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OPTIMIZATION OF TRIBOLOGICAL BEHAVIOUR OF HYBRID COMPOSITES BASED ON A356 AND ZA-27 ALLOYS

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Optimization of tribological behaviour of hybrid composites based on A356 and ZA27 alloys reinforced with 10 wt. % SiC and 0, 1 and 3 wt. % Gr is presented in this paper. Optimization was performed using the Taguchi method and the artificial neural network (ANN). Hybrid composites were obtained by compocasting procedure. The analysis shows that hybrid composites based on A356 alloy have better tribological characteristics, while the one reinforced with 10 wt. % SiC and 1 wt. % Gr shows the least wear.

Keywords: *A356, ZA-27, hybrid composites, wear, Taguchi design, ANN.*

1. INTRODUCTION

Composite materials are formed by combining two or more different materials. The base materials have different properties from each other, and their combination gives a completely new material. This material has unique, completely new and different properties in relation to the constituent components. The goal is to improve the structural, tribological, thermal, chemical or some other characteristics of individual materials. Hybrid composites are composites in which there are two or more types or forms of reinforcements and/or enhancers. Aluminium alloy A356 and zinc alloy ZA-27 are used as the basic materials or matrices in this research. The improved properties of composite materials provide the possibility for their wide application. Aluminium composites are used in the automotive, military, aerospace and electronics industries. Metal composites with ZA alloys are used for the production of sliding bearings, worm gears, etc.

2. PROCEDURE FOR OBTAINING HYBRID COMPOSITES

Composites were obtained by compocasting procedure. Figure 1 shows the structure of hybrid composites based on A356 and ZA-27 alloys reinforced with 10 wt. % SiC and 3 wt. % Gr. It was noticed that the matrix was well filled with reinforcing particles, i.e. that the surface area of the matrix without particles is reduced, which indicates a very favourable distribution of SiC particles. The soft graphite particles did not retain their average size during the compocasting procedure. They were eroded and crushed in the process of preparation.

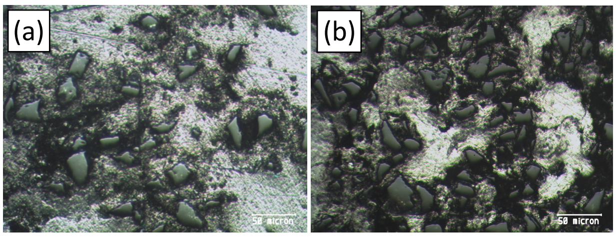

Figure 1. Hybrid composites structure: (a) A356 + 10 wt. % SiC + 3 wt. % Gr and (b) ZA-27 + 10 wt. % SiC + 3 wt. % Gr

3. HYBRID COMPOSITES WEAR

Testing of tribological characteristics of hybrid composites was realized on a block-on-disk tribometer in conditions without lubrication. The measurement of the composite wear width and determination of the wear rate was performed for the sliding distance of 600 m.

Using the Taguchi method, the influence of four factors on the wear rate was analysed. Two different composite materials (A356 + 10 SiC and ZA-27 + 10 SiC) reinforced with 0, 1 and 3 wt. % Gr were observed and tested at speeds of 0.25, 0.5 and 1.0 m/s and loads of 10, 20 and 30 N.

The analysis of the results was performed using ANOVA analysis. It was shown that a composite with the least wear was the one based on A356 + 10 SiC at the load of 10 N, the sliding speed of 0.25 m/s and with reinforcement of 1 wt. % graphite. Figure 2 shows the results of Taguchi optimization.

Verification of the obtained results was confirmed using the artificial neural network (ANN). ANN shows a very high degree of agreement of the obtained results.

4. WEAR MECHANISMS

Under the given conditions of hybrid composites testing, it was determined that abrasive and adhesive wear were the dominant wear mechanisms. Abrasive wear occurs under high load conditions, while adhesive wear with delamination is characteristic for low loads and low sliding speeds.

5. CONCLUSIONS

Based on the analysed results, it can be determined that hybrid composites have better characteristics than basic alloys. The applied compocasting procedure for obtaining the hybrid composites gives a good distribution of reinforcements in the matrix. It is also noticed that, under the given test conditions, the wear of composites based on A356 is lower than in composites based on ZA-27. The best tribological characteristics were obtained for a hybrid composite based on A356 reinforced with 10 wt. % SiC and 1 wt. % Gr at a load of 10 N and a sliding speed of 0.25 m/s.

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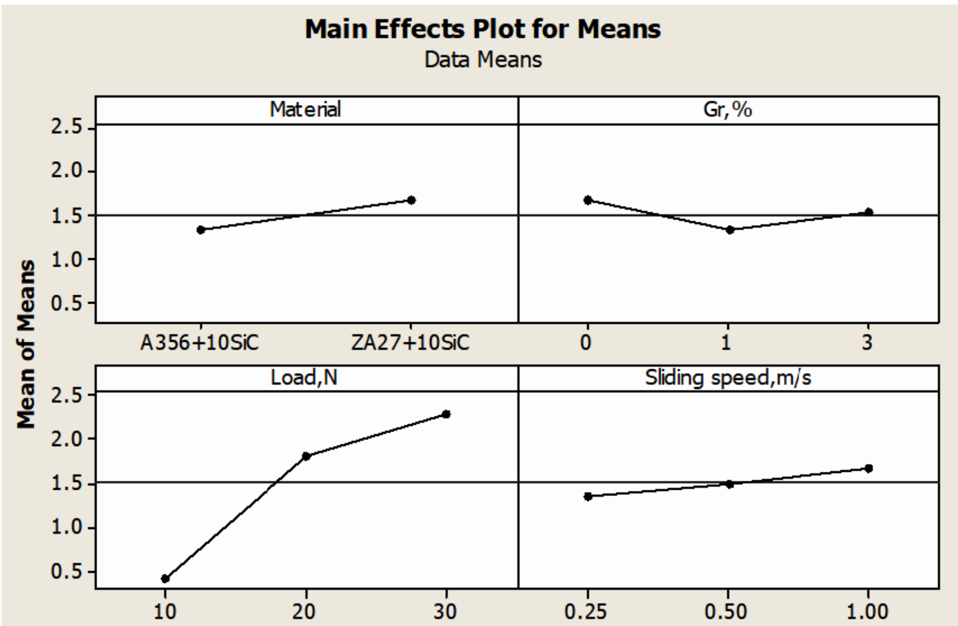

Figure 2. Main effects plot for S/N ratio for wear rate