Materials and Design 32 (2011) 4714–4719

Contents lists available at ScienceDirect

Materials and Design

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

Microstructure and mechanical properties of in situ Mg_2Si/AZ91D composites through incorporating fly ash cenospheres

Zhiqiu Huang [a,b,*], Sirong Yu [a,c,*], Jiaan Liu [a], Xianyong Zhu [a]

[a] Key Laboratory of Automobile Materials, Ministry of Education, College of Materials Science and Engineering, Jilin University, Changchun 130025, PR China
[b] College of Materials Science and Engineering, Jiamusi University, Jiamusi 154007, PR China
[c] College of Mechanical and Electronic Engineering, China University of Petroleum, Qingdao 266555, PR China

ARTICLE INFO

Article history:
Received 18 February 2011
Accepted 21 June 2011
Available online 28 June 2011

Keywords:
A. Metal matrix composites
E. Properties
F. Microstructure

ABSTRACT

5 wt.% of fly ash cenospheres with average size of 100 μm were added to the molten AZ91D magnesium alloy to prepare in situ Mg_2Si/AZ91D composites by means of compo-casting. The effect of the isothermal temperature and time of the composite slurry (the melt containing fly ash cenospheres) on the microstructure and mechanical properties of the composites was investigated. The effect of the solution treatment at 420 °C on the morphology of Mg_2Si particles in the composites was discussed. The results showed that compared with the matrix alloy, the tensile strength of the composites was higher at both room temperature and 150 °C. After the solution treatment, the shape of Mg_2Si particle transformed from the Chinese script Mg_2Si to spherical, and the tensile strength of the composites was further improved.

1. Introduction

Mg and its alloys are considerable promising materials because of the combination properties of high specific strength and specific stiffness, low density, and excellent castability, so they are widely used in the automotive and aerospace industries, and electron products [1–3]. However, the utilization of Mg alloys was limited owing to their poor heat resistance as compared with other materials [4,5]. Therefore, it is necessary to develop new high performance Mg matrix composites to make Mg alloys have great potential for practical application.

In recent years, Mg matrix composites reinforced by in situ compound Mg_2Si have been attracting attention as light heat-resistant metal materials [6,7]. This is because Mg_2Si is of low density (1.99 g/cm^3), high melting point (1085 °C), high hardness, low thermal expansion coefficient (7.5×10^{-6} K^{-1}), and high Young's modulus (120 GPa) [8]. Recently, it was reported that Mg_2Si particles could be in situ formed by the reaction between SiO_2 originated from rice husks and Mg alloys [9,10], in which the results indicated that the Mg_2Si/Mg composites showed a good wear resistance. However, Mg_2Si is prone to form Chinese script type ones resulting from the eutectic reaction during the general cooling rate of a casting and deteriorate the mechanical properties [6–8]. The morphology of primary Mg_2Si can be improved by many methods such as incorporating modifying agent mischmetal and P [11,12], hot rolled [13], centrifugal casting [14], and mechanical alloying [15]. As can be speculated on the basis of thermodynamic analysis, the in situ compound Mg_2Si can also be obtained through adding fly ash cenosphere (FAC) particles to the molten Mg alloy [16]. (FAC) composed of silica and alumina mainly is a by-product of coal combustion in thermal power plants, and its density is about 0.6 g/cm^3. Some researchers added FAC particles to the metallic or polymeric matrix to make composite foams [17,18]. FAC particles are extremely attractive materials because of their relatively low price, and excellent physical and mechanical properties. Moreover, the application of FAC particles in syntactic foam is a kind of consumption of the industrial garbage and can reduce the environmental pollution. Unfortunately, few reports can be found on preparing Mg_2Si/Mg composites through incorporating FAC particles up to now [18–20].

Compared with die casting technique [19], in situ composites fabricated using compo-casting are very interesting for researchers because of the clean interface between reinforcement and matrix, excellent properties, simple fabricating procedure, and low cost. Accordingly, the present paper reports the fabrication of in situ Mg_2Si/AZ91D composites through incorporating FAC particles in the molten Mg alloy using compo-casting. The microstructure and mechanical properties of the composites were investigated at both room temperature and 150 °C. Furthermore, the effect of the solution treatment at 420 °C on the morphology of Mg_2Si in the composites was also discussed.

* Corresponding authors. Address: Key Laboratory of Automobile Materials, Ministry of Education, and College of Materials Science and Engineering, Jilin University, Changchun 130025, PR China (Zhiqiu Huang). Tel.: +86 431 85095862; fax: +86 431 85095876.
E-mail addresses: huangzq08@mails.jlu.edu.cn (Z. Huang), yusr@upc.edu.cn (S. Yu).

0261-3069/$ - see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.matdes.2011.06.043