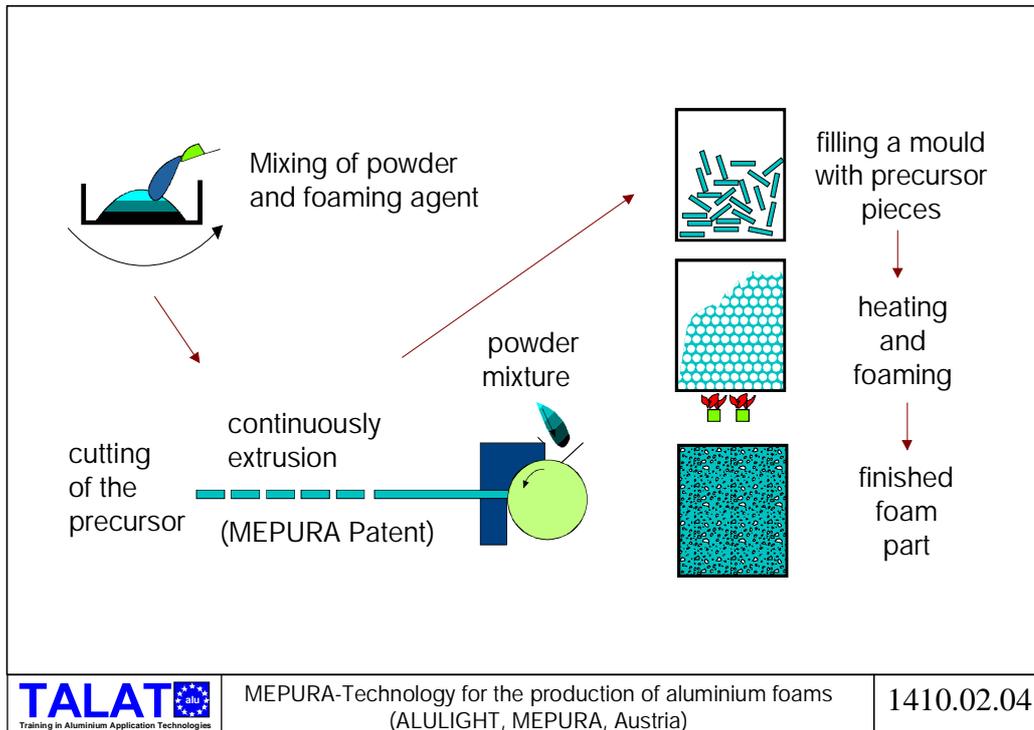
The mixture is compacted to a dense, semi-finished product. In the IFAM-process (Fraunhofer-Institute in Bremen, Germany) the material is compacted by uniaxial compression, CIP, powder rolling or extrusion depending on the required shape. The MEPURA process (Alulight by Mepura, Ranshofen, Austria) uses a continuous extrusion technology for the compaction of the mixture.

The next step is a heat treatment up to the melting point of the matrix metal and above the decomposition temperature of the blowing agent. At this temperature the foaming agent decomposes and releases hydrogen gas. This gas leads to an expansion of the material resulting in a highly porous structure with closed cells. By cooling under the melting point the foaming process is stopped. The porosities range from 60% to 85%.



The quality of the resulting foams is depending on several factors, e.g. conditions of compaction (technology, degree of deformation, temperature, pressure, time), powder quality (particle type, particle size, alloy, mixing conditions), foaming parameters (temperature, heating rate, cooling time, atmosphere), and the geometry of the semi-

finished product. The density of the foam can be controlled by the content of the foaming agent, by the temperature and by the heating rate.

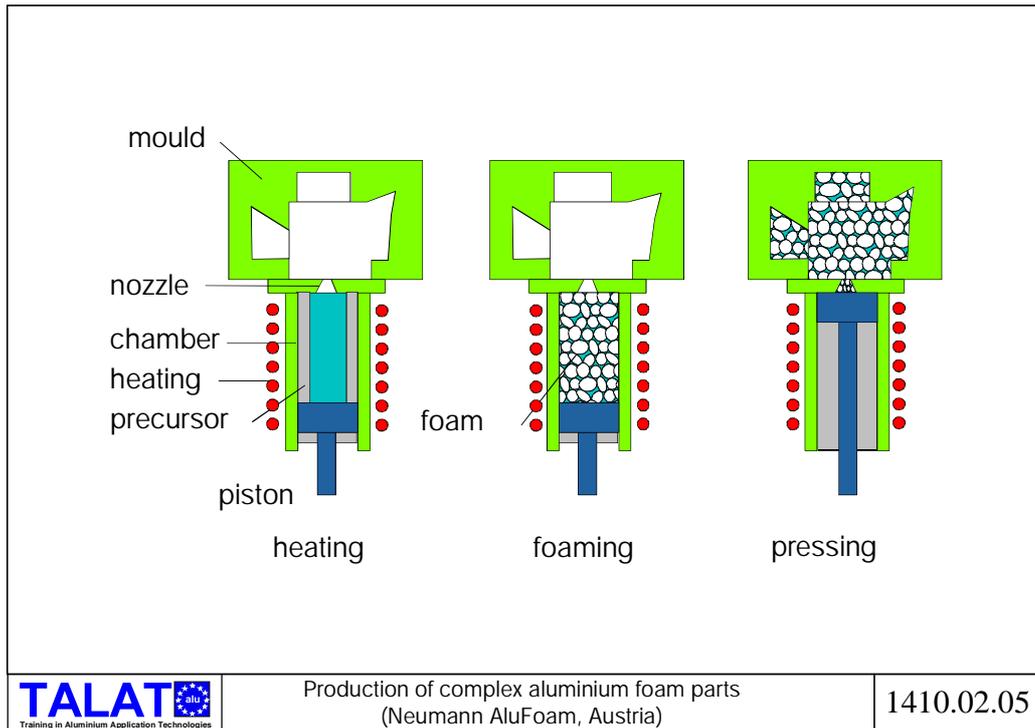


For attaining the desired shape of the foam it is necessary to insert the precursor material into a hollow mould. Otherwise the result would be a lump of metal foam with an undefined shape. By foaming insides closed mould almost any shape can be made.

