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Microstructure Assessment of AA7050-$ZrSiO_4$ Composites Synthesized by Stir Casting Route

V. Kesavan[1], S. Sakthivelu[1*], M. Meignanamoorthy[2]
[1]Department of Mechanical Engineering, M. Kumarasamy College of Engineering, Karur, India-639 113
[2]Department of Mechanical Engineering, Anna University, Chennai, India-600 025
***Corresponding author: E-Mail: Sakthis1691@gmail.com**

ABSTRACT

Aluminum metal matrix composites have wide spread applications in the field of aerospace, automobile and defence due to its superior mechanical properties like ultimate strength and hardness. AMCs possess better tribological properties too. This research work aims to synthesis aluminum metal matrix composites through stir casting route. The matrix material chosen was AA7050 and reinforcement material chosen was $ZrSiO_4$. The compositions namely AA7050+2.5$ZrSiO_4$, AA7050+5%$ZrSiO_4$, AA7050+7.5%$ZrSiO_4$, AA7050+10%$ZrSiO_4$, AA7050+12.5%$ZrSiO_4$ and AA7070+15%$ZrSiO_4$. From the microstructure examination it was observed that when increasing the reinforcement weight percentage significant changes in the microstructure was occurred and homogenous distribution between the matrix and reinforcement material was take place. The microstructure assessment of various composites were carried out by using scanning electron microscope and stated.

KEY WORDS: Aluminum metal matrix composites, $ZrSiO_4$, Microstructure, Stir Casting.

1. INTRODUCTION

The main objective of choosing aluminum alloy composite materials in the field of engineering is due to its several advantages namely high strength, high stiffness, high thermal stability, high corrosion and wear resistance. Among the various types of aluminum alloys, AA7050 has been attracted because of its better mechanical and wear properties. The main thing in MMCs fabrication is proper chemical link at the edge, this can be achieved by stir casting. Stir casting is recommended as easiest and economical technique to manufacture metal matrix composites and this is the suitable method to fabricate components in mass production. MMCs are being used in the structural fields despite of their enriched mechanical properties, superior wear resistance and low thermal expansion. Kumar et al investigated the Wear performance of dual particle size (DPS) zircon sand strengthened with aluminum alloy and reported that zircon sand possess greater wear rate under various loads. Dora Siva Prasad et al studied the mechanical properties of aluminum hybrid composites fabricated through double stir casting.

In this study an attempt has been made to synthesis AA7050-$ZrSiO_4$ with different weight percentage. The synthesized composites were subjected for microstructure examination using scanning electron microscope to investigate the distribution of reinforcement particles in the matrix material.

2. EXPERIMENTAL DETAILS

Materials: The matrix material chosen here was AA7050 its chemical compositions and mechanical properties are listed in the below table1&2. The reinforcement material chosen here was $ZrSiO_4$ its mechanical properties are listed in the below table.2.

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 and $ZrSiO_4$

Properties	**AA7075**	**$ZrSiO_4$**
Density	2.83 g/cc	3.9 g/cm^3
Ultimate Tensile Strength	524 Mpa	290 Mpa
Melting Point	629^0C	2550^0 C

Preparation of Composites: The stir casting route was adopted to fabricate the composites. Initially AA7050 was entirely liquefied in a furnace. The temperature maintained in the furnace was 750^0C for 4 hours. To remove the moistness in the reinforcement particle $ZrSiO_4$, it was preheated at 700-800^0C for 1 hour. In the next step to fabricate the composites with various weight percentages necessary amount of reinforcement particle $ZrSiO_4$ was added into the molten metal at a temperature of 850^0C. The stirring was done at a speed of 100 rpm for a 10 min. To improve the wettability between matrix and reinforcement materials 1% weight of magnesium was added. Finally the prepared composites were poured into a mould cavity to get desired dimensions.

Microstructure Examination: The fabricated samples were initially polished by using emery paper having a grit size 600-1200 and finally polishing was completed by using the grinding machine consists of velvet material. The polished samples were subjected for microstructure investigation via scanning electron microscope to examine the distribution of reinforcement particles between the matrix materials.

