STUDIES ON MECHANICAL BEHAVIOUR OF ALUMINIUM BASED COMPOSITES

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ABSTRACT

Due to its high strength the Hybrid Aluminium metal matrix composites are employed in mechanical industries. Composites can be prepared using stir casting method. In this study, an Al 7075 alloy is employed as the matrix with varying weight percentage of Silicon carbide and Boron Carbide particles as the reinforcement material. In this analysis the mechanical properties of the composite specimen with varying weight percentage were discussed. Results showed that there is increase in hardness and tensile strength of the fabricated composites than the parent metal.

Keywords: Reinforcement, hardness, metal matrix composites, weight percentage, casting.

Introduction

Reinforcement material is mixed with matrix to give desired characteristics [1]. MMCs are widely used in aerospace applications because of enough strength. [2-3]. Due to less weight aluminium and its alloys are used in many industries [4]. The various reinforcements like SiC, Al₂O₃, Zircon, Graphite, Boron carbide, Mica were also taken for many applications [5]. Boron carbide particles are used as reinforcement in engineering applications. [6]. Exploration of mechanical properties of aluminium alloys reinforced with Boron carbide and silicon carbide is an inspiring field of research. [7]. In latest years, composite materials are considered due to its lesser cost and their ability for processing. [8,9]. Stir casting is an effective processing method since it is very less expensive and provides a wide selection of materials. [10,11]. Consequently, the intend of this study is to examine the consequence of Boron Carbide content and silicon carbide content on the hardness, tensile strength Al7075- varying wt. % of B₄C (5%) and SiC (5%) composites.
2. EXPERIMENTAL INVESTIGATION

2.1 Material Details

Due to excellent strength, less density and increased thermal properties Aluminium 7075 is used in automobile industries. Aluminium alloy have high-quality wear resistance with additional reinforced particles. $\text{B}_4\text{C}$ is an successful reinforcement material because of its high-quality chemical and thermal steadiness. Mechanical property tests were performed on $\text{B}_4\text{C}$ and SiC particulates reinforced with Al 7075 composite. Table 1 shows the composition of weight percentage of matrix materials Al7075. The assortment of reinforcement materials $\text{B}_4\text{C}$ and SiC 20-25 $\mu$m. The assessment of density for matrix and reinforcement materials are miniature and hence resultts in uniform mixing.

2.2 Processing Methodology

In Stir casting method the stirrer was linked to a Motor from end to end flexible link and was used to stir the molten metal. Material was heated above its melting temperature. Silicon carbide about 20% and Boron carbide about 10 % were added in the melt. Uniform stirring was done using stirrer. Stirrer was rotated at 500rpm. After uniform stirring the bottom portion of the furnace is opened. A die with the dimension 50X50X50mm was kept under the furnace. The lid at the bottom was opened and the molten metal was forced to settle in the die. After Solidification the die was broken and the specimen was taken out. Then the second specimen with silicon carbide 10% and Boron carbide 5% was made with the same procedure. The mechanical property such as tensile strength and hardness were tested. Tensile strength was tested in universal testing machine and hardness were tested using Rockwells hardness testing machine. Five set of readings were taken and average value was taken as the hardness value.
Table 1. Composition of Al7075 by weight percentage

<table>
<thead>
<tr>
<th>Elements</th>
<th>Si</th>
<th>Fe</th>
<th>Cu</th>
<th>Mn</th>
<th>Ni</th>
<th>Zn</th>
<th>Ti</th>
<th>Mg</th>
<th>Cr</th>
<th>Al</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wt%</td>
<td>0.06</td>
<td>0.18</td>
<td>1.63</td>
<td>0.074</td>
<td>0.05</td>
<td>5.62</td>
<td>0.049</td>
<td>2.52</td>
<td>0.22</td>
<td>Balance</td>
</tr>
</tbody>
</table>

3. Results and Discussion

3.1 Tensile Test

It is noticeable that tensile strength of composites containing 10 wt% B₄C and 20% SiC reinforcement particles was superior when compared to other composites. This is due to thermal variant happened in the matrix. The presence of B₄C and silicon carbide particles in the matrix makes the matrix much harder and avoid crack during deformation. Fig 1 illustrates the Tensile strength. The ductility of the Al alloy-based composites, quantified in prerequisites of tensile elongation, decreased with an increase in B₄C and SiC particle size. The accretion of B₄C and SiC particles into composites improved the tensile strength.

3.2 Compression Test

Fig 2 shows the variation of compressive strength. During compression test the specimen is compressed and the deformation takes place. Elastic limit, proportional limit, yield point, yield strength, compressive strength can be determined by compression strength. When the deformation comes, the intermolecular forces rise and overcome the force applied. A superior applied force may lead to a everlasting deformation of the object or even to its structural breakdown.

3.3 Hardness Evaluation

A noteworthy increase in hardness of the alloy matrix was seen with adding together of SiC and B4C particles. This indicated that the continuation of particulates in the matrix enhanced the on the whole hardness of the composites. This is owed to the fact that aluminum is a soft material and the reinforced particles being hard, contribute positively to the hardness of the
composites. The presence of stiffer and harder B₄C and SiC reinforcement leads to amplify in resistance to plastic deformation of the matrix. Fig 3 shows the hardness evaluation.

Ultimate Tensile strength of Al7075 composite alloy

Ultimate Compressive strength of Al7075 composite alloy

Hardness Evaluation of Al7075 Composite alloy
4. Conclusion

The occurrence of the higher reinforcing particles causes a decisive increase in tensile strength. The prevalence of stiffer and harder B₄C and SiC reinforcement lead to the raise in resistance to plastic deformation of the matrix. It was also experimental that in the Al7075 matrix alloy B₄C and SiC reinforcements act as a superior bond. A compression test results the decisive performance of materials..

References


