Fabrication and Mechanical Properties of Aluminium-Aluminium Oxide Metal Matrix Composites

Dewan Muhammad Nuruzzaman*
Faculty of Manufacturing Engineering, University Malaysia Pahang, Malaysia

Siti Nur Sakinah Jamaludin
Faculty of Engineering, International College of Automotive, 26607 Pekan, Pahang Darul Makmur, Malaysia

Farah Fazira Binti Kamaruzaman
Faculty of Manufacturing Engineering, University Malaysia Pahang Malaysia

Shahnor Basri
Faculty of Creative Technology and Heritage, University Malaysia Kelantan, 16100 Kota Bharu,. Kelantan, Malaysia

Nur Amira Mardiana Binti Zulkifli
Faculty of Manufacturing Engineering, University Malaysia Pahang, Malaysia
*Corresponding author: E-mail: dewan052005@yahoo.com

***Abstract*--** **In this research study, aluminium-aluminium oxide (Al-Al_2O_3) metal matrix composites (MMCs) of different percentage reinforcements of aluminium oxide were prepared. Three different types Al-Al_2O_3 composite specimens having 10%, 20% and 30% volume fractions of aluminium oxide were fabricated using conventional powder metallurgy (PM) route. These composite specimens were fabricated under different compaction loads 15 ton and 20 ton. The effects of volume fraction of aluminium oxide particulates and compaction load on the properties of Al-Al_2O_3 composites were investigated. The obtained results revealed that density and hardness of the composites are significantly influenced by volume fraction of aluminium oxide particulates. Results also showed that density, hardness and microstructure of Al-Al_2O_3 composites are markedly influenced depending on the compaction load. The increase in the volume fraction of Al_2O_3 enhances the density and hardness of the Al-Al_2O_3 composites. It was found that for 20 ton compaction load, the composites show increased density and hardness as well as improved microstructure than the composites prepared under 15 ton compaction load. Moreover, optical micrographs revealed that aluminium oxide particulates are almost uniformly distributed in the aluminium matrix. It was also observed that after sintering process, flat and undistorted specimens were prepared successfully.**

***Index Term*--** **Aluminium-Aluminium Oxide, Metal Matrix Composite, Density, Hardness, Microstructure.**

1. Introduction

In recent times, metal-ceramic composites are gaining popularity for advanced engineering applications. Generally, a metal-ceramic composite is fabricated using a soft metal as the base material which is reinforced by a hard ceramic material. The desired properties of metal (ductility and toughness) and ceramic (high hardness, high strength and high modulus) are combined in the metal-ceramic composites production, leading to greater strength in compression and shear as well as higher service temperature capabilities. Metal-ceramic composites or metal matrix composites (MMCs) are new generation engineering materials to fulfil multiple functions in many engineering fields and substantial progress in the development of metal matrix composites has been achieved so that these composites can be used for high performance structures such as in aerospace, automotive and armor industries [1,2]. Nowadays, aluminium based metal matrix composites are very popular due to high modulus, stiffness, strength-to-weight ratio, corrosion and wear resistance. These composites exhibit better mechanical properties over conventional metals/alloys [3,4].

Many factors are related to the properties of MMCs which include different properties of the base material, volume fraction, shape, size, and arrangement of the reinforcement etc. [5]. Aluminium alloy-alumina silicate particulate composites exhibited longer fatigue lives than the unreinforced aluminium alloy in lower stress state but showed reduced fatigue lives at elevated stress state regardless of their reinforcement fractions [6]. Wear and friction behavior of sand cast brake rotor made of A359-20 vol% SiC particle composites sliding against automobile friction material were investigated [7]. Results showed that the wear resistance of the composites is much related to the hardness and strength of the SiC particles. Microstructure and properties of aluminium based metal matrix composites reinforced with ZnO whiskers were investigated [8]. Microstructure and thermal conductivity of aluminium oxide particulate reinforced aluminium composites were investigated [9] and it was found that the thermal conductivity of the composites was significantly influenced by the aluminium oxide volume fraction. It was reported that the improvement in the hardness, mechanical and sliding wear resistance properties was achieved by adding silicon carbide particulates [10]. Mechanical Properties of the developed Al/SiC metal matrix composites were investigated by varying the weight fractions of SiC and particle size [11]. It