Foam and metals parts can be joined during the foaming process. For example tubes can be filled with aluminium foam in various ways ([Figure 1410.03.04](#)).

Another method is the production of sandwich panels consisting of foamed metal and face sheets ([Figure 1410.02.04](#)). These can be obtained by gluing the face sheets to a sheet of foam or roll cladding of aluminium or steel sheets onto a foamable precursor material. The last way produces a metallic bonding between all layers of the sandwich. The resulting “precursor sandwich” can be deformed prior to foaming, e.g. by deep drawing.

Quite complicated foam parts can be obtained by injecting a liquid expanding foam into suitable moulds and allowing for final expansion there (Neuman AluFoam, Marktl, Austria, [Figure 1410.02.05](#)). The finished parts have densities between $0,5 \text{ g/cm}^3$ and $1,0 \text{ g/cm}^3$. The first steps of this technology are comparable with the MEPURA process: i.e. mixing of aluminium powder plus a foaming agent and continuous extrusion into a compact foamable precursor. But now the precursor is heated in a foaming chamber up to the melting point of the alloy. This leads to the formation of liquid foam, which is injected in a controlled manner into the mould that can be of sand or metal. This allows cost effective large and small-scale production and prototyping. Such foam parts can also be used as cores in aluminium die-casting (see section 5.7).



b) Processes with an entrapped gas

In this technologies a hermetic lockable container is filled with the aluminium powder. After this a gas e.g. Argon is pressed into the powder, e.g. Argon. The gas fills all spaces between the powder particles. If this mixture is heated the powder particles melt together and entrap the gas. If the so produced metal block is rolled and heated the entrapped gas expands and delivers a metal foam (McDonnell Douglas).

3. Properties of aluminium foams

Aluminium foams are isotropic porous materials with several unusually properties, that make them especially suited for some applications. Due to their low densities between 0.3 g/cm^3 and 0.8 g/cm^3 the foams can float in water (in case of closed porosity). Foams exhibit a reduced conductivity for both heat and electricity. The strength is lower than conventional dense aluminium and declines with decreasing density. Foams are stable at temperatures up to the melting point. They are incombustible and non-toxic.

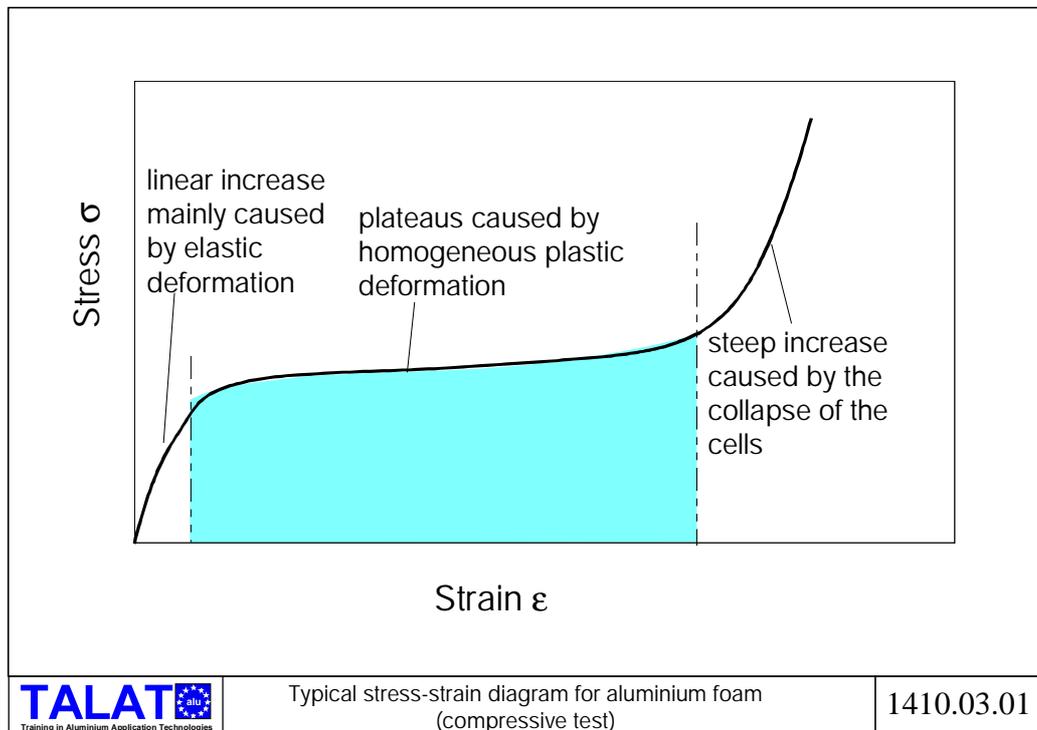
In most foam production technologies the properties can be varied over a wide range by controlling the production parameters. Some examples of properties are given in table 1.

