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Effects of Al_2O_3 particle reinforcement on the lubricated sliding wear behavior of ZA-27 alloy composites

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Abstract The present investigation deals with the effect of Al_2O_3 particle reinforcement on the lubricated sliding behavior of ZA-27 alloy. The composites with 3, 5, and 10 wt% of Al_2O_3 particles were produced by the compocasting procedure. Tribological properties of alloy and composites were studied, using block-on-disk tribometer at different specific loads and sliding speeds. The test results revealed that composite specimens exhibited significantly lower wear rate, but higher coefficient of friction than the matrix alloy specimens in all the combinations of applied loads and sliding speeds. The improved antiwear characteristics of the composites were influenced by positive effects of higher frictional heating on compatibility of the composite phases and suppressing micro-cracking tendency. Due to that, effects of reinforcing hard particles were manifested through the reduced wear rate of composites, especially in conditions of higher load, lower sliding speeds and higher Al_2O_3 particle content. In present wear tests, the significant forming of mechanically mixed layers was not noticed, what is confirmed by the SEM microphotographs.

Introduction

Over the past few decades Zinc-Aluminum alloys (ZA alloys) have been widely investigated as promising material for tribological applications. At this moment the ZA alloys have become the alternative material primarily for aluminum cast alloys and bearing bronzes due to good castability and unique combination of properties [1–11]. They can also be considered as competing materials for cast iron, plastics, and even steel when being applied for operation under conditions of high mechanical loads and moderate sliding speeds (moderate operation temperatures) [12, 13]. Interest for extending the practical application of these alloys is based on tribological, economic, and ecological reasons [14–17].

Major limitations of the ZA alloys are their 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.

Mechanical properties' characterization of ZA alloys reinforced with dispersed hard ceramic particles has been a matter of broad interest over the recent years. It was reported that hard and thermally stable ceramic reinforcements in ZA alloys contributed to a higher hardness [10–14], superior elastic modulus [12], and lower coefficient of thermal expansion of the matrix alloy at ambient temperature [15]. Furthermore, increasing content of reinforcing phase leads to further improvement of properties. The increase of hardness could be accompanied with decrease of strength [11, 12] or without this effect [13]. However, composites attain improved elevated temperature strength [13].

The tribological characteristics of ZA-based metal matrix composites (MMCs) have received little attention. The primary attention has been focused on ZA alloy

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