Friction Stir Processed AA6082 with Si-Gr Hybrid Surface Composites and its Mechanical Behaviour

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ABSTRACT
Aluminium alloys are replacing many conventional metal alloys in the manufacture of wear resistant parts. Aluminium alloys are used in Truck Frames, aircraft structures, automotive parts, cylinders & pistons, machine parts and structural applications. These aluminium alloys are resistant to chemical attack & weathering, low cost, ductile for deep drawing & easy to weld, used in chemical equipment, fan blades, sheet metal work.

Keywords--- Composites, Aluminium, Friction Stir processing, Mechanical Properties

I. INTRODUCTION
Friction-stir processing (FSP) is a solid-state joining process where the revolving tool generates heat between the tool piece to be joined. The two pieces of metal mechanically intermixes at the place of the joint which can be joined by applying pressure. FSW tools undergoes severe stress and high temperatures particularly for the welding of hard alloys such as steels and titanium alloys.

To increase the material properties AA 6082 alloy, in this work is mixed with silicon and graphite mixture for preparing the metal composite. The mechanical property of the composite metal is tested using hardness and wear tests.

The formation of Friction stir processing (FSP) zone has been analyzed macroscopically. Hardness, microstructure and wear properties of the joints are evaluated and correlated with the FSP zone formation and thereby shown that as the percentage of Silicon and graphite mixture increases, the mechanical properties of the metal increases for a certain level and then starts decreases.

The experiment was carried out with various welding parameters by varying the rotational speed and tool pin profiles. As a result the microstructures of all joints were analyzed using low magnification optical microscope to reveal the quality of FSP regions. A defect free FSP region will have smaller grains with uniformly distributed finer strengthening along the FSP region.

II. REVIEW OF LITERATURE
N. Sun and D. Apelian (2011) The author said that Friction stir processing (FSP) is a novel process developed based on the principle of friction stir welding (FSW) that locally manipulates the microstructure by imparting a high level of energy in the solid state resulting in improved mechanical properties.

R.S. Mishra (2003) He has FSP as a novel surface modifying technique which has been developed for fabrication of surface composite. The solid-state processing and very fine microstructure that results are also desirable for high performance surface composites.

Y. Morisada (2006) The author in this study said that the SiC particles were dispersed into AZ31 in order to reveal the effect of the FSP with the SiC particles on the microstructure and hardness of the magnesium alloy. The pinning effect of the SiC particles on the grain growth of the AZ31 matrix was also evaluated with respect to the change in the grain size after the heat treatment.

R. Sathiskumar (2013) Friction stir processing (FSP) was applied to fabricate boron carbide (B4C) particulate reinforced copper surface composites. The effect of FSP parameters such as tool rotational speed, processing speed and groove width on microstructure and micro hardness was investigated. The results indicated that the selected FSP parameters significantly influenced the area of surface composite, distribution of B4C particles.
and micro hardness of the surface composites.

III. METHODOLOGY

Problem Identification
It is been generally known that the fusion welding of aluminium alloys is always accompanied by defects such as solidification cracks, slag inclusion, porosity etc. These defects remain as the major cause for poor quality of welding. Since Aluminium is used as the major component for manufacturing automobile parts, air craft structures etc. it is important to find an alternative solution to overcome the defects. Friction Stir processing are known to be free from these defects since there is no melting takes place during welding and the metals are joined in the solid state itself due to the heat generated by friction and flow of metal by Stirring action

Main Objective of the Project
The main objective of this project is
- To get fine grained microstructure
- To increase the strength of AA6082 alloy
- To test the mechanical properties of reinforced alloy

Process Frame Work
In this experiment two Aluminium alloy one with reinforced silicon and graphite powder and the other without reinforcements are tested to know the mechanical properties.

Readings are taken for Aluminium alloy reinforced with Silicon and graphite powder by increasing the proportion of silicon and graphite powder using the process parameters such as traverse speed 500 rpm, rotational speed of 60mm/sec and axial force of 7KN. The increase or decrease in the hardness value based on the increase in the proportion of reinforced material is used to comprehend the changes in the mechanical behavior after reinforcement

IV. EXPERIMENTAL PROCEDURE

Preparation of AA6082 Alloy
Cutting machine is used to cut the rolled AA 6061 Aluminium alloy plates of 7 mm thickness. It is shaped using the grinding machine. A groove of 1.5*1.5mm is made by using grinding machine to pour the reinforcement material.

Once the groove is made the work piece is clamped on the fixture where the friction stir processing is carried out. The reinforcement mixture of Silicon and graphite is mixed and placed along the groove using thickness gauge.

As an initial process of Friction Stir Processing as the tool descends over the work piece the rotating pin contacts the tool surface which created friction between the tool and the workpiece. This frictional heat is used to plasticize metal column around the pin. The shoulder of the tool is pressed to create additional force and the metals are joined in the solid state itself with the heat energy generated.

The processed zone cools without solidification, as there is no liquid. Hence the defect-free recrystallized, fine grained micro structure is formed. The work piece is un clamped from the fixture and polished using graphite paste and emery sheets.

Testing the Sample
The sample work piece is now ready for testing. The hardness of the sample is tested using Brinell Hardness machine.

The work piece is divided into Centre processed Zone, Parent Metal-Left and Parent Metal-Right. Each of these zones of the work piece is tested using Brinell hardness machine to know the strength of the metal.

The hardness value for various specimen along various zones are taken using Brinell Hardness Number (BHN) and their hardness value is as shown below
As per the reading in the table it can be observed that as the percentage proportion of Silicon increases in the reinforced composite material the hardness value proportionately increases up to 8% addition of aluminium after which the hardness starts decreasing showing the saturation limit.

Hence it can be suggested that the reinforcement of 8% of Si2-0.5 Gr hybrid reinforcement can be used to fabricate AA6082 alloy in order to achieve improved properties over the surface.

### Table 1. Hardness Value for various Specimen

<table>
<thead>
<tr>
<th>Sp No</th>
<th>Si %</th>
<th>Gr %</th>
<th>Parent Metal-Left (BHN)</th>
<th>HA Z-Left (BHN)</th>
<th>Centre Processed Zone (BHN)</th>
<th>HA Z-Right (BHN)</th>
<th>Parent Metal-Right (BHN)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>79.5</td>
<td>7</td>
<td>87.5</td>
<td>115.67</td>
<td>93.1</td>
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<tr>
<td>2</td>
<td>2</td>
<td>1</td>
<td>89.7</td>
<td>6</td>
<td>115</td>
<td>124.87</td>
<td>107</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>1</td>
<td>89.7</td>
<td>6</td>
<td>126</td>
<td>135.56</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>1</td>
<td>95.3</td>
<td>4</td>
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<td>167.32</td>
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<tr>
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<td>8</td>
<td>1</td>
<td>100.4</td>
<td>45</td>
<td>127</td>
<td>140.72</td>
<td>121</td>
</tr>
<tr>
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<td>0</td>
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<td>8</td>
<td>119</td>
<td>133.56</td>
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<tr>
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<td>2</td>
<td>97.8</td>
<td>9</td>
<td>116</td>
<td>120.98</td>
<td>106</td>
</tr>
</tbody>
</table>

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### V. CONCLUSION

Friction Stir processing of AA6082 alloy with various proportion of Silicon – Graphite composite was carried out in this experiment and their hardness value is measured.

The maximum hardness of 140 BHN was obtained with the welding speed of 60mm/min at 500 rpm.

The reinforcement percentage was 8% Si and 0.5% Gr hybrid composite.

Defect-free and sound surface composites were fabricated within the range of selected parameters.

### REFERENCES