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Analysis of dry sliding wear behavior of the nano composites using statistical methods with an emphasis on temperature effects

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Abstract
The objective of the present work is to understand the effects of speed, load, distance and temperature on the dry sliding wear behavior of Al/B_4C, $Al/B_4C/MoS_2$ nanocomposites and the Al alloy. The nanocomposites and the alloy were fabricated by the stir casting technique and tested in a pin on disc wear testing apparatus. The parameters considered were: load – 10-50N, speed – 0.942-4.713 m/s, sliding distance – 500-1500 m, temperature – 50-90^{o}C. The central composite design was used to design the experiments. The response surface methodology was used to identify the important factor affecting the wear resistance and to study the interaction effects among the factors. The temperature was found to be a primary factor affecting the wear resistance. The interactions between the load and the speed and, the load and the distance were found to be significant. Excellent correlation existed between the predicted and the experimental results within 2.5% error. The confirmatory experiments proved the adequacy of the model with a reasonable accuracy. The worn surface of the nanocomposites and the alloy were characteristised using the scanning electron microscope equipped with energy dispersive spectroscopy and X-ray diffraction techniques to understand the prevailing wear mechanisms for the selected conditions. The stable tribofilm and the nano particle strengthening reduced the intensity of abrasion, delamination, oxidation and third body wear mechanisms and keep the wear under control in the nanocomposites. Particularly, the $Al/B_4C/MoS_2$ hybrid nanocomposites showed the best wear resistance due to the formation of MoS_2 rich tribofilm.

Key words: Metal matrix nano composites; Response surface methodology; Wear mechanisms; Temperature effects.

Introduction

Metal matrix composites (MMCs) are known to outperform the conventional monolithic materials in several structural and contact applications. In sliding contact applications, the wear resistance is the most important property. Between continuous (fiber) and discontinuous (particle) reinforcements, the discontinuous reinforcements are preferred for contact applications because of two reasons: (1) the discontinuous reinforcements provide isotropic properties