Mechanical Properties of Al_2O_3 Particle-Reinforced A356 Composite Produced by a Multi-step Process Regime

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ABSTRACT

The aim of this study was to produce a composite material of A356 aluminum alloy reinforced with 250 μm alumina (Al_2O_3) powder. A multi-step process regime was developed. Strain was induced via milling in production of A356 chips. The chips were dry mixed with Al_2O_3 at 5, 10, and 15 wt% and cold pressed, followed by sintering at 600°C for 20 min. Then the molten composite was sand casted into a cylinder with a diameter of 20 mm and length of 50 mm. Afterward, all cast specimens were heat treated by solution treatment at 527°C for 12 h, quenched in water, and naturally aged at room temperature for 10 h; then artificially aged at 177°C for 12 h and furnace cooled. Specimens were subjected to hardness and wear tests. The results of hardness testing of the 'as received' A356 and casted A356-5, 10, and 15 wt% Al_2O_3 were 23.5 HRB, 41.3 HRC, 44.0 HRC, and 46.0 HRC, respectively, and the average hardness values after heat treatment were 46.0 HRB, 46.3 HRC, 48.0 HRC, and 51.1 HRC, respectively. The percentage of Al_2O_3 was a significant factor based on statistical analysis. The hardness values increased significantly after heat treatment. In addition, heat-treated A356-5, 10, and 15 wt% Al_2O_3 exhibited average wear rates of 0.00387, 0.00375, and 0.00350 mm^3/m, respectively. Increasing the amount of alumina reduced the wear rate, but the difference was not statistically significant. The cross-section micrographs revealed that the alumina powders were uniformly dispersed in A356 matrix.

Keywords: A356/Al_2O_3, Strain-induced, Sintering, Hardness, Sand casting

INTRODUCTION

Currently, aluminum metal matrix composites (AMMCs) have been widely studied and broadly accepted by industries as efficient alternative materials in many applications, especially as components in drum or disc brakes. Generally,