ABSTRACT

Aluminium based Metal Matrix Composites (MMCs) are newer materials having many favourable mechanical properties and a wide range of applications from automotive to aerospace, gradually replacing the conventional engineering materials. Aluminium based MMCs are gaining increasing importance because of their attractive properties of better specific strength, specific stiffness, wear resistance, excellent corrosion resistance, high elastic modulus and light weight.

In the present work, LM24 aluminium alloy – aluminium oxide / silicon carbide metal matrix composites are developed by a new combination of vortex method and pressure die casting technique. The reinforcing hard ceramic particles of aluminium oxide / silicon carbide play a vital role on the material properties. Hence, the LM24 aluminium alloy based metal matrix composites are fabricated with different percentage weight of aluminium oxide / silicon carbide particles. The present work also deals with mechanical property, tribology, drilling, milling and electrical discharge machining studies of the newly developed LM24 aluminium alloy based metal matrix composites.

The hardness of the aluminium alloy based MMCs are determined by using a Brinell hardness testing machine. The actual densities of the
specimens are determined by using ‘Archimedes’ principles. The hardness of the aluminium alloy based MMCs is higher than that of the plain LM24 aluminium alloy. The hardness of the aluminium alloy - silicon carbide composite is higher than that of the aluminium alloy - aluminium oxide composite. The hardness increases with the amount of particle reinforcement. The density of the aluminium alloy based MMCs is higher than that of the plain LM24 aluminium alloy. The density of the aluminium alloy - aluminium oxide composite is higher than that of the aluminium alloy - silicon carbide composite. The density increases with the amount of particle reinforcement.

The aluminium alloy based metal matrix composite components will be used in sliding, reciprocating or rotating motions with steel based components for engineering applications. When aluminium metal matrix composites are being chosen for high volume and machine intensive components, it is crucial that the friction and wear characteristics of the materials are understood. Tribological investigations are conducted on the plain LM24 aluminium alloy and the newly developed aluminium alloy based MMCs specimens mated with an EN 36 steel disc under different normal loads and sliding speeds on the pin on the disc testing apparatus. The wear increases with the normal loads and sliding speeds. The wear decreases with the increase of particle reinforcement. The wear of the aluminium alloy - silicon carbide composite is lower than that of the aluminium alloy -
aluminium oxide composite, which is lower than that of the plain LM24 aluminium alloy.

Drilling and milling processes are used for all aluminium alloy based automobile and aerospace components for providing critical dimensions and appropriate surface finish for the engineering applications. The drilling and milling experiments are conducted on the newly developed aluminium alloy based MMCs. The drilling and milling tests are performed on the plain LM24 aluminium alloy and aluminium alloy - aluminium oxide / silicon carbide reinforced composites at different cutting speeds and feeds. In both the drilling and milling studies, the surface roughness improves with the increase in speed and decrease in feed. The surface roughness of the plain LM24 aluminium alloy is better than that of the aluminium alloy - aluminium oxide composite, which is better than that of the aluminium alloy - silicon carbide composite. The surface roughness decreases with the increase of particle reinforcement.

In view of higher tool wear and higher tooling costs incurred during conventional machining, non contact material removal processes such as Electrical Discharge Machining (EDM) offer an effective alternative. In EDM, there is no contact between the tool and workpiece, and it prevents the tool wear loss. Hence EDM is chosen to machine the composite material. EDM studies have been performed on the plain LM24 aluminium alloy and
on the newly developed aluminium oxide / silicon carbide reinforced composites with different current rates. The material removal rate and surface roughness of the workpiece increase with the increase of current and decrease with the amount of particle reinforcement of aluminium oxide / silicon carbide. The material removal rate and the surface roughness, of the aluminium alloy - aluminium oxide composite are lower than that of the aluminium alloy - silicon carbide composite, which is lower than that of the plain LM24 aluminium alloy.

To ensure maintaining standards, all these experiments are repeated with the same conditions for five samples and the mean values are taken to ensure repeatability. Statistical analysis has been carried out on the results, the mean, standard deviation and standard error are calculated. From the results, it is observed that the mean of all the experimental values lies within a 95% confidence interval.