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Light-metal foams: Some recent developments

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Abstract

Metallic foams have now reached the maturity of development in terms of process stability, materials properties and costs required for industrial applications. The fine-tuning of the manufacturing process carried out in the past few years has been responsible for this success. Nowadays, Al foam panels as large as 2.5 m × 1.5 m in area and having a uniform pore structure are commercially available. In parallel to this development, new processing routes are being explored, including foaming with novel blowing agents, foaming by application of under-pressure, foaming of scrap and of other metals such as magnesium. Some of the steps of these developments are reviewed.
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1. Introduction

The first ideas to foam metals date back to the 1920s, but only since the 1950's and 1960's, actual production technologies have been developed [1]. In the 1970s, foamed aluminium materials of good quality became available. Commercial success, however, was restricted, probably due to cost issues. In the 1980s and 1990s, a second surge of process development enlarged the range of available materials and led to some small commercial applications [1]. This is the current status: metal foams can be made by processing aluminium powders or melts and are produced for a range of applications, mostly architecture.

There are a number of commercial aluminium foam manufactures: the company Pohltec metalfoam in Cologne (Germany) is a producer of aluminium foam sandwich panels made by foaming densified mixtures of aluminium and TiH_2 powders. Cymat Corp. (Canada) and Aluinvent (Hungary) are suppliers for foams made by injecting gas into particle-metal suspensions. Foamtech (Korea), for example, produces foams by admixing TiH_2 blowing agent to aluminium melts.

A large part of aluminium foam application is currently in the architectural and design sectors. An example is shown in Fig. 1, featuring a foam-cladded building in the Swiss Alps. The panels were made from aluminium foam sandwich panels produced by Pohltec metalfoam, Cologne (Germany). The unique surface resembling natural stone was prepared by partially remelting one of the face sheets of the panels.

Other applications include automotive parts and components of tools and machines. The market for aluminium foams is currently quite small, which is why new developments and a reduction of materials' costs are necessary.

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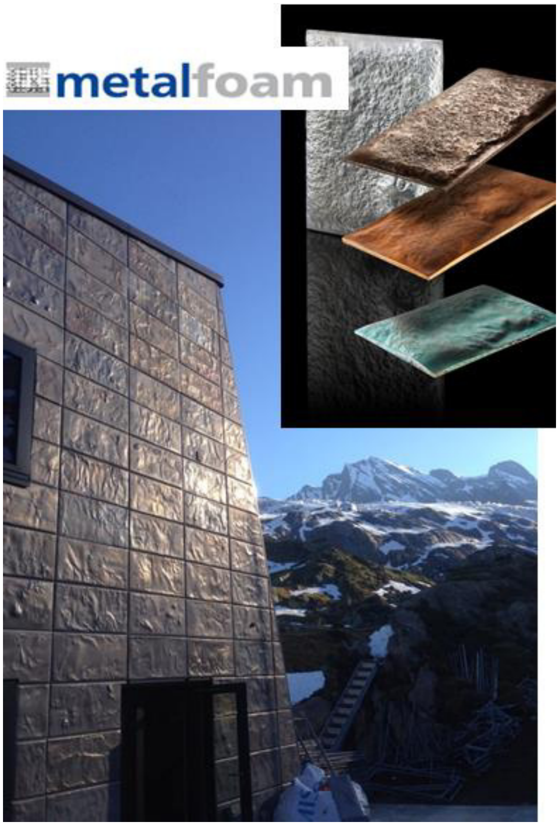


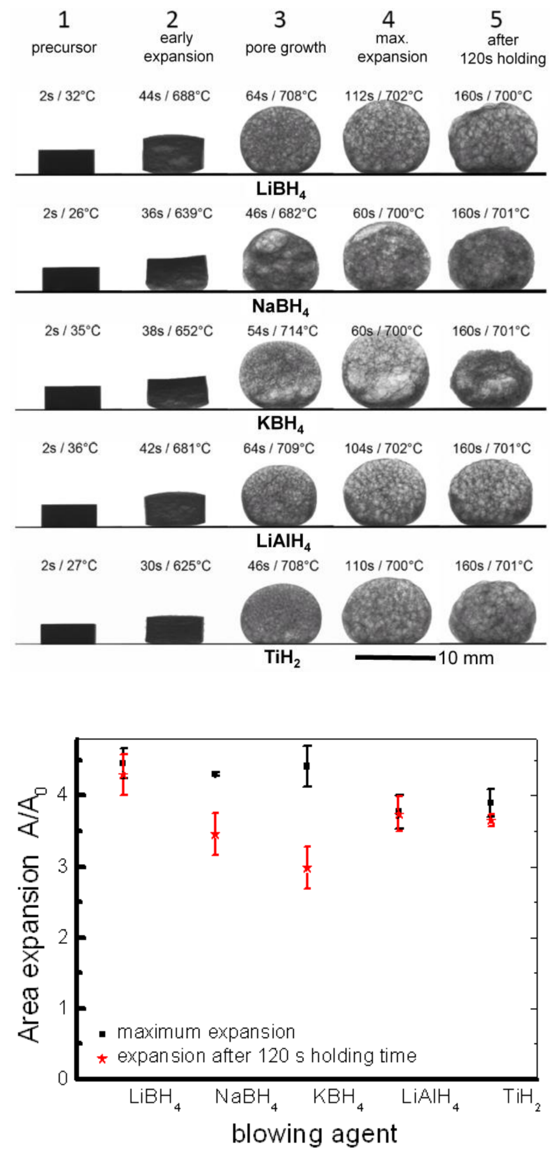
Fig. 1. Aluminium foam tiling of the Anenhütte in the Swiss Alps. Inset: different AFS surface treatments (Courtesy W. Seeliger).

This paper focusses on some recent suggestions on how to improve foaming of light metals. The aim is to make better and less expensive foams and to extend the range of foamable materials to magnesium alloys.

2. Improving the powder route of foam manufacture

2.1. Novel blowing agents

When manufacturing Al alloy foams from metal powders, usually the blowing agent TiH_2 is used. Other possible blowing agents have not been systematically investigated. Especially mixed hydrides based on alkaline elements contain a high amount of hydrogen. Use of them might lead to a cost advantage compared to TiH_2 and possibly to other improvements. To evaluate such hydrides, $LiBH_4$, $NaBH_4$, KBH_4 and $LiAlH_4$ powders were acquired and applied in the usual way to promote foaming, i.e. 0.5 wt.% of each hydride was admixed to a blend of Al, Si and Mg powders, the mixture was hot compacted and foamed at 700 °C. The foaming process was followed in-situ by X-ray radiography. The corresponding foams are shown in Fig. 2 for five stages of the foaming process. The traditional blowing agent TiH_2 was included for matters of comparison.



(a)

(b)

Fig. 2. a) Radioscopic images in various stages of expansion of alloy AlSi8Mg4 containing 0.5 wt.% blowing agent. The foaming temperature was 700 °C. b) Increase of projected foam area A compared to initial area A_0 given as ‘area expansion’ A/A_0 achieved at maximum expansion and after 120 s of holding at 700 °C [2].

The radiographs demonstrate the ability of all the hydrides to promote foaming. In terms of foam quality, however, the Na and K-based compounds yield an inferior result. $LiAlH_4$ is comparable to TiH_2, while $LiBH_4$ is the best blowing agent in this series, but more expensive than $LiAlH_4$.

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