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Research Article

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Tribological Behavior of AA7050-$ZrSiO_4$ Composites Synthesized by Stir Casting Technique

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Abstract: This research made an attempt to synthesize aluminum metal matrix composites through stir casting technique. The matrix material chosen in this study was AA7050 and the reinforcement material was $ZrSiO_4$. The composites AA7050, AA7050-10%$ZrSiO_4$, and AA7050-15%$ZrSiO_4$ were used. The wear behavior of the aluminum matrix composites was investigated by using pin-on-disc tribometer. The advanced material has substantial development in tribological behavior when the reinforcement percentage is increased. From the experimental results, it was confirmed that sliding distance of 1200 m, applied load of 3 N and sliding speed of 2 m/s result in minimum wear loss and coefficient of friction, while adding 10%$ZrSiO_4$ to the AA7050.

Keywords: Stir casting, metal matrix composites, tribological behavior

1 Introduction

Aluminum matrix composites with enhanced properties are most desirable in the field of aerospace and automotive field [1]. Nowadays, due to various advances in the field of engineering and its applications, metal matrix composites possess several advantages. When we compare particulate reinforced MMCs with fiber strengthened MMCs, the particulate reinforced MMCs cost much lesser. Zircon strengthened composites retain better confrontation to abrasion; these are also thermal resistant and free from chemical occurrences [2]. MMCs proved that it has greater tribological and mechanical properties in various engineering applications [3]. Due to its high strength, high stiffness and wear resistance, aluminum based composites have been accredited as superior material in all the engineering fields [4]. The aluminum alloy based composites are especially being used as automobile components manufacturing such as piston, connecting rod, microwave filters, vibrator component, contactors, impellers and space structures because of its extended properties [5]. Stir casting technique is one of the promising techniques to manufacture MMCs in large quantities. Owing to its easiness and litheness, it has been fascinated. Complicated components with proper distribution of particulates in the matrix material can be fabricated by stir casting method [6–9].

In this study, aluminum metal matrix composites have been fabricated through the stir casting technique and the tribological behavior has been investigated.

2 Experimental Details

2.1 Materials

The aluminum alloy AA7050 was used as a matrix material, its chemical composition and properties are presented in Table 1 and Table 2. $ZrSiO_4$ was used as a reinforcement material and its properties are presented in Table 3.

2.2 Preparation of composites

The composites were prepared through liquid metallurgy method. Initially, the matrix material AA7050 was melted in a crucible furnace. The temperature maintained in the furnace was 800°C for a time period of 4 hours. Before pouring the $ZrSiO_4$ into the melt, it was preheated at a temperature of 150°C. Finally, the essential amount of $ZrSiO_4$

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Table 1: Chemical composition of AA7050

AA7050	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	Pb	Sr	Zr	Al
Weight (%)	0.061	0.139	1.629	0.105	2.543	0.218	5.243	0.084	0.022	0.002	0.003	Bal

Table 2: Mechanical properties of AA7050

Properties	AA7075
Density	2.83 g/cc
Ultimate tensile strength	524 Mpa
Melting point	629°C

Figure 1: Experimental setup of stir casting

Table 3: Mechanical properties of $ZrSiO_4$

Properties	$ZrSiO_4$
Density	3.9 g/cm^3
Ultimate tensile strength	290 Mpa
Melting point	2550°C

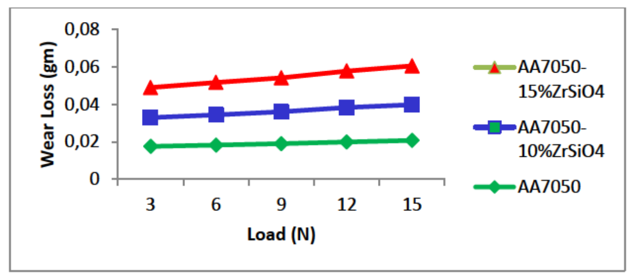

Figure 2: Load versus wear loss

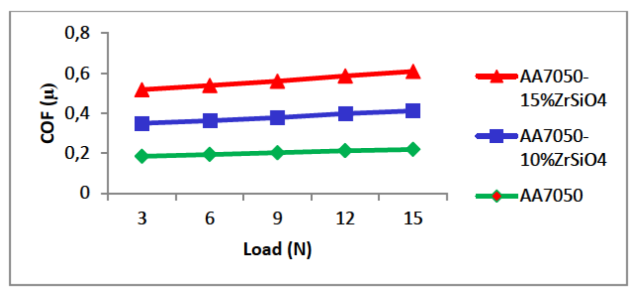

Figure 3: Load versus COF

was mixed with AA7050 to make a cast. At that time, the stirring speed was maintained at 300–500 rpm [10]. The temperature maintained was 750°C and stirring was done for a time period of 10 min.

