ABSTRACT

Aluminium metal matrix composites are a class of advanced materials which have been developed for weight-critical applications in the aerospace and automotive industries. The present investigation aims to establish the tribological behaviour of aluminium-based graphite (Gr) and silicon carbide (SiC) particle-reinforced micro- (40 to 100 μm particle size) and nano- (50 to 100 nm particle size) composites manufactured (using ball mill) by powder metallurgy was studied using a pin-on-disk apparatus under dry sliding conditions. The pins made of these composites were then slid against a steel disk under ambient conditions. The sintered samples have been characterized by X-ray diffraction (XRD). The worn surfaces of the pins and wear debris were analyzed using a Scanning Electron Microscope (SEM).

In micro composites, the results of the tests revealed that the SiC-reinforced hybrid composites exhibited a lower wear loss compared to the unreinforced alloy and Al–Gr composites. It was found that with an increase in the SiC content, the wear resistance increased monotonically with hardness. The hybridisation of the two reinforcements also improved the wear resistance of the composites, especially under high sliding speeds. Additionally, the wear loss of the hybrid composites decreased with increasing applied load and sliding distance, and a low friction coefficient and low wear loss were achieved at high sliding speeds. The composite with 5 wt.% Gr and 20 wt.% SiC showed the greatest improvement in tribological performance. The wear mechanisms in micro composites was dictated by the formation of both a delamination layer and mechanically mixed layer
(MML). Analysis of variance (ANOVA) was used to investigate the influence of the parameters on both the wear loss and the coefficient of friction. The hardness of the micro composites decreases as the % of graphite increases.

The hardness and wear resistance of the hybrid nano composites were increased considerably by increasing the SiC reinforcement content. Moreover, density of the nano composites was worse with the increase in weight percent of graphite reinforcements. The nano composite with 5 wt. % SiC and 10 wt. % Gr showed the greatest improvement in tribological performance. The wear and friction coefficient were mainly influenced by both the sliding distance and the load applied. Primary wear mechanisms for hybrid nano composites were determined to be formation of lubricating layer on the surface of samples.

Based on the experiments, it was observed that the nano-composites significantly outperformed all of the other materials. It was also discovered that the nano-composites exhibited the best wear performance among the composites investigated. The overall results revealed that hybrid aluminium nano composites can be considered as an outstanding material where high strength and wear-resistant components are of major importance, particularly structural applications in the aerospace, automotive and military industries.