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Experimental and Investigation of Aluminium Metal AA2219 using Friction Stir Welding and to Evaluate the Mechanical Properties

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Abstract: *Friction Stir Welding (FSW) is an environment friendly solid-state joining technology that uses a rotating tool to generate frictional heat and plastic deformation with mixing of the soft material by the pin along the welding line. The advantages are low distortion, lack of traditional defects commonly found in fusion welds and high joint efficiency. The paper focuses on microstructure evolved after welding and the effect of welding process is discussed for aluminum alloy 2219. This alloy is selected because of high strength and good resistance to stress corrosion cracking at cryogenic temperature. The optimum process condition for FSW is determined with microstructural and mechanical properties. It is shown that the FSW provides higher performance for this alloy than the conventional welding technology*

Keywords: Friction stir welding, Aluminium alloys, Cylindrical tool, L9 Orthogonal array.

I. INTRODUCTION

Friction Stir Welding (FSW) process is an environment protective process and does not produce toxic fumes with no consumable filler material involved unlike the conventional fusion welding. In most fusion welding processes, there are problems of possible porosity, hot cracking, solute segregation and precipitation behavior change. In FSW, the probe of the tool is applied to the contact faces of the workpieces and spinned to produce frictional heat in the work piece. This process creates a softened deformed region around the probe and by keeping the tool rotating and moving it along the joint line to be welded. The softened material is stirred and mechanically mixed together by the rotating probe forming a weld without melting [1, 2]. The rotating shoulder provides additional frictional heat as well as preventing deformed material from being expelled from the weld. One plate where the direction of rotation is the same as that of welding direction is the advancing side (AS), with the other plate designated as being the retreating side (RS). As the temperature increases, the plastically deformed material is extruded from the advancing side to the retraction side of the tool by the applied shear stress. As a solid state joining process, FSW significantly improves the weld properties and has been extensively applied in joining light metals by offering advantages over fusion welding due to the absence of metal melting. Absence of melting in FSW reduces oxidation, residual stress, and other solidification related defects. The resulting FSW joint consists of several zones involving different microstructures and mechanical properties. The microstructure of the typical friction stir weld shows a central stirred zone which is the region that is thermo-mechanically processed zone where the grain size is refined and homogenized, the thermo-mechanically affected zone (TMAZ), close to the stirred zone, where the grain is elongated, and the heat affected zone (HAZ) with the same grain structure of the base material.

II. LITRATURE REVIEW

1. An experimental investigation on FSW of AZ31B magnesium alloy.

G. Paramandhan Balasubramaniyan

Base metal: Magnesium alloy

Tool Material: High Carbon Steel Process: Friction Stir Welding

FSW techniques used to join two thin plates.

Vary the tool rotational speed, welding speed, axial force a tensile properties of magnesium alloy to observe the result.

From this investigation, it is found that the joint fabricated using tool rotationl speed of 1600 rpm, a welding speed of .67 mm/sec and axial force of 3 KN yielded superior tensile properties compared to other joint.
Conclusion: To understand the investigation change the different tool parameters select the best one.

2. Optimizing friction stir welding parameter to maximize tensile strength.
S. Bsbu
K. Ilangovan,
V. Balasubramanian
Base material: aluminium alloy Process: friction stir welding Tool material: HCHCR
The welding parameters such as tool rotationl speed , axial force . and the tool pin profile play a major role in determining the joint strength
Determine micro structure test, tensile strength
A central composite design with been used to minimize the number of experimental conditions Conclusion :
The hooke and jeeves algoritham has been used here to optimize the FSW parameter and tool proifile to attain maximum tensile strength in the welding joints

