



Fly ash characterization and application in Al-based Mg alloys

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ABSTRACT

Continuing study in metallurgical field calls for growing reinforcements of which fly ash plays an important role. In this study, Al alloys were reinforced with different solid fly ash particles. The X-ray diffraction (XRD), scanning electron microscopy (SEM) and X-ray fluorescence (XRF) analyses were used to identify the fly ash particles, and they were also applied to the composite alloys. The X-ray diffraction (XRD) results indicated that the crystalline phase of the fly ash was an effective reinforced phase. Meanwhile, the SEM and optical micrographs of the composite samples indicated that fly ash could be reacted or settled in the matrix of the aluminium. The physical, tribological and microhardness analyses were also used to study the Al-fly ash composites. The best wear resistance corresponding to the lowest loss was obtained in the samples with as-received fly ash which were mostly in accordance with the results in the samples containing treated fly ash. Meanwhile, the proportion of the wear results to the hardness of the samples was observed. Finally, the light weight Al alloys was realized, and increasing the strength is a likeness.

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1. Introduction

The increasing attention in offering various environment-friendly products has recently focused on the use of fly ash in strengthening metal alloys. Fly ashes are residues that leave furnaces, and are formed from mineral matters which are present in coal particles and mostly alumino-silicate-based ceramic spheres with a lesser number of iron-rich spheres [1]. In addition, fly ashes can be classified into solid collected in precipitators, or cenospheres which are collected on the surfaces of ash ponds or separated from the solid using the flotation methods. The cenosphere fly ash, which consists of hollow particles, can be used for the synthesis of ultra-light composite materials due to its significantly low density, while the precipitator or solid fly ash can improve various properties of selected matrix materials, including stiffness, strength, wear resistance and reduce density [2].

Metal alloys of light-weight and low-cost in the automotive industry have been among the preferable materials because of the market requirements. Some examples of the components which are made of such metals include pistons for diesel engines and connecting rods [3]. The important casting metals are Al–Mg and Al–Si–(Mg) alloys. Meanwhile, Magnesium is commonly added to increase the strength of light weight Al alloys and to improve the wetting properties of the added ceramics [4–6]. However, as a ma-

jor alloying element, silicon can impart the presence of relatively large volume of Al–Si eutectic [7]. Hence, fly ash represents an important natural source used to strengthen these materials because of its low price, as well as the advantageous of its physical and mechanical properties.

Most of the work reported in literatures was carried out on the infiltrated aluminum–cenosphere fly ash composites, and therefore, there was little or no attempts made on the Al-based monolithic alloys reinforced with solid fly ash (i.e. with the density of fly ash exceeding 1 g/cm³). Through this work, the chemical and physical characterizations of fly ash and their applications in the Al-based Mg alloys using liquid-phase route are reported. Hence, the microstructure of different alloys, using both the as-received and treated fly ashes, was primarily chosen. The results are presented and discussed in the subsequent sub-sections.

2. Materials and experimental procedures

2.1. Materials

The as-received fly ash (FA) powder obtained from a Power Station in Malaysia (precipitator fly ash) was chosen for this investigation. The as-received fly ash was first used to study and discover the microstructure of the alloys. Then, the wetting properties of the fly ash particles were found when heated at elevated temperatures, about 800 °C in air. Secondly, parts of the as-received powder were poured into a solution of water (H₂O) and ethanol (CH₃CH₂OH) and stirred for about 6 h. After that, the temperature

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