ABSTRACT

Discontinuous particle reinforced metal matrix composites have attractive features like isotropic properties, high specific strength, specific modulus, damping capacity, good wear resistance compared to unreinforced alloys, low cost of manufacture and can be shaped by conventional metalworking processes. This has led to increased interest in the potential for large-scale use of particle reinforced Metal Matrix Composites (MMCs) in the fields of automotive, transportation, aerospace, construction and commercial applications.

Conventional stir casting technology has been employed for producing Aluminium Metal Matrix Composites (AlMMCs) for decades. The casting methods and associated techniques are used to fabricate present composites. The homogeneous particle distribution is concern to enhance the mechanical properties. The evaluation of homogeneous particle distribution was made from microstructure analysis, hardness distribution and density distribution on the cast specimen. The hardness distribution in the cast specimen ensures the uniformity of hard particle in the matrix. From the density distribution the close density variation was observed at the mid portion of fabricated specimen. The better distribution of particles was viewed using Scanning Electron Microscope (SEM) analysis. To enhance the mechanical properties, the fabricated composites were also subjected to heat treatment at T6
condition. The effect of reinforcement volume fraction, particle size and heat treatment on micro hardness of MMCs has been studied.

It is generally agreed that resistance to wear of MMCs are improved remarkably by introducing hard ceramic compound into the aluminium matrix. The reinforcing materials are generally SiC, Al₂O₃, TiB₂ etc and are costly. The present research work has been undertaken with an objective to explore the use of zircon and garnet as a reinforcing material. The wear behavior of MMCs is influenced by several factors. Hence the present research problem is formulated as fabrication of AlMMCs and their wear behaviour.

In the present investigation, aluminium alloy LM25 grade is chosen as matrix material and silicon carbide, zircon and garnet particles as reinforcement. AlMMCs has been fabricated by stir casting process. The wear test specimens are prepared according to the ASTM G99 standard and wear test was conducted under laboratory conditions using a pin-on-disc wear test rig. The wear behaviour of these composites under sliding on EN32 steel disc and silicon carbide abrasive paper glued disc conditions are studied. The wear parameters like reinforcement volume fraction, particle size, sliding speed, applied load, sliding distance and abrasive mesh size for abrasive sliding are considered to evaluate wear behaviour of AlMMCs. A Central Composite Design (CCD) was selected for designing the wear experiments. The statistical model is made using Response Surface Method (RSM) and Adaptive Neuro Fuzzy Inference System (ANFIS) soft computing model is also made to predict the wear rate and coefficient of friction on AlMMCs. The
significance of the statistical model were tested by Analysis of Variance (ANOVA). The values obtained from RSM and ANFIS models are correlated with experimental values and above predicted values are validated by conducting confirmation experiments. The effect of wear parameters are discussed statistically. The worn out surfaces were subjected to microscopic examination and the effect of parameters on wear mechanism is illustrated by the SEM image analysis.

From the investigation it is to be noted that the wear resistance of the composites are higher, further the reinforcements contributed significantly in improving the wear resistance for all composites sliding on steel and abrasive paper glued disc. From the SEM analysis we see that the abrasive, adhesive and plastic deformation are found to be a predominant wear mechanism at sliding on steel disc, abrasive wear and particle pull out is a predominant wear mechanism at sliding on abrasive paper glued disc.

From the experimental results it is to be noted that Al/Zircon MMCs fabricated with 15% volume fraction and 105 μm particle size exhibit superior wear resistances than Al/SiC MMC at sliding on steel disc, 58.86 N applied load, 1.5 m/s sliding speed and 1.5 km sliding distances. Hence at above condition Al/Zircon MMCs may be considered as a good replacement for Al/MMCs. However, based on the overall performance Al/SiC MMCs exhibits superior mechanical and tribological properties.