

Analysis of Fabrication process of TiB2 Reinforced Friction Stir Welding joint of AL-1120

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Abstract— Joining process of metals is important for manufacturing industries specifically for the dissimilar metals. Welding of Aluminium and its alloy can be done with solid state welding specially friction stir welding which enables better material properties at heat affected zone with variable input. Input variables speed, rpm and profile of tool pin directly contribute to enhance mechanical properties during process. Selection of reinforcements also provides its affect to quality of outcome. Titanium diboride in powder form with araldite as adhesive is useful coating element works as reinforcement for better quality of welded joint.

Keywords— Friction Stir Welding, tool profile, thermo-mechanically affected zone

Introduction

In modern day manufacturing aluminium is one of the key elements because of its specific mechanical properties. Welding quality is important for product life cycle. Different types of solid state friction welding

- Rotary friction welding
- Linear or Orbital friction welding
- Friction stir welding

Source of heat energy is friction between moving surface. In solid state heat is generated in localized area for joining of materials. In case of rotary and orbital friction welding butt joint type welding is done generally.

In rotary and linear friction welding heat is generated through friction between moving surfaces. Both type of welding suitable for butt type joints.

In case of rotary friction welding direct-drive or inertia drive can be used for process.

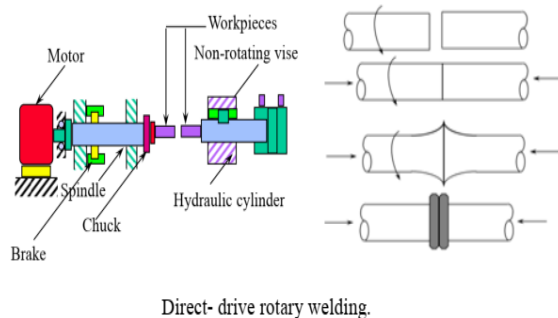


Figure 1 : Schematic diagram of rotary friction welding set up

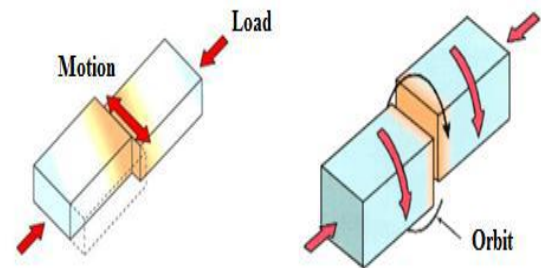


Figure 2: Schematic diagram of Linear and orbital friction welding

Friction Stir welding can be useful for specific application of butt and lap joint. Similar and dissimilar both types materials can be welded by this process. The frictional heat is used for joining the base material.

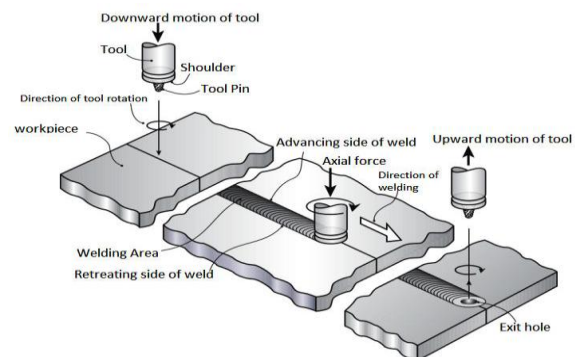


Figure 3: Process layout of friction stir welding

Literature Review

The literature review helps to know about the selection of welding parameter and required precaution for quality of welding. Analysis on different research information provides the intricate details of material properties after welding and changes in microstructure. Attah et al. [1], this study is useful for understanding effect of welding speed and rotational speed on tensile strength. It provides details of hardness changes due to change in tilt angle. Best result can be achieved with respect to impact energy of 21.4 J at a medium 2 ° of tilt.

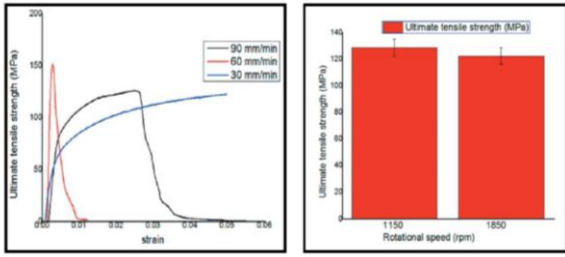


Figure 4 : Effect of different speeds on tensile strength [1]

Yan et al. [2], the experimental results on special alloys of Al- Zn confirm that effective tensile strength is 4.6% higher in friction stir welding in comparison with metal inert gas welding keeping other parameter unchanged.