III. AIMS AND OBJECTIVES

The fusion welding processes that are routinely used for joining structural alloys, friction stir welding (FSW) is an emerging solid state joining process in which the material that is being welded does not melt and recast.
Friction stir processing (FSP) is emerging as a promising tool for micro structural modification.
The current study assesses the effects of FSP on the microstructure and mechanical properties of an Aluminium alloy. FSP eliminates porosity and significantly refines the grain structure. The extent of particle refinement varied with changes in tool pin profile. In this study TiC and SiC are mixed in the welded zone using different tool pin profiles with constant welding parameters. Hardness value and microstructure of the localized friction processed area were to be studied and possibility of adding inclusions in the welded area is to be analysed.
In the present work, 2219 TO Sl aluminum alloy plates were used for friction stir processing. Aluminium plate of 350* (length. width, and thickness, respectively) were taken for the experimental work, through holes of mm diameter were to be drilled. The holes to be packed with the mixture of titanium carbide and silicon carbide
The bead on plate welding (Friction stir processing) taken at a constant load by controlling the penetration depth of the tool into the joint line. Effect of FSW process were to be came out with different tool pin profile (cylinder, triangle. square, pentagon). In addition the inclusions (silicon carbide, titanium carbide) were to be added and stirred to change the mechanical properties of the base metal. The process parameters such as tool rotational speed, axial force, and welding speed were to be kept constant.Finally investigation on microstructure modification and hardness value of the weld processed area were to be carried out.

IV. MATERIALS AND METHODS

AA2219 T6 51 is used as a base metal and it possesses the following characteristics:

1. Light Weight
2. Corrosion Resistance
3. Electrical and Thermal Conductivity
4. Reflectivity
5. Ductility
6. Impermeable and Odourless
7. Recyclability
8. Good conductor of heat.
9. Non-magnetic.
10. They exhibit toughness and become stronger at temperatures below the ordinary atmospheric range.

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4.1 Composition of Base Metal

CHEMICAL COMPOSTION (Wt%) OF BASE METAL	
Si	0.9
Fe	0.2
Cn	0.03
Mg	0.66
Zn	0.8
Ti	0.05
Others	0.03

Fig. 1 A sample line graph using colors which contrast well both on screen and on a black-and-white hardcopy

Fig. 2 shows an example of a low-resolution image which would not be acceptable, whereas Fig. 3 shows an example of an image with adequate resolution. Check that the resolution is adequate to reveal the important detail in the figure. 4.2

4.2 Physical Properties of Base Metal

SI NO	PHISICAL PROPERTY	VALUE
1	Density	2600-2800kg/m3
2	Melting point	660^c

Table 4.2 Physical properties of base metal

4.3 Mechanical Properties of Base Metal

Mechanical property ofAA6082-T651	Value
Yeild strength	313.0
Ultimate strength	330.0
Elongation	9.0
Rockwell hardness	55

Table 4.3 Mechanical properties of base metal

4.4 Thermal Properties Of Base Metal

SINO	THERMAL PROPERTY	VALUE
1	Thermal conductivity coefficient	20.4-25.0*10^-6/K
2	Thermal conductivity	231(W/m-K)

Table 4.4 Thermal properties of base metal

4.5 Electrical Properties of Base Metal

Sl. No	Electrical property	Value
1	Electic resistivity	28*10^-9 -m

Table 4.5 Electrical properties of base metal

4.6 Uses of Base Metal

1. Cryogenic applications.
2. Overhead conductors and heat exchanger parts.
3. As heavyduty structures such as dragline booms, traveling cranes, hoist, conveyor supports, bridges, etc.
4. Transportation industry-structural frame work, engine parts, trim and decorative features, hardware, doors, windows frame, tanks, furnishing and fittings.
5. Mangles and waffle molds.

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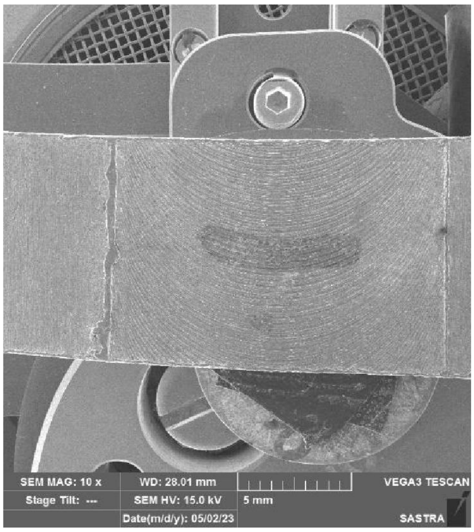
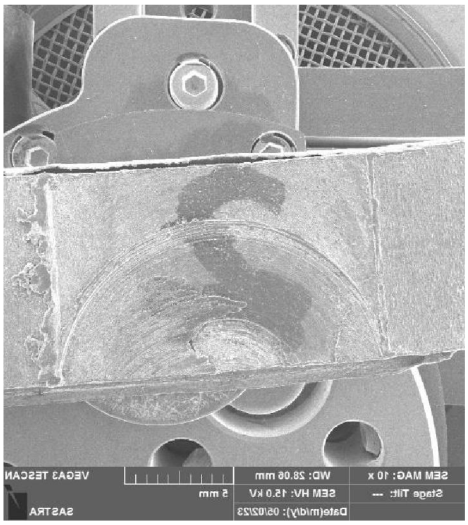
V. MICRO STRUCTURAL STUDIES

