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Wear Behavior of Composites Based on ZA-27 Alloy Reinforced by Al_2O_3 Particles Under Dry Sliding Condition

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Abstract In present study, the effect of Al_2O_3 particle reinforcement on the sliding behavior of ZA-27 alloy composites was investigated. The composites with 3, 5, and 10 wt% of Al_2O_3 particles were produced by the compocasting procedure. Tribological properties of unreinforced alloy and composite were studied, using block-on-disk tribometer under unlubricated sliding conditions at different specific loads and sliding speeds. The worn surfaces of samples were examined by the scanning electron microscopy (SEM). The test results revealed that those composite specimens exhibited significantly lower wear rate than the ZA-27 matrix alloy specimens in all combinations of applied loads and sliding speeds. The difference in the wear resistance of composite with respect to the matrix alloy, increased with the increase of the applied load/sliding speed and Al_2O_3 particle content. The highest degree of improvement of the ZA-27 alloy tribological behavior corresponded with change of the Al_2O_3 particles content from 3 to 5 wt%. At low sliding speed, moderate lower wear rate of the composites over that of the matrix alloy was noticed. This has been attributed to micro cracking tendency of the composites. Significantly reduced wear rate, experienced by the composite over that of the matrix alloy at the higher sliding speeds and loads, could be explained due to enhanced compatibility of matrix alloy with dispersoid phase and greater thermal stability of the composite in view of the presence of the dispersoid. Level of wear rate of tested ZA-27/Al_2O_3 samples pointed to the process of mild wear, which was primarily controlled by the formation and destruction of mechanical mixed layers (MMLs).

Keywords ZA-27 alloy · Al_2O_3 particles · Composites · Tribological behavior

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1 Introduction

Zinc–aluminum (ZA) alloys have emerged as important material for tribological applications, especially suitable for high-load and low-speed applications [1, 2]. Commercially available ZA alloys are characterized by good tribomechanical properties, low weight, excellent foundry castability and fluidity, good machining properties, low initial cost, and environmentally friendly technology. Due to this unique combination of properties, the ZA alloys (mostly ZA-12 and ZA-27) are capable of replacing aluminum cast alloys and bearing bronzes, as well as the cast iron, plastics, or even steels for manufacturing the triboelements for operation under conditions of moderate exploitation temperatures [2–8].

However, major limitations of the alloy system are its inferior elevated temperature mechanical and wear properties, dimensional instability at temperatures above 120 °C and large coefficient of thermal expansion [9]. One of the possible measures for overcoming these deficiencies is reinforcement of the ZA alloy by incorporation of thermally stable second phase [1, 10, 11] to form composites. This approach is based on positive experiences about the influence of the ceramic particle reinforcement on properties of aluminum-based alloys.