Table 1: Properties of aluminium foams (IFAM and MEPURA)

alloy	Al 99,5 dense	Al99,5	AlSi12	
foaming agent	-	TiH ₂	TiH ₂	
density g/cm ³	2,7	0,4	0,54	0,84
compression strength MPa	-	3	7	15
energy absorption at 30% compression MJ/m ³	-	0,72	2	4
kJ/kg	-	1,8	3,7	4,8
modulus of elasticity GPa	67	2,4	5	14
electrical conductivity m/(Ω·mm ²)	34	2,1	n.a.	n.a.
thermal conductivity W/(m·K)	235	12	13	24

3.1. Mechanical properties

Due to their cellular structure foams behave differently in testing when compared to conventional metal. Therefore conventional testing methods can not be used, for example tensile testing. The test with the most meaningful results is the compression test which delivers as a result the typical compressive stress-strain diagram with a division into three parts (Figures 1410.03.01 and 1410.03.02). This behaviour was found to be typical for foams with both open or closed cell walls.



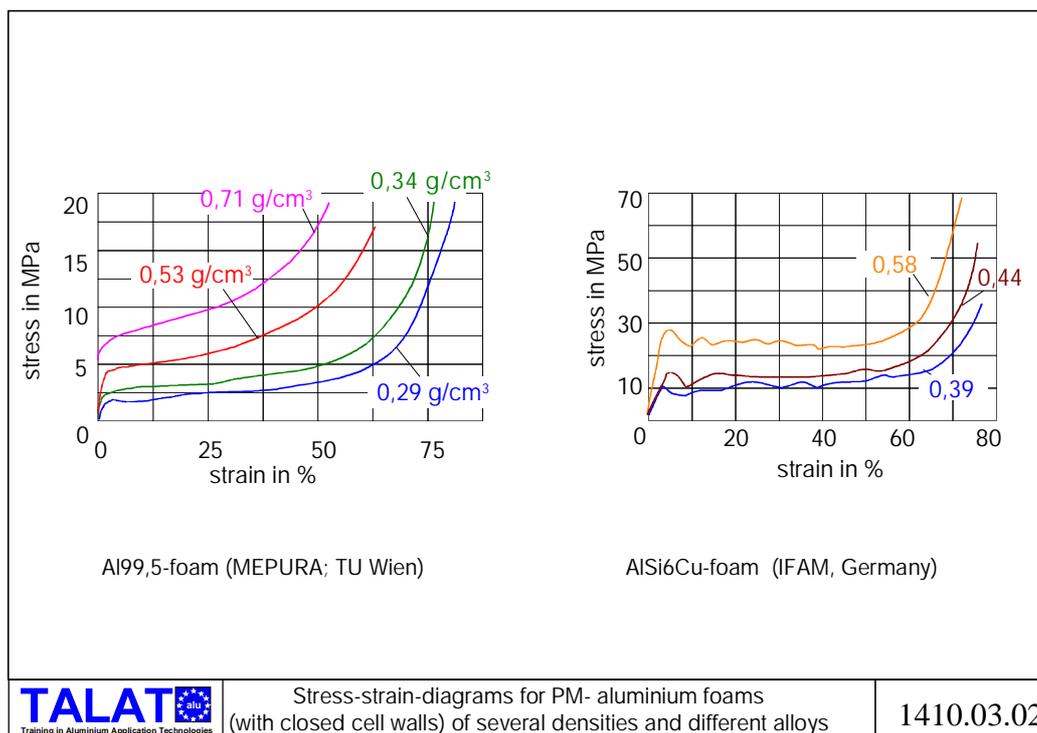
It shows a linear increase of stress (1) at the beginning of deformation and a plateau regime of nearly constant stress in the middle (2), that is followed by a step increase in flow stress at the end (3). The reasons for this typical behaviour are to be seen in the following processes:

- The first stage is not only caused by an elastic deformation as it is in the case of dense metals. In foams irreversible (plastic) deformations can occur at low stresses.
- The plateau is caused by a homogeneous plastic deformation.
- The steep increase 3 is caused by the collapse of the cells. Opposing cell walls begin to touch each other.

It has been shown that the tensile strength of foams is nearly the same as the stress at which the plateau occurs. That's why this "plateau stress" is used as the main property value of foams.

Due to the special shape of the curve - especially the long plateau - metallic foams are capable of absorbing large amounts of energy at relatively low stresses (the potential for absorbing energy increases with an increasing area under the plateau). Metallic foams behave exactly like PU-foams – with the difference that their strength is about 30 times higher at the same level of porosity.

Several factors are affecting the behaviour of foams in the compression test, mainly the density of the foam and the choice of the matrix alloy, see **Figure 1410.03.02**. For PM-aluminium-foams the length of the plateau increases with decreasing density. But it is also to be seen that the plateau stress is lower in the case of low density. That means, the strength increases with increasing density. The same results were found for other alloys and foams produced with other technologies.



Also the content of alloying elements has a great influence on the mechanical properties. As shown in **Figure 1410.03.02** lower values were reached by foams made out of commercially pure aluminium. The same behaviour was found for foams produced with other technologies.