Sample 1

Sample 2

10X





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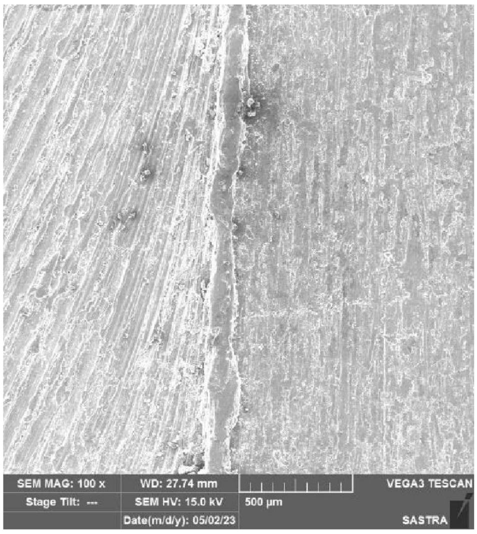

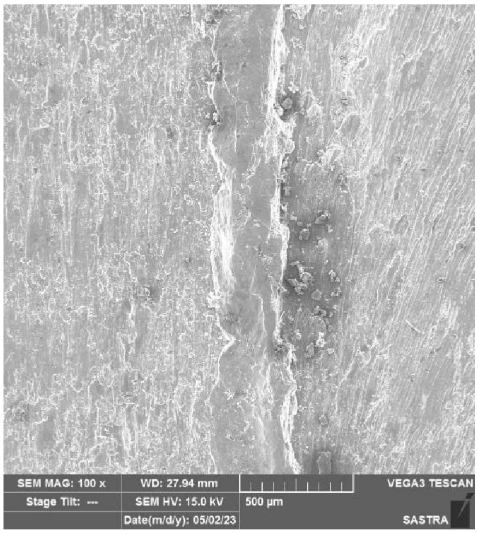

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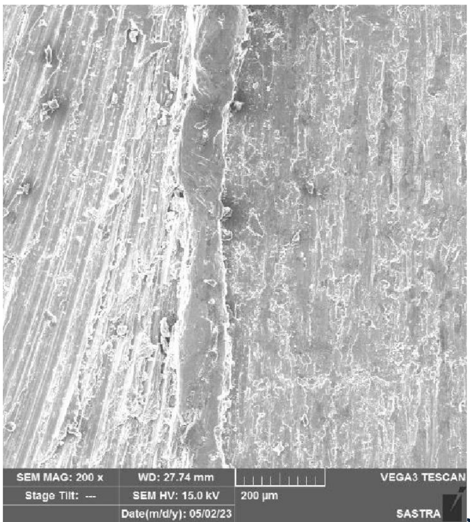

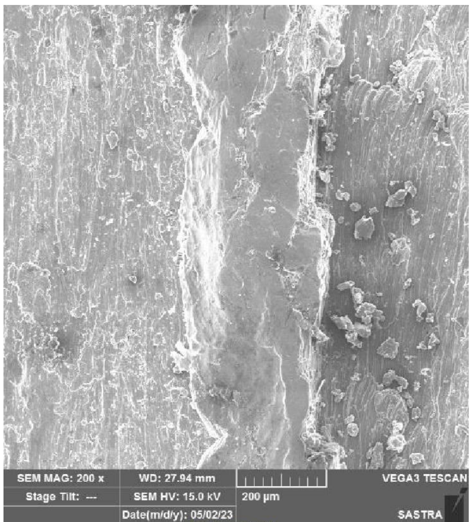

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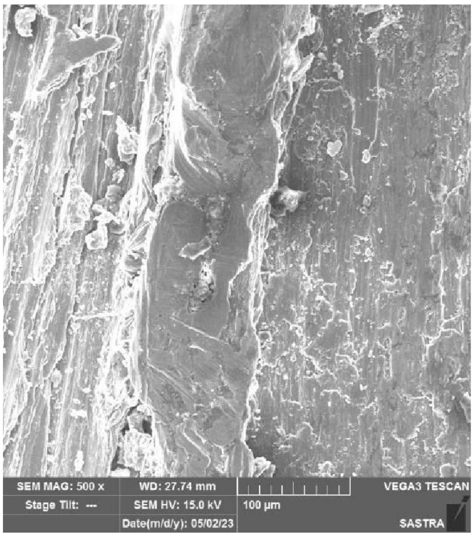