Ganesh and Kumar [3], examined material behaviour like superplasticity during welding process. Figure 5 shows how this particular nature of superplasticity is increased with tool rotational speed. This specific case provide how tool rotating speed and flexibility of joints are interrelated

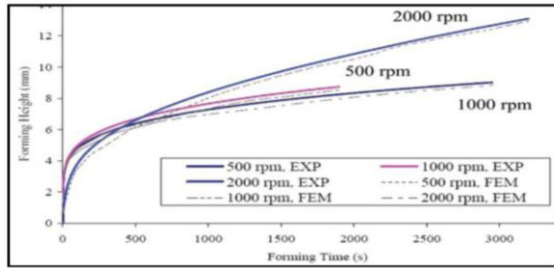


Figure 5: Relation between tool rotational speed on superplasticity [3]

Kalema and Dymek, and Braga et al [4-5], have found that lithium based aluminium alloys are gives faulty welding due to crack formation, porosity etc during friction stir welding. Specifically lap joint of friction stir welding forms different faulty structure mainly hooks like structure. Hybrid mode of welding of this aluminium alloys gives satisfactory results

Shaik et al[6], used Taguchi Grey relational analysis to determine the most suitable parameters for having better result at nugget zone. A straight cylindrical threaded tool used for testing friction stir welding joints on AL7075-T651 and AL6082-T651, especially stir zone.

Method and Material

The sample piece for fabrication is taken of material Al 1120 commercial grade for experiment due to its versatile application in engineering field. For samples of size 6x80x200 (Thickness x width x length) are cut.

Following table provides constituent of material Al 1120

Silicon	Magnesium	Calcium	Iron	Copper	Aluminium
0.18	0.26	0.12	0.43	0.22	98.79

Table 1: Constituent of Al1120

Reinforcement is provided to enhance mechanical properties and microstructure of materials. Titanium diboride (TiB₂) in combination with araldite is used for coating purpose.

The welding of aluminium cut piece is done with cylindrical threaded pin. Variable speed is used 1400 rpm and 900 rpm. Set up is used with vertical milling machine.

Different profile of tools pin can be used for welding. Main objective of tool is to mix the material near weld zone for better mechanical properties. Following figure are the tool profile used for experiment purpose.

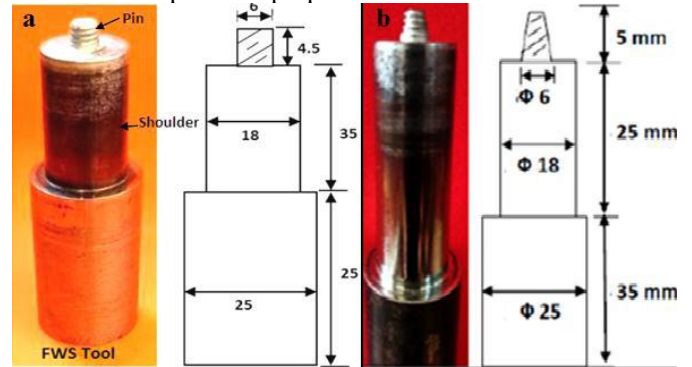


Figure 6: Friction stir welding tool (a) Cylinder tool (b) Taper threaded tool

Fabricated samples at 2240 rpm and 1400 rpm with cylindrical tool are shown below in figure 7 and figure 8



Figure 7: Fabricated joint at 2240 rpm

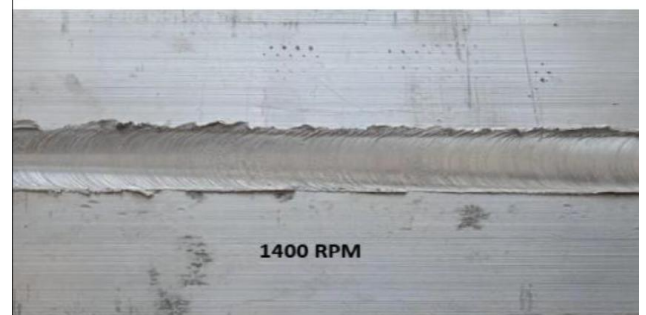


Figure 8: Fabricated at 1400 rpm

Results and Discussion

The TiB₂ coated friction stir welding joints are fabricated with Al-1120 material with specific set up. The cylindrical threaded tools with two different speed of 1400 rpm and 2240 rpm are used for fabrication purpose. The fabricated welding joints are found with quality as desired. For analysis and experiment of mechanical properties these or more samples can be used with required specifications.

References:

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