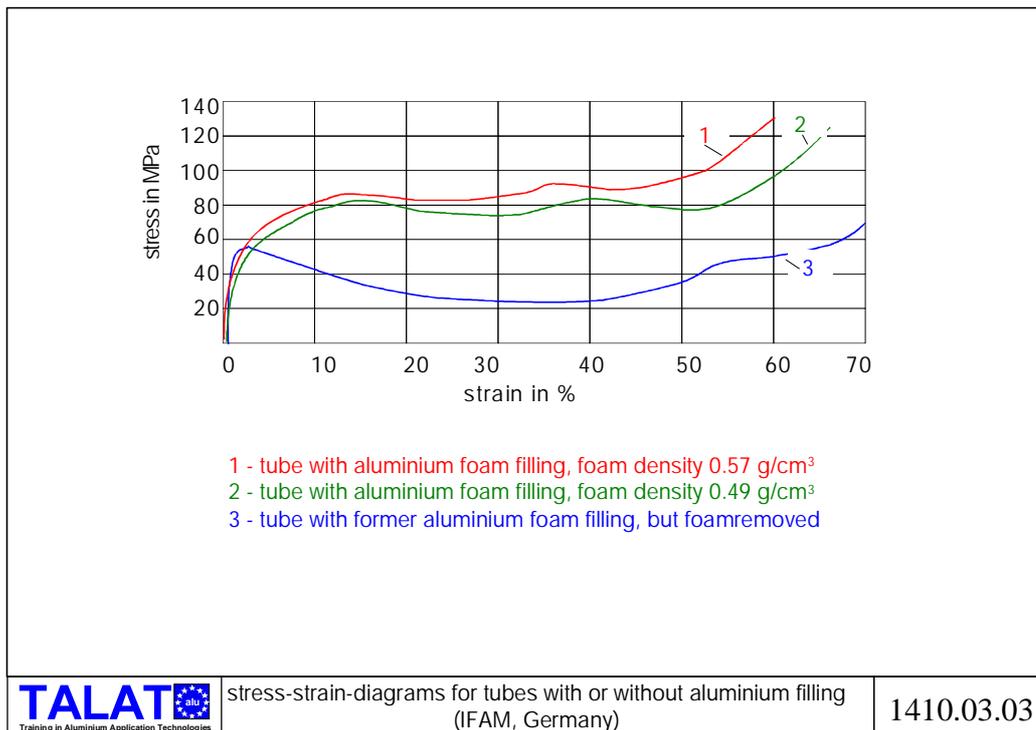
The plateau stress of foams with open or closed cells is nearly the same, if foams of the same alloy and the same density are compared.

The surface of the foam also affects the properties. If the foam is tested with its dense casting surface (“casting skin”) higher stresses are reached compared to foam without the casting skin (e.g. removed by milling or cutting). The reason for this is that the casting surface acts as a stiffening component – comparable to a sandwich structure. The same behaviour was noticed by testing a tube that is filled with aluminium foam. The foaming direction has not a great influence. That’s why foam can be seen as isotropic materials.

As is the case with solid metals foams can also be thermal treated, but this process is more difficult due to the low thermal conductivity of the porous structure. Quenching is difficult because the same cooling rate is not reached in the whole part. Water can not be used as quenching agent, because it would destroy the cells. Compressed air is used, which leads to lower cooling rates. Because of these difficulties the strength can not be increased to the values for dense metals.

3.2 Strength of sandwiches – Absorption of energy

As mentioned above the casting skin gives a higher strength to the foam material due to a stiffening effect. Using sandwiches of steel or aluminium plates that are filled with aluminium foam can also increase this stiffness.



Tubes can also achieve a higher stiffness and rigidity by filling it with aluminium foams. **Figure 1410.03.03** shows this effect in a comparison of the results of compression tests of several tubes with and without filling. In the case of filled tubes the plateau stress is higher than in the unfilled tubes. Also the plateau of the filled tubes is longer, that means these tubes are better suited for the absorption of crash energies. The aluminium foam prevents an early folding of the tube. If the tube in later stages is

folded the aluminium foam is compacted – an effect that counteracts further compressive deformation. Some examples for aluminium foam filled tubes are illustrated in **Figure 1410.03.04**.