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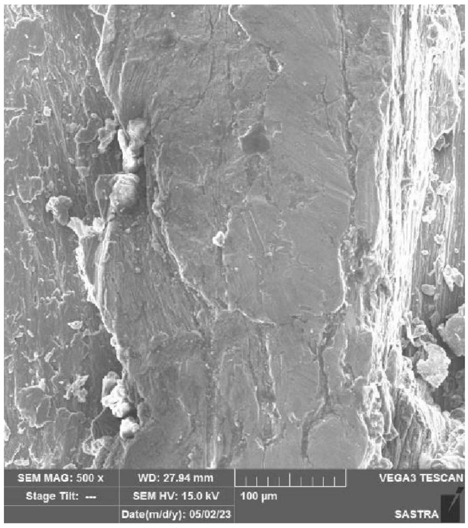

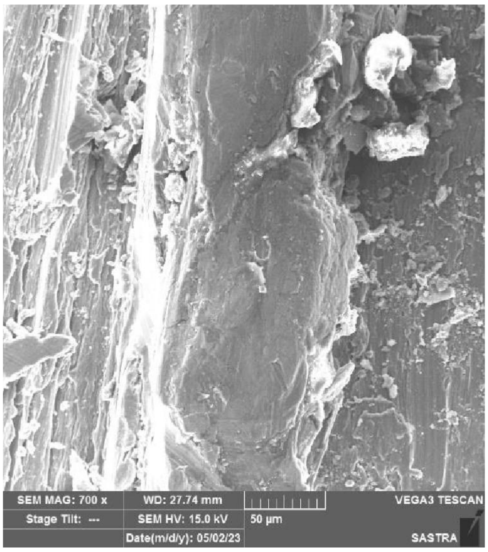

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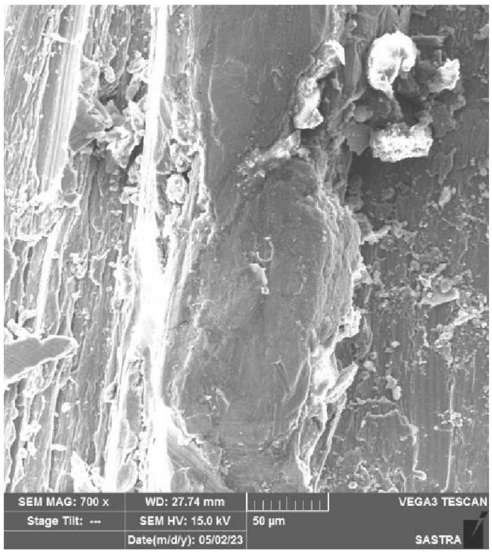

VI. CONCLUSION

In the present study, the AA2219 T6 51 Al surface and Al/SiC /TiC composites were successfully fabricated by FSP. The microstructure and hardness were evaluated observing the matrix grains and dispersion of the reinforcement particles.

The following results were obtained:

l. It has been demonstrated that FSP was an appropriate method to modify the microstructure and mechanical properties of AA2219 T6 51 Al-alloy. In general, FSP decreased the grain size and increased the hardness of processed material.

2. Good interfacial conditions between particles and base metal can be formed during this solid-state process which avoids the chemical reactions on the interface.

3. The depth of the surface layer can be tailored by welding parameters or pin design.

4. The high hardness of Al/SiC/TiC composite can be attributed to the presence of reinforcement particles.

5. Of the four tools pin profiles used to fabricate the joints pentagonal pin profiled tool produced defect free FSP region and distribution of inclusions and grain refinement were found to be better.

6. With further research efforts and increased understanding, FSP could be conducted for mechanical behaviour of these composites, like fatigue and creep response and new tool design for uniform distribution of reinforcement particles into the matrix materials.

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