Figure 1. Experimental Setup of Stir Casting

3. RESULTS AND DISCUSSIONS

The desired quantity of composites was fabricated through stir casting method. The microstructures of the fabricated samples AA7050+2.5$ZrSiO_4$, AA7050+5%$ZrSiO_4$, AA7050+7.5%$ZrSiO_4$, AA7050+10%$ZrSiO_4$, AA7050+12.5%$ZrSiO_4$ and AA7070+15%$ZrSiO_4$ were clearly shown in the figures.2-7. Figs.2 &3, clearly shows the uniform distribution of reinforcement particle between the matrix materials. When increasing the reinforcement weight percentage from 7.5 large size particulates has been observed. Figs.4 & 5, shows the little agglomerations between the reinforcement particles and matrix materials this was happened by impeller, it causes the shear force on the composite materials. From figs.6 & 7, it was evident that reinforcement particle in large size can be clearly seen and it was distributed homogeneously throughout the matrix materials. Hence it has been proved that stir casting method is the suitable method to synthesis composites with proper distribution of reinforcement particles with the matrix materials.

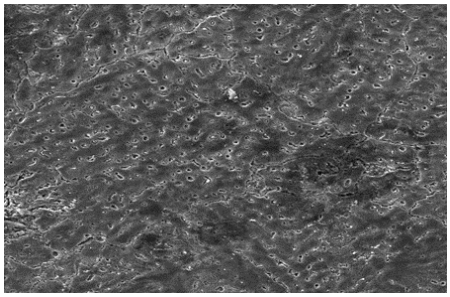

Figure.2. SEM Image of AA7050+2.5% $ZrSiO_4$

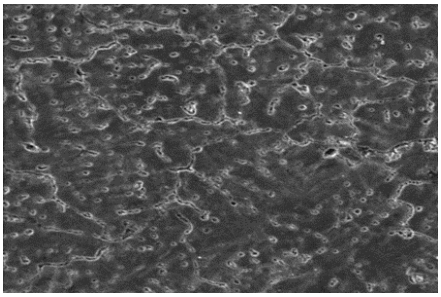

Figure.3. SEM Image of AA7050+5% $ZrSiO_4$

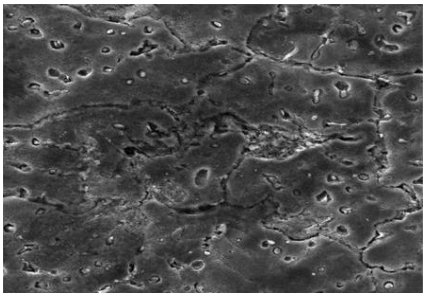

Figure.4. SEM Image of AA7050+7.5% $ZrSiO_4$

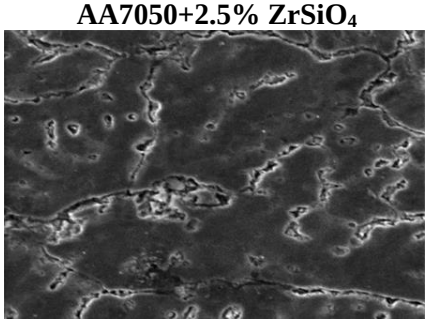

Figure.5. SEM Image of AA7050+10% $ZrSiO_4$

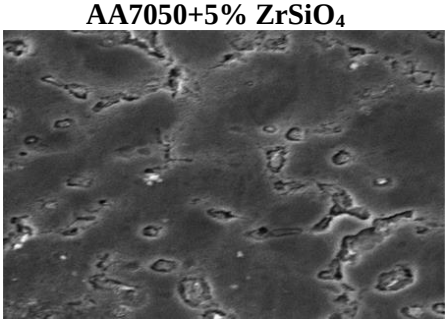

Figure.6. SEM Image of AA7050+12.5% $ZrSiO_4$

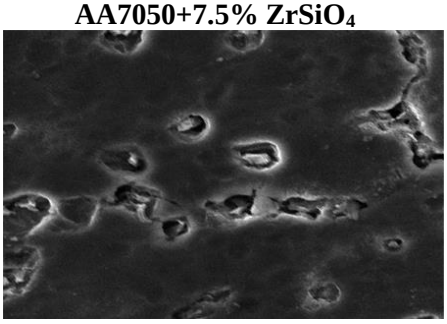

Figure.7. SEM Image of AA7050+15% $ZrSiO_4$

4. CONCLUSIONS

- The AA7050-$ZrSiO_4$ composites with various weight percentages have been effectively manufactured through stir casting route.
- From the microscopic examination is has been confirmed that homogenous distribution was occurred between the reinforcement material and matrix materials. Even though when adding 7.5 and 10 wt.% of $ZrSiO_4$ to AA7050 little clusters has been observed.
- Hence it is reported that stir casting is the upgraded technique to fabricate MMCs to attain uniform dispersal between the particulate material and matrix materials.

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