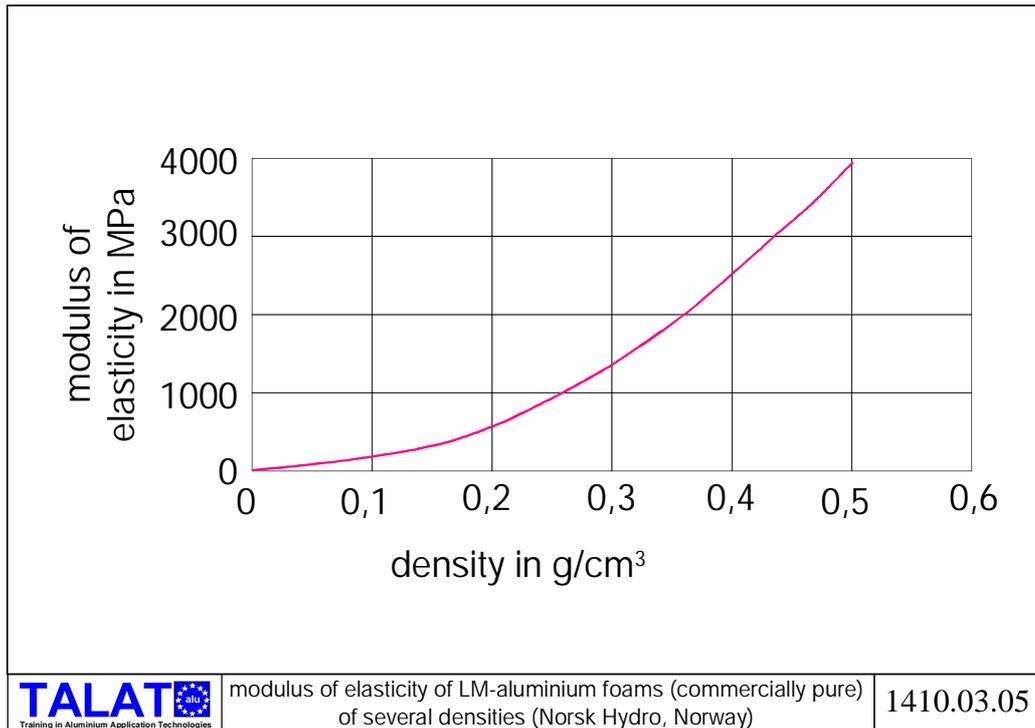
The area below the plateau is larger – and therefore the potential for absorbing energy - in the case of filled tubes. Therefore filled tubes can be used as crash-absorbers for cars. Filled tubes with a smaller diameter can absorb the same energy as unfilled tubes of a higher diameter. Therefore filled tubes need less space - a great advantage for the automotive industry!



3.3 Modulus of elasticity

The modulus of elasticity is, in combination with the geometry an important characteristic for the estimation of the stiffness of a finished metallic product. The specific modulus (E/ρ) of aluminium foams is much lower than that of dense aluminium. For example: The specific-modulus of an Al99,5-foam is about $6 \text{ Gpa cm}^3/\text{g}$ (i.e. 2.4 Gpa for a density of the PM-foam 0.4 g/cm^3), while that of a dense aluminium is about $25 \text{ Gpa cm}^3/\text{g}$ (i.e. 67 GPa for a density of 2.7 g/cm^3).

As shown in **Figure 1410.03.05**, The modulus of foams increases with increasing density. This effect appears in both cases – PM- and LM-foams. Therefore the modulus can be adapted to a special application by controlling the density of the foam.



3.4. Physical properties

The physical and chemical properties of foams are different than those of dense metals. But these differences can give advantages for several applications.

a) Conductivity

The conductivity of foams for both electricity and heat is generally lower than in a dense metal: The reason: The metallic cells walls are the lowest share of the foam volume; by far bigger share is made of gas-filled pores. Moreover the walls are coated with an oxide layer (see Table 1). So it is understandable, that the conductivity increases with higher density of the foam.

The thermal conductivity of foam can be estimated as 1/10 that of a dense metal of the same alloy. With an additional oxidising treatment the thermal conductivity can be decreased further. The thermal expansion coefficient remains the same as for dense metal and that means foams will not lose their shape up to high temperatures. Because of their low thermal conductivity foams can act as thermal insulating material.

b) Sound-proofing properties

Another advantage of foams is their excellent sound and vibration absorbing. Beside this foams can absorb vibrations. The dissipation factor is lower than this of dense aluminium. In the foam sound waves are reflected by the irregular porous structure. The vibrational energy causes minimal deformations of the cell walls and is converted into heat energy. Therefore the intensity of the reflected sound decreases. The results of

several investigations showed that the absorbing degree could be increased when the pores of the foam are very fine and homogeneous. Also the more connections between the pores also brings an improvement. It seems that open cell walls lead to a better sound absorbing effectiveness. Therefore an extensive research is made with these foams.

Investigations of the sound absorbing coefficient of Alporas showed that rolled Alporas has a large sound absorbing coefficient equivalent to glass wool (see 4.4.).

3.5. Chemical properties

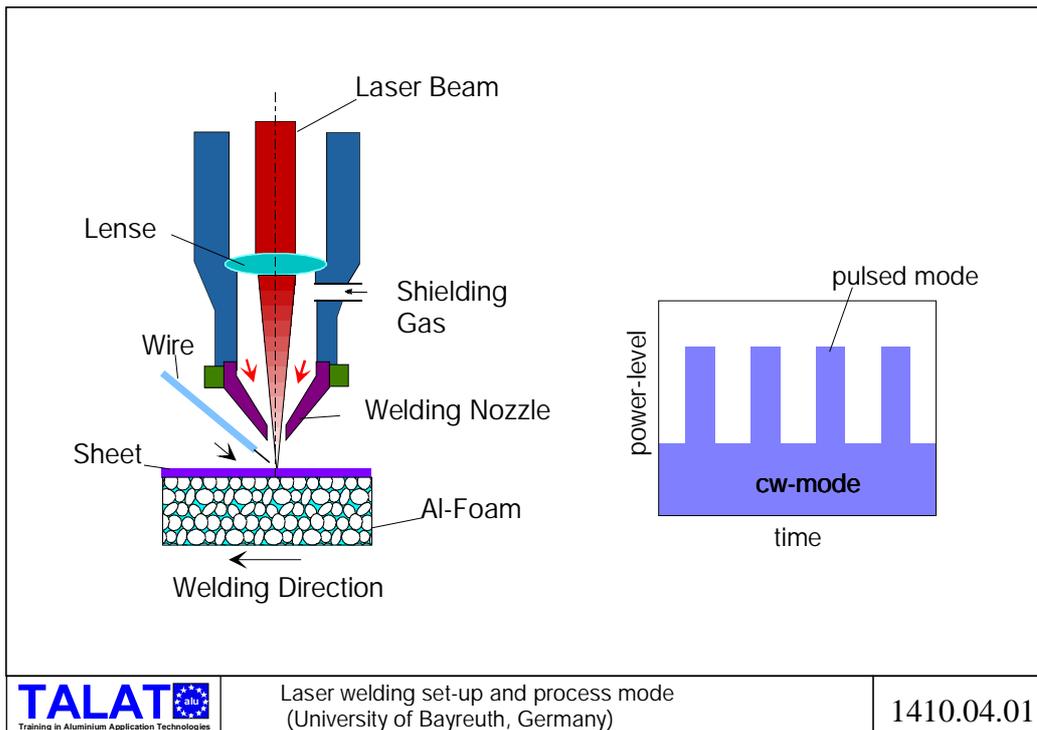
Aluminium foam is incombustible. Under the influence of heat foams do not release toxic gases. The corrosion behaviour is comparable to that of dense aluminium alloys, but further investigations will provide more information.

