Materials and Design 32 (2011) 2413–2422

Contents lists available at ScienceDirect

Materials and Design

journal homepage: www.elsevier.com/locate/matdes

Technical Report

Effect of glass in aluminum matrix on workability and strain hardening behavior of powder metallurgy composite

D.R. Kumar [a,*], C. Loganathan [b], R. Narayanasamy [c]

[a] Department of Mechanical Engineering, Mookambigai College of Engineering, Kalamavur-622 502, Tamil Nadu, India
[b] Department of Mechanical Engineering, St. Joseph's College of Engineering & Technology, Thanjavur-613 001, Tamil Nadu, India
[c] Department of Production Engineering, National Institute of Technology, Tiruchirappalli-620 015, Tamil Nadu, India

ARTICLE INFO

Article history:
Received 4 September 2010
Accepted 3 December 2010
Available online 9 December 2010

ABSTRACT

A complete experimental investigation on workability behavior of the Al–Glass has been carried out during cold upsetting. The present study has been performed to evaluate the effect of different percentage of Glass addition in Powder metallurgy (P/M) preforms of Al–Glass composite on workability behavior. The material studied in this paper is aluminum with glass as reinforcement. Glass content has been varied from 0% to 8% with particle size of 60 μm. The experimental results were analyzed for workability under triaxial stress state condition as a function of the relative density. The formability stress index (β), stress ratio parameters (σ_0/σ_{eff}) were obtained for each percentage addition of Glass. It is found that as percent content of Glass increases, the workability parameter also increases. The addition of glass in Aluminum matrix affects the strain hardening index (n) of the composite.

1. Introduction

Powder forging is particularly attractive because it blends the cost and material-saving advantages compared to the conventional castings and forgings through better dimension and weight control. Powder forged parts can outperform parts machined from a forged blank, probably as a consequence. Particle reinforced aluminum alloy matrix composite is one of the best materials to substitute the conventional structural alloys [1]. Metal matrix composites have more structural applications. In the present scenario wide spectrum of applications are available in such tungsten lamp filaments, dental restorations, oil-less bearings, automotive transmission gears, armor piercing projectiles, electrical contacts, nuclear powder fuel elements, business machine parts, high temperature filters, aircraft brake pads, rechargeable batteries, porous materials, compressor component, gears, cams, nozzles for rocket and jet engine components.

Mechanical, metallurgical and machinability studies on Al–SiC P/M composites have been done by various authors [3–11]. When the size of the SiC reinforcement of the composite is fine, the degree of cyclic hardening becomes high [2]. The composite materials have a monotonic increase in relative density with pressure [3]. The cyclic stress response of MMCs has strong dependence on the percentage of the reinforcement.

The ductile failure of the Aluminum matrix has been studied for the nucleation, growth and coalescence of voids under tensile load [4]. Studies have revealed that the Al–SiC composite gives better tensile fatigue performance compared to monolithic alloy [12]. Compression deformation test on Al–SiC composite has been carried out at elevated temperature and it has been found that the SiC added Aluminum powder metallurgy composite gives better formability compared to pure Aluminum and proved thro FEM technique [13].

Workability criterion of P/M compacts have been discussed by Abdel-Rahman and El-Sheikh [14], investigating the effect of relative density on the criteria forming limit of P/M compacts during upsetting also. They have proposed the criteria called formability stress index (β) for describing the effect of the mean stress and the effective stress with the help of two theories, proposed by Kuhn-Downey and Whang-Kobayashi.

Narayanasamy et al. [15] presented some of the important criteria generally used for the prediction of workability. Narayanasamy et al. [16] have done more experimental work on workability behavior of Aluminum–Iron composites namely, Al–Al_2O_3 [17], Al–Fe [18,19], Fe [20], Fe–TiC [21,22] and Fe–C [22] composite during cold upsetting. The same author analyzed the workability of Fe and Fe–TiC under hot forging [20,23–25] technique also.

One of the chief characteristics of the plastic deformation of metals is the fact that the shear stress required to produce slip continuously increases with increasing shear strain [26]. The strain hardening is a phenomena of slip caused by the previous plastic

* Corresponding author. Tel.: +91 94424 65147; fax: +91 4339 262272.
E-mail address: kumardr2006@rediffmail.com (D.R. Kumar).

0261-3069/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.matdes.2010.12.008