ABSTRACT

Wear is damage to a solid surface usually involving progressive loss of materials, owing to relative motion between the surface and contacting substances. It is a material response to the external environment and can be mechanical or chemical in nature. The effect of wear on the reliability of industrial components is recognized widely and the cost of wear has been recognized to be high. Wear behaviour of various alloys and metal matrix composites has been extensively studied; there are still wear problems present in industrial applications. This actually reveals the complexity of the wear phenomenon. An improvement in the weight specific properties can result, offering the possibilities of widens the application area, substitution of advanced materials and optimization of component properties is required. The possibility of combining various material systems for example, metal matrix composites gives the opportunity for unlimited variation in properties.

Aluminium is the most popular matrix for the metal matrix composites (MMCs). They are usually reinforced by alumina (Al_2O_3), silicon carbide (SiC), boron carbide (B_4C) and titanium oxide (TiO_2). It is well recognized that when a soft metal like aluminium slides on hard steel without any external fluid or solid lubrication, the former is expected to flow and adhere to the latter, creating an interface of low shear strength. Transfer of aluminium will continue with sliding, and wear debris may form as a result of ploughing of the soft aluminium surface by the asperities of the hard steel, or

flaking off of patches from the transfer film. Self-lubricating composites have found wide application in many special machine parts; yet oil or grease cannot lubricate inaccessible parts and contamination is not acceptable. The development of aluminium MMCs dispersed with solid lubricants is primarily directed towards overcoming the major drawbacks of aluminium as a tribological material. The incorporation of soft reinforcement as Molybdenum disulphide (MoS_2) solid lubricant will give the desired results even at higher temperatures. Hence the study on wear behaviour of Al-Si10Mg / Al_2O_3 metal matrix composites and Al-Si10Mg / Al_2O_3 / MoS_2 hybrid composites has been considered for investigation.

The Al-Si10Mg / Al_2O_3 metal matrix composites and Al-Si10Mg / Al_2O_3 / MoS_2 hybrid composites are fabricated using stir casting technique. Microstructure and properties like density, hardness, tensile strength, dry sliding wear and abrasive wear behaviour are studied. Wear behaviour of composite materials is effected by number of process and material parameters. Among the several methods available to optimize the parameters, the Taguchi method is a traditional approach for experimental design that seeks to obtain a best combination set of wear parameters with the lowest cost solution. However, Taguchi method cannot be used to optimize a multi-response problem. Hence Grey Relational Analysis (GRA) has been combined with Taguchi method to optimize the multi response wear behaviour through the various parameters with different levels.

The study on the microstructure has resulted in a well-dispersed and porosity free Al-Si10Mg /Al_2O_3 and Al-Si10Mg/Al_2O_3/MoS_2 dispersed composites are obtained. The mechanical properties of hardness and tensile hardness are significantly improved. The findings of the dry sliding wear experiments and abrasive wear experiments indicate that the wear rate, specific wear rate and coefficient of friction of the MMCs and Hybrid composites is greatly influenced by the load, sliding speed, content of alumina and molybdenum disulphide. An optimum parameter combination has been determined, which leads to minimization of wear of composites. Analysis of Variance (ANOVA) was performed on the wear rate, specific wear rate and coefficient of friction. It was demonstrated that the predicted results obtained using this equation are consistent with experimental observations. Finally, optimum factor settings for minimum wear rate, specific wear rate and coefficient of friction are determined using Grey Relational Analysis (GRA). The worn surface was analyzed using Scanning Electron Microscopy (SEM), to study the influence of wear mechanisms in particular and on the overall behaviour in general.