Important notice:

All foam properties are depending on the specific structure of the material. This structure is developed during the production process, and in consequence the production process has a great influence on the properties of the foam. Foams of different production technologies can have different properties, even if they are made out of the same alloy. Therefore for an application it is useful to list all the required properties of the foam and than choose the production technology and the alloy.

4. Processing of foams

Aluminium foams can be processed without any problems. Foam blocks can be sawed, drilled and cut. It is easy to drive nails or drill holes into the foam (Foams containing SiC or Al₂O₃-particles can create some problems due to these hard particles). Aluminium foams are easy to bend. Chemical adhesives can be used to stick pieces of aluminium foams to each other or to other materials.



Foams can be joined to dense materials by screwing and riveting. Using sockets or sleeves can increase the durability.

Soldering is possible, but can bring some corrosion problems due to the need to remove the dense oxide layer of aluminium.

Welding is possible, especially laser welding. This technology is advantageous because it gives very low heat input into the foam. That means, the foam structure will be stable.

Figure 1410.04.01 shows the welding set up. The filler is placed in front of the laser head (along the welding direction). The welding can be made with a Nd:YAG-Laser (see **TALAT 4200**). For the special task of welding foams it was advantageous to work with a combination of cw- and pulsed mode. Examinations showed that such welding is very useful for the joining of aluminium foams to dense sheet. Compared to glued samples the toughness of welded joints was higher.

Aluminium foams can be painted with organic or inorganic paint. The painting has no influence on the sound absorbing properties of the foam.

5. Applications

There are many possible engineering applications for metallic foams ranging from light-weight construction, sound and heat insulation to energy absorption applications. As is mentioned above, aluminium foam can become an interesting material for applications in the automotive industry and in aerospace, but also in engineering and in construction. The use of foams can satisfy the demand for light-weighting parts of several branches of industry. Compared to synthetic materials (plastics, PUR-foams), which are also light weight, aluminium foams have special advantages: the good heat resistance, a higher strength, the incombustibility and the possibility for an easy recycling. Up to now aluminium foams have been applied on a small scale in particular for demonstration and

testing, but various ideas are currently under investigation and some commercial uses are being made.

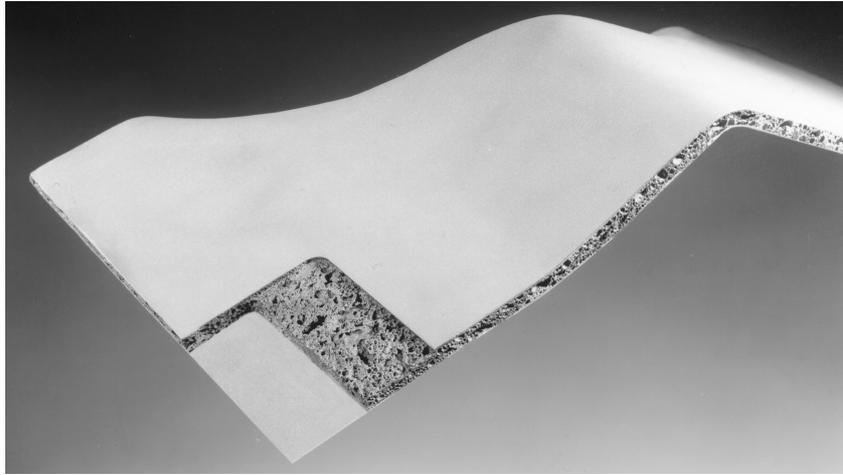
Because foams are relatively expensive, their use is motivated by an interesting sum of their specific properties. But it is to be expected that the price of foams will decrease in the next years, as the volume production increases.

5.1 Automotive applications

Driven by a range of environmental concerns and social pressures backed by legislation there is a move towards reducing weight in vehicles. Another requirement is the improvement of the passive safety of cars, which is mainly influenced by the choice of materials and the car design. Also important are all aspects of materials recycling.

