Abstract

Aluminium matrix composites (AMC) reinforced with micro and nano-sized Al_2O_3 particles are widely used for high performance applications, such as automotive, military, aerospace and electrical industries because of their improved physical and mechanical properties. Reinforcing aluminium matrix with small particles, micron or nano-sized range, is one of the key factors in producing high-performance composites, which yields improved mechanical and damping properties.The fabrication of A332 Al composites with different grain sizes (12 μm-1 μm -50 nanometer) at different weight percentages of Al_2O_3 particles up to 0.05-1% was achieved by stir casting technique. Melt processing which involves the stirring of ceramic particles into melts, has some important advantages, such as better matrix-particle bonding, easier control of matrix structure, simplicity, low cost of processing and nearer net shape .

In order to improve the wettability and distribution of micro and nano-sized Al_2O_3 particles within the A332 aluminium alloy and to avoid agglomeration and separation of particles, a novel three step mixing method was adopted in the present work, including heat treatment of nano-micro particles, injection of heat-treated particles within the melt by inert Argon gas and stirring the melt with suitable speed .

The influence of various processing parameters, such as the reinforcement nano-micro particles sizes at different weight percentages of reinforcement particles from 0.05 to 1 wt. % on the microstructure, mechanical and damping properties of composites were investigated.. The matrix grain size, morphology and distribution of Al_2O_3 nano particles were recognized by scanning electron microscopy (SEM), optical microscope (OM) equipped with image analyzer. The density of the samples was measured by mass-volume method. The hardness of samples was investigated. A pin-on disc wear testing machine was used to evaluate the wear rate of composites at different sliding distances, different loads and times. Damping was measured from the frequency response function of the

transverse periodic time method. The effect of dispersion of Al_2O_3 micro –nano particulates and the effects of electrophoretic deposition of nano alumina coating at different thickneses on the damping ratio of the A332 aluminum alloy were investigated.

Taguchi method was used for the design of the experiments and to obtain the optimal values of the selected parameters. Taguchi design technique using MINITAB 16 was used to rank several factors that may affect the stress, hardness, wear and damping in order to determine the optimum conditions. The Taguchi orthogonal array L9 (3^2) was used for experimental design with three levels of consideration for each factor. The response was analyzed based on the Taguchi's signal-to-noise ratio.

The main results of the present research showed that the use of heat-treated particles, injection of particles and the stirring system improved the wettability and distribution of the nano particles within the aluminium melt. The results revealed that the ultimate tensile stress, hardness, wear rate decrease with the increase of the percentage of reinforcement of Al_2O_3 . It was found that the wear resistance of the composites became considerably more than that of the aluminum alloy at all applied loads as the percentage of reinforcement increases. A significant improvement in damping ratio was noted when the alloy is reinforced with 1% weight percentage of nano particles. The high damping capacity of the composite is mainly attributed to the ceramic phases and found to be intrinsic.