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Evaluation of Microstructure, Mechanical and Abrasive Wear Response of in situ TiC Particles Reinforced Zinc Aluminum Matrix Alloy Composites

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Abstract : The present investigation deals with the microstructures, mechanical and detailed wear characteristics of in situ TiC particles reinforced zinc aluminum-based metal matrix composites. The composites have been synthesized by liquid metallurgy route using vortex technique. The composite was found to be harder than the matrix alloy due to high hardness of the dispersoid particles therein. The former was also lower in ultimate tensile strength and ductility as compared to the matrix alloy. This could be explained to be due to the use of coarser size dispersoid and larger interparticle spacing. Reasonably uniform distribution of the dispersoid phase in the alloy matrix and good interfacial bonding between the dispersoid and matrix was observed. The composite exhibited predominantly brittle mode of fracture with microcracking in the dispersoid phase indicating effective easy transfer of load from matrix to the dispersoid particles. To study the wear behavior of the samples three different types of tests were performed namely: (i) sliding wear tests using a pin on disc machine under dry condition, (ii) high stress (two-body) abrasive wear tests using different combinations of abrasive media and specimen surfaces under the conditions of varying abrasive size, traversal distance and load, and (iii) low-stress (three-body) abrasion tests using a rubber wheel abrasion tester at various loads and traversal distances using different abrasive media. In sliding wear test, significantly lower wear rates were observed in the case of base alloy over that of the composites. This has been attributed to the poor room temperature strength as a result of increased microcracking tendency of the composite over the matrix alloy. Wear surfaces of the composite revealed the presence of fragmented dispersoid particles and microcracking whereas the wear surface of matrix alloy was observed to be smooth with shallow grooves. During high-stress abrasion, the presence of the reinforcement offered increased resistance to the destructive action of the abrasive particles. Microcracking tendency was also enhanced because of the reinforcement in the matrix. The negative effect of the microcracking tendency was predominant by the abrasion resistance of the dispersoid. As a result, the composite attained improved wear resistance than the matrix alloy. The wear rate increased with load and abrasive size due to a larger depth of cut made by the abrasive medium. The wear surfaces revealed fine grooves, and damaged reinforcement particles while subsurface regions revealed limited plastic deformation and microcracking and fracturing of the dispersoid phase. During low-stress abrasion, the composite experienced significantly less wear rate than the matrix alloy irrespective of the test conditions. This could be explained to be due to wear resistance offered by the hard dispersoid phase thereby protecting the softer matrix against the destructive action of the abrasive medium. Abraded surfaces of the composite showed protrusion of dispersoid phase. The subsurface regions of the composites exhibited decohesion of the dispersoid phase along with its microcracking and limited plastic deformation in the vicinity of the abraded surfaces.

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