In view of this background the good energy and sound absorbing properties of the aluminium foam support the use of foams in passenger cars. Three main applications of metallic foams can become important in a car – energy absorption, lightweight construction and insulation:

1. The first application is illustrated in the case of crash-absorbers against side and frontal impact. In fact, many of today's vehicles include deformable energy absorbing elements within the vehicle structure. These elements, which represent the crushable zone, have to absorb the collision energy for the rigid passenger cell protection. These elements (e.g. fenders and side members, pillars next to car doors, or other elements, which are in danger of buckling or being compressed or have to absorb a large amount of energy) can be filled with aluminium foams (see examples for foam filling of profiles in [Figure 1410.03.04](#)). In trucks aluminium foams can be used for stiffening of the underside protection. With these elements it will be possible to induce a controlled, programmed deformation of the crash zone in cars with maximum energy absorption. This is important especially in the case of the new compact city cars, where the realisation of such energy absorbers is a difficult task because of the limited space available.
2. The good relation between weight and stiffness supports the use of foams for large-area light-weighting automobile body sheets and structural parts, that are used in areas of the cars with increased requirements on stability. Examples are trunk lids, engine hoods and sliding roofs. All these parts should suffer no elastic deformations caused by the air stream. Vibrations must be avoided. Aluminium foams with their good insulation properties can be a good solution for these components. Another example is the stiffening of convertibles and the bodies of commercial vehicles.

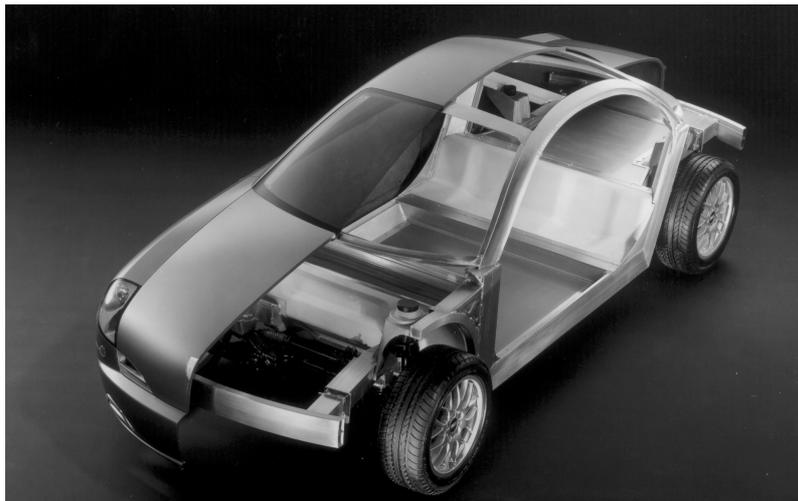


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cross-section through an ASF
 /Aluminium Foam Sandwich, Karmann, Germany)

1410.05.01

3. To the third group belong applications that use the good sound absorbing and thermal insulating properties of aluminium foams. The sound absorbing properties make foams useful for a sound insulating covering of the engine compartment of cars. The objective in this case is it to prevent transfer of noise into the passenger compartment and into the environment.



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prototype AFB
 /Aluminium Foam Body, Karmann, Germany)

1410.05.02

An interesting concept was developed by Karmann, Osnabrück, Germany, with the Aluminium Foam Sandwich AFS (see [Figure 1410.05.01](#)). AFS is a foam filled aluminium sheet. It is produced out of a foamable precursor material and two aluminium sheets. This combination is rolled into the desired shape. After this the material is brought into a furnace, where the foaming takes place up to thickness between 8 and 12 mm (the outer aluminium sheets have a thickness of about 1mm). Gluing is not necessary. AFS is 50% lighter and up to 10 times stiffer than a comparable steel sheet. Compared to a dense aluminium sheet the thermal insulation is 95% higher. The ideal combination of all those foam properties makes AFS to an excellent material for car bodies. Due to the high torsional strength and stiffness it is possible to reduce the number of parts that have to be assembled for a car body.

An example for the use of AFS is the AFB (Aluminium foam body, [Figure 1410.05.02](#)) concept that was developed as a prototype. AFS parts in combination with a space frame are stiffening the car body. The stability of this space frame is 30% higher due to the use of the AFS-parts.

Another interesting idea is the making of “tailored blanks”, where only these parts are stiffened with aluminium foams that have higher requirements to their stiffness.

5.2. Aluminium foams in aerospace applications

Due to its lightweight aluminium foams can become important for the aerospace industry. For example, aluminium foam sheets or sandwich panels could replace the expensive honeycomb structures. This would have several advantages, for example reduced costs. Another important advantage is the isotropy of the properties of such panels and the absence of any kind of adhesive bonding. The latter could help to maintain the integrity of the structure in cases of fire. However, an important issue, which is addressed in current investigations, is the fatigue behaviour of aluminium foams and panels.

5.3 Aluminium foams in ships

In ships the need for lightweight materials is also important. But, in comparison with cars, a high flexibility of materials processing is needed, because ships are not built in large series and are not built with highly standardised parts. Therefore aluminium foams or panels can have great advantages. Prerequisite for the use will be the development of suitable fastening elements and the investigation of corrosion of aluminium foams in salt water. First investigations on closed-cell-PM-foams showed, that a sodium chloride solution could enter only the uppermost layer of the foam without causing structural defects.

5.4 Aluminium foams in building and construction

Building and construction applications are good possibilities for the use of aluminium foams mainly because of their good fire penetration resistance and thermal insulation properties. For example foam parts or foam-filled panels can be used as elements in facades on the outside of buildings or wall coverings inside of buildings. In both cases

aluminium foams can serve as energy saving elements because of their good thermal insulation properties.



