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Slurry erosive wear behavior of Ni–P coated Si_3N_4 reinforced Al6061 composites

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ABSTRACT

Ni–P coated Si_3N_4 reinforced Al6061 composites were fabricated by liquid metallurgy route. Percentage of reinforcement was varied from 4 wt% to 10 wt% in steps of 2. The developed composites were subjected to microstructure and sand slurry erosive wear studies. The influence of experimental parameters such as slurry concentration, rotational speed of slurry, size of impinging particles and the test duration on slurry erosive wear behavior of developed composites have been studied. Results reveals that, Al6061–Si_3N_4 composites exhibited improved wear resistance when compared with the matrix alloy under identical test conditions. With increase in slurry concentration, rotational speed of slurry, test duration, size of impinging particles, the slurry erosive wear rates of both matrix alloy and developed composites increases. However, under all the tests conditions studied, the developed composites possess higher wear resistance when compared with that of matrix alloy. Energy dispersive spectroscopy (EDS), X-ray diffraction analysis (XRD) and X-ray photoelectron spectroscopy (XPS) techniques were used to identify the oxides/passive layer formed on the worn surfaces. Scanning Electron Microscopy (SEM) examinations were also carried out on worn surfaces to observe the possible mechanisms of material removal in the matrix alloy and developed composites.

1. Introduction

Discontinuously reinforced aluminum based matrix composites (DRAMCs) are the class of materials that has been widely reported by numerous researchers owing to their exciting properties. Excellent strength to weight ratio, low cost, good wear resistance, isotropy and reproducibility etc., are some of the properties of DRAMCs that make them suitable for many engineering applications [1,2].

These engineering properties of the composites do depend mainly on the quality of the processed composites which in turn depends on the routes adopted to develop them [3]. In this regard, major focus is on synthesis of high quality DRAMCs developed by liquid metallurgy route which is the most sought after and well accepted owing to its simplicity and cost effectiveness [4,5].

However, composites prepared by this technique exhibit certain limitations. They are:

1. Poor wettability of the reinforced particles with molten metal which in turn leads to generation of inherent casting defects in the composites [6,7].
2. Deterioration of mechanical and tribological properties as a result of interfacial reaction between matrix and reinforcement [8].
3. Anisotropic behavior in material properties due to non-uniform distribution of reinforced particles in matrix material [9].

These problems can be successfully addressed by providing thin metallic coating on the surface of ceramic particles before addition into the molten metal as reported by many researchers [10–13].

The detailed studies on mechanical and tribological properties of DRAMCs have made them suitable for application which demands high structural integrity and excellent wear resistance [14].

However, use of DRAMCs as a material in mining and chemical environment has not gained much importance. This may be due to the fact that these applications require material to combat the slurry erosive wear due to the hard solid particles in liquid medium.

Caron et al. [15] have studied the slurry erosive wear behavior of 5083-Al_2O_3 composites. They have noticed that, slurry erosive wear of composites increased with increase in Al_2O_3 content in the matrix material.

Das et al. [16] have reported on slurry erosive wear behavior of Al–Si alloy reinforced with SiC in acidic and NaCl media, they have observed that wear resistance of the composites was significantly higher in both acidic and NaCl media when compared with the matrix alloy.

Ramachandra and Radhakrishna [17] have reported on slurry erosive wear behavior of Al–12 wt%Si alloy reinforced with flyash composites. They have reported that use of flyash has enhanced the slurry erosion wear resistance of the developed composites which has been attributed to the formation of protective passive layer on the worn surfaces.

However, meager information is available as regards the slurry erosive wear behavior of metallic coated silicon nitride reinforced

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