Frictional Behavior of Aluminium MMC Foam Synthesized Using Dual Foaming Agent

Shamim Haidar, Department of Mechanical Engineering, Aliah University, Kolkata, India
Mukandar Sekh, Department of Mechanical Engineering, Aliah University, Kolkata, India
Joyjeet Ghose, Department of Production Engineering, Birla Institute of Technology, Ranchi, India
Goutam Sutradhar, Department of Mechanical Engineering, Jadavpur University, Kolkata, India

ABSTRACT

In the present article, an attempt is made to develop aluminium foam indigenously. The experimental setup for the production of aluminium foam is designed and fabricated. Investigation are made into the use of dual foaming agents (i.e. TiH₂ and CaCO₃) along with SiC to develop suitable aluminium foams which can be utilized for various engineering products like load-bearing elements, crash resistance elements etc. The process is standardized to produce aluminium foam with specific density with minimum variability. This aluminium foam produced possesses a very low coefficient of friction. This work successfully characterized the frictional properties of the developed material. In order to define the Frictional properties of this material, a mathematical model which uniquely defines the frictional behavior of this modified Al-MMC foam has been developed.

KEYWORDS

Al-Si MMC Foam, Dual Foaming Agent, Frictional Behavior, Frictional Behavior of Cellular Materials,
INTRODUCTION

Metal foam is a type of cellular solids, having a combination of properties such as high stiffness with very low density and a capability to absorb impact energy (Gibson & Ashby, 1997; Simone & Gibson, 1998). The main focus of the present study is to produce and characterize low cost, low density aluminium foams by indigenously designed and fabricated equipment. Therefore, the basic objective of this study is to synthesize Aluminium foams of different constituents. Aluminium foams, produced by melting Aluminium alloy (LM6) containing blowing agent(s) and vigorous stirring (Haidar & Ansary, 2016). TiH$_2$ is a known agent for producing Aluminium Foams (Degischer, Kriszt, Andrews, Sanders, & Gibson, 1999). As TiH$_2$ begins to decompose into Ti and gaseous H$_2$ when heated above about 465°C, large volumes of hydrogen gas are rapidly produced (Matijasevic-Lux et al., 2006), creating bubbles that leads to a closed cell foam, which requires a high melt viscosity. This is achieved by the addition of Silicon Carbide (SiC) particulate to the melt Aluminium before stirring, which increases the viscosity of the melt and hence allows liquid Aluminium to be stable at a temperature of TiH$_2$-decomposition (465°C).

The mechanical and surface properties of aluminium foams are yet to be characterized properly (Greneestedt, 1998; Degischer, Kriszt, Andrews, Sanders, & Gibson, 1999; Andrews, Sanders, & Gibson, 1999; Ashby et al., 2000; Clyne & Gergely, 2000; Lu & Ong, 2001; Lenard, 2002; Gergely, Curran, & Clyne, 2003; Tzenng & Ma, 2006; Bryant, 2006). Therefore, the basic intention of the present investigation is to determine the frictional characteristics of the closed cell Aluminium foams developed in the laboratory. The outcomes of the experimental investigation are considered for building a theoretical model so that it can be further referred for different industrial applications. A setup is developed to measure the frictional forces during compressive deformation of aluminium foam. The setup successfully utilized tool force dynamometer for measurement of frictional forces in real time. A friction behaviour model is developed and the theoretical results are correlated with the experimental data. It is found that the heat treatment of metal hydrides prior to production of foam produces better results.

SYNTHESIS OF AL-MMC FOAM

The material under investigation is closed cell aluminium foam, manufactured through Stir-Casting route in the laboratory, using aluminium alloy (LM6: consisting of 0.1% Cu, 0.1% Mg, 0.13% Si, 0.6% Fe, 0.5% Mn, and trace amount of Zn, Pb, Sn and rest Al). The achieved high viscosity, due to addition of SiC in the melt, allows liquid Aluminium to be stable at a temperature of TiH$_2$-decomposition (465°C) (Sutradhar, 2015; Haidar & Ansary, 2016).

2 - 3% foaming agent (Titanium Hydride) is added to the mold. TiH$_2$ begins to decompose into Ti and gaseous H$_2$ when heated above about 465°C. Thus, large volumes of hydrogen gas are rapidly produced, creating bubbles that leads to a closed
Thermo-Mechanical Analysis on Thermal Deformation of Thin Stainless Steel in Laser Micro-Welding
[www.igi-global.com/article/thermo-mechanical-analysis-on-thermal-deformation-of-thin-stainless-steel-in-laser-micro-welding/146823?camid=4v1a](www.igi-global.com/article/thermo-mechanical-analysis-on-thermal-deformation-of-thin-stainless-steel-in-laser-micro-welding/146823?camid=4v1a)

[www.igi-global.com/chapter/non-conventional-technologies-selection/212430?camid=4v1a](www.igi-global.com/chapter/non-conventional-technologies-selection/212430?camid=4v1a)