Another advantageous property for buildings is the excellent acoustic insulation of aluminium foams. Aluminium foam panels can be used as sound absorbing materials in railway tunnels, under highway bridges or inside of building. As an example **Figure 1410.05.03** shows an Alporas-foam laid on the underside of an elevated expressway for noise absorption. A sound absorbing structure is laid on a noise reflecting surface of an elevated viaduct to absorb the vehicle noise, thus relieving the noise nuisance to the neighbourhood residents.

Another field of application are light-weighting structural elements. These can be used for mobile bridges. Aluminium foams or foam panels could also be used for reducing the energy consumption of elevators by a lightweight construction.

Due to its lightweight, aluminium foams are easy to handle. They can be easily installed without mechanical lifting equipment. This is perfect for high locations, for example ceilings, walls and roofs.

5.5 Aluminium foams in the household and furniture industry

Because of its interesting, unique surface aluminium foam offer a great potential for designers. It can be used for lamps, tables or household articles and accessories. In combination with wood the surface of the aluminium foam can bring new effects into a room. Furniture made out of foam is light weighing, which can be a great advantage in offices or at fairs and exhibitions.

5.6. Aluminium foams in engineering

For the paper industry it is possible to make light-weighting rolls with aluminium foam filling. Foams can also serve as heat exchangers, heat shields, filters or carriers for catalysts. Another possibility is the use as electromagnetic wave shielding materials. Foams can be used for ceilings and walls of rooms containing electronic equipment.



5.7. Foamed aluminium cores for aluminium casting

Casting that are used in cars are often made with weight-saving cavities. These cavities can be filled with aluminium foams in such a way that foamed parts replace the sand cores, which is usually used for the preparation of cavities. The foam parts does not have to be removed after casting. This method accomplishes closed lightweight sections in the casting and creates internal configurations (stiffeners) not feasible with sand cores. Also relatively small cross-sections can be filled up with foamed cores. Beside the additional stiffening effect the use of foams has several other advantages, for example an increase of the capability of castings to absorb crash energy. They suppress noise and vibration of the structure. The use of foam cores avoids costs of sand cores, sand removal and reclamation and enables the application of casting techniques so far not accessible with sand cores (e.g. squeeze casting, thixocasting, high pressure die casting, according to Neuman Alufoam, Austria, examples see [Figure 1410.05.04](#)).

6. Recycling

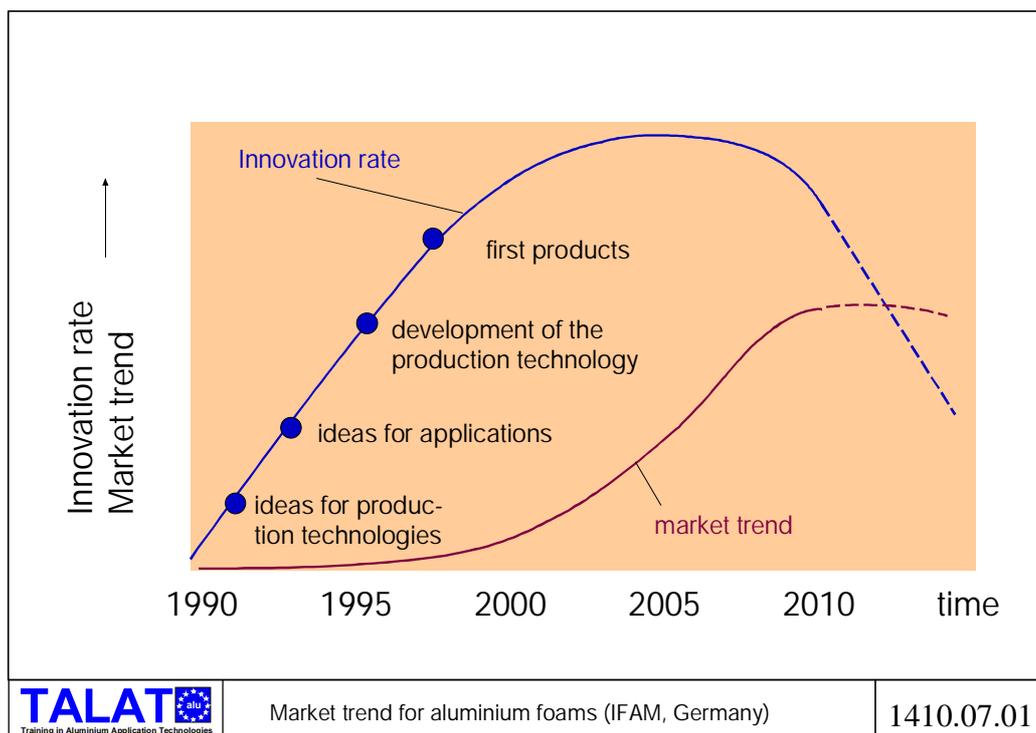
Aluminium foams can be recycled without any problems. In some cases e.g. very low density or big parts, it would be better to press the foam before melting. The melting technology is the same as it is in the case of dense aluminium scrap.

7. Summary and outlook

The research field of aluminium foams is very young. Many questions have to be answered in the future and at the moment a lot of investigations are being made, that include for example

- the foam production in an industrial scale,
- further improvement of foam properties
- the determination of the foam properties of several alloys
- costs analysis of the foam production
- the search for new application

Figure 1410.07.01 shows the expected development for the future. It is likely that the commercial use of foam parts will become true within the next ten years.



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