2.3 Wear behavior

The wear behavior of the different composites was investigated by using a pin-on-disc tribometer. The experiments were conducted under dry conditions at different loads and speeds to investigate the wear behavior such as friction loss and co-efficient of friction for different composites.

3 Results and Discussions

The wear loss and coefficient of friction behaviors of AA7050, AA7050-10%$ZrSiO_4$, and AA7050-15%$ZrSiO_4$ were investigated by using pin-on-disc apparatus. The experiments were done at different loads of 3 N, 6 N, 9 N, 12 N and 15 N, different sliding distances of 1200 m, 1700 m, 2200 m, 2700 m and 3200 m, and different sliding speeds of 0.4 m/s, 0.8 m/s, 1.2 m/s, 1.6 m/s and 2.0 m/s.

The experimental results showed that when the applied load was increased, the wear loss also increased. The results of wear loss and coefficient of friction against load and sliding speed are listed in Table 4 and Table 5. The least wear loss of 0.0154 gm and least coefficient of friction of 0.165 µ were achieved for AA7050-10%$ZrSiO_4$ composite, while applying a load of 3 N. From the graphs, it was

Table 4: Wear loss (gm) and coefficient of friction (μ) for applied load (N)

Applied Load (N)	AA7050		AA7050-10%$ZrSiO_4$		AA7050-15%$ZrSiO_4$	
	Wear Loss (gm)	Coefficient of Friction (μ)	Wear Loss (gm)	Coefficient of Friction (μ)	Wear Loss (gm)	Coefficient of Friction (μ)
3	0.0175	0.185	0.0154	0.165	0.0161	0.168
6	0.0182	0.194	0.0162	0.169	0.0173	0.176
9	0.0190	0.203	0.0170	0.175	0.0182	0.182
12	0.0199	0.213	0.0184	0.185	0.0195	0.188
15	0.0207	0.219	0.0191	0.193	0.0208	0.197

Table 5: Wear loss (gm) and coefficient of friction (μ) for sliding speed (m/s)

Sliding speed (m/s)	AA7050		AA7050-10%$ZrSiO_4$		AA7050-15%$ZrSiO_4$	
	Wear Loss (gm)	Coefficient of Friction (μ)	Wear Loss (gm)	Coefficient of Friction (μ)	Wear Loss (gm)	Coefficient of Friction (μ)
0.4	0.0186	0.196	0.0188	0.185	0.0192	0.197
0.8	0.0178	0.188	0.0182	0.179	0.0185	0.191
1.2	0.0170	0.177	0.0176	0.175	0.0180	0.186
1.6	0.0169	0.170	0.0169	0.167	0.0174	0.181
2.0	0.0165	0.164	0.0159	0.161	0.0170	0.175

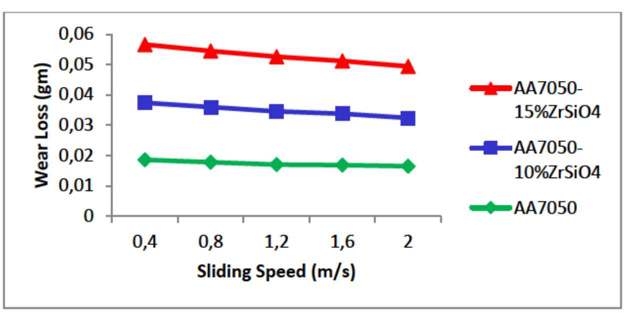

Figure 4: Sliding speed versus wear loss

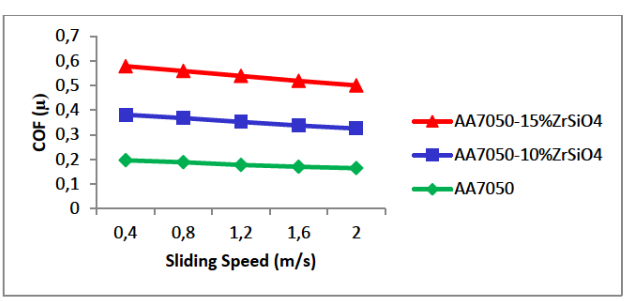

Figure 5: Sliding speed versus COF

clear that at high sliding speed, wear loss and coefficient frictions were minimum. At a sliding speed of 2 m/s, the least wear loss achieved was 0.0159 g and least coefficient friction was 0.161, identified for the composite AA7050-10%$ZrSiO_4$.

4 Conclusions

1. The aluminum metal matrix composites with different reinforcement weight percentage were successfully fabricated through stir casting technique.
2. The wear properties such as wear loss and friction coefficient were influenced by 10%$ZrSiO_4$.
3. The least wear loss and coefficient friction was detected for the composite AA7050-10%$ZrSiO_4$ with an applied load of 3 N.
4. The least wear loss and coefficient friction was attained for the composite AA7050-10%$ZrSiO_4$ at a sliding speed of 2 m/s.

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