

Foaming kinetics of Al-Si-Cu alloys

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Abstract

The gap between the decomposition temperature of blowing agent and melting temperature of aluminium alloys is considered to play a key role for future structure of aluminium foams by the powder metallurgical route. One way to improve foaming is the usage of new alloys with lower melting temperatures. One promising alloy-system is Al-Si-Cu. The influence of the copper content on the expansion of powder metallurgical aluminium foams containing 6% Si is studied with two different methods of expansion measurement, mechanical expandometry and in-situ x-ray expandometry. We characterize the foaming behavior of alloys quantitatively, in order to explain the effect of melting temperature on foaming kinetics.

1. Introduction

Metallic foams can be produced by the powder metallurgical (PM) route [1]. Metal powder is mixed with a blowing agent and compacted to a precursor material. This precursor material can either be further processed or directly foamed. Foaming means melting the material in a furnace, so that gas released by the blowing agent forms bubbles in the melt. Unfortunately, for aluminium alloys, the gas release start temperature (-400°C) of the common blowing agent TiH_2 is lower than the melting temperature of most alloys. The result is gas being released in the solid or early semi-solid state, forming cracks instead of bubbles and leading to a very inhomogeneous pore structure and gas losses to the environment. The two principal ways to encounter this problem are either the pre-treatment of the blowing agent to delay gas release [2], which means pre-oxidizing the TiH_2 powder, or the application of an alloy that melts at lower temperatures.

One way to decrease the melting temperature of the precursor material is using an aluminium-silicon alloy. The binary phase diagram shows an eutectic point at a silicon content of 12.6% and 577°C , which is much closer to the gas release temperature range of TiH_2 than pure aluminium (660°C). Improved results in metal foaming were achieved with hypoeutectic alloys. The currently most common alloy in PM metal foaming is the AlSi7 casting alloy.

In some cases, however, there is a need for new alloys with an even lower melting temperature range, especially developed for metal foaming. One example are Aluminium Foam Sandwiches (AFS) [3], which are manufactured by roll-cladding of face sheets to foamable precursor, followed by foaming. An alternative alloy to AlSi7 used in the production of AFS is the AlSi6Cu6 alloy. The lower liquidus temperature compared to AlSi7 makes it possible to use high-strength EN AW-60XX alloys as face sheets, which would melt if an AlSi7 core were heated up to a temperature high enough to provide a satisfactory expansion.

