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Research Article

PAPER ON INVESTIGATIONS OF ALUMINIUM 6061 TO BRASS (CuZn30) BY FRICTION STIR WELDING PROCESS ----AN OVERVIEW

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ABSTRACT
The aim of the study is to show the practicability for joining of dissimilar Aluminium 6061 plate to brass (CuZn30) plate by Friction Stir Welding (FSW). Friction Stir Welding (FSW) is a solid state welding process. It is different from fusion welding process and also different from other old solid welding process. It is a way of joining materials without melting them. FSW of Aluminium and Aluminium alloys and Brass has captured important attention from manufacturing industries, such as Shipbuilding, Automotive, Railway and Aircraft production. A brass plate in Aircraft structures mainly as substitution on stringer reinforced plates has an important role. Brass materials are widely used as engineering materials in industry because of their high electrical and thermal conductivity, high strength, and high corrosion resistance. They are easily shaped and they possess nice appearance. However, it is difficult to do fusion welding of brass. The main problem of these alloys in fusion welding is the evaporation of the zinc during the welding process. After welding the weld metal becomes porous. Moreover, the amount of zinc in the alloy is reduced due to evaporation. To overcome these problems Friction Stir Welding is developed. So, it needs experimental investigation in these areas. In this research Aluminium and Brass plates which are 4mm in thickness are used for welding procedures. It has been investigated microstructure properties, micro hardness, and tensile tests in order to evaluate the joint performance and the weld zone characteristics of dissimilar Aluminium/Brass (Al/CuZn30) joints.

Keywords: *Welding, FSW, Dissimilar Al/CuZn30 Joint, Microstructure, Mechanical Properties*

INTRODUCTION
Friction Stir Welding (FSW) is a unique welding method and new invention for the welding technology world. FSW will not change the microstructure of the metal diverse unlike the conventional welding. It also can reduce the cost if compared to the conventional welding cost. It involves the joining of metals without fusion or filler materials. It is used already in routine, as well as critical applications, for the joining of structural components made of brass, aluminium and its alloys. Since FSW is essentially solid-state, i.e. without melting high quality weld can generally be fabricated with absence of solidification cracking, porosity, oxidation and other defects typical to traditional fusion welding. Friction stir welding was used to control properties in structural metals including aluminium and the other nonferrous alloys. The pin may have a diameter one-third of the cylindrical tool shoulder. The process is illustrated in figure1 where a tapered shouldered tool plunges into the dissimilar plates and locally plasticizes the joint region during its movement along the joint line that causes a join between the work pieces. In this process, the heat is originally derived from the friction between the welding tool (including the shoulder and the probe) and the Welded material, which causes the welded material to soften at temperature less than its melting point.
The softened material underneath the shoulder is further subjected to extrusion by the tool rotational and transverse movements. It is expected that this process will inherently produce a weld with less residual stress and distortion as compared to the fusion welding methods, since no melting of the material occurs during the welding. Conventional milling machine is selected to innovate become as the FSW machines. The innovations of FSW machine are made by changing some setting on the conventional milling machine. Investigation on friction stir welding has so far mainly focused on developing tools and procedures for making welds in various alloys, characterize the properties of welding permitted to design and consider the possible mechanisms of flow in and around the weld bead.

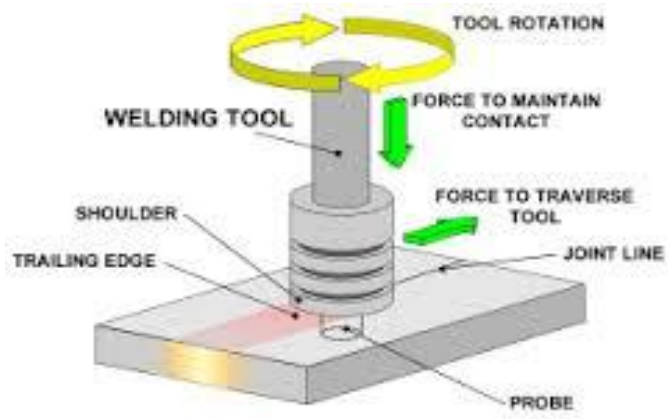

Figure 1: A FSW with Tool Rotational and Transverse Movements

Experimental Procedures and Studies

Materials and Experimental Setup

Vertical milling machine of 7Kw is used to join the dissimilar plates of Aluminium 6061 and Brass (CuZn30) with dimensions (75mm x 75mm x 4mm) shown in figure 2.

Figure 2: H13 Tool

Table 1: Specifications of Vertical Milling Machine Capacity of 10 Tonnes

Process Parameters	**Minimum**	**Maximum**
Spindle Speed	100 rpm	1120 rpm
Transverse Speed	16 microns/sec	1120mm/min
Plunge Speed	16 microns/sec	1000mm/min

Table 2: H13 Tool Dimensions

Shoulder Diameter(SD)	**Pin Diameter(PD)**	**Pin Length (PL)**
25mm	6mm	3.6mm

Table 3: Nominal chemical composition of 6061 Al alloy and Brass

6061 Al alloy	Si 0.80 Fe 0.70 Cu 0.40 Mn 0.15 Mg1.2 Cr 0.35 Zn 0.25 Ti 0.15 Al balance
Brass	Zn 30 Cu rest

Welding Parameters

Different parameters like tool rotation (rpm), welding speed (mm/min), tool plunge depth (mm), tool design etc, are involved in sufficient heat generation for the effective solid state joining of materials.

Table 4: Process Parameters

	Unit	**Sample 1**	**Sample 2**
Rotation Speed	rpm	710-900	1120
Transverse Speed	mm/min	10-60	10-110
Offset	mm	1	1
Plunge Depth	mm	3	3

Tilt angle as 1 degree, offset were kept constant. Plunge depth is little bit varied but 3mm is sufficient for proper joint. Sample 2 has sufficient heat generation with more rpm so it has good strength of joint, whereas, sample 1 has insufficient heat generation with less rpm sample is not able to join properly.

RESULTS AND DISCUSSION

Tensile Strength

Tensile specimens of required dimension are prepared by Electric Discharge Machine (Wire EDM). The tensile test has been carried out with the help of Universal Testing Machine (UTM). The % elongation is 0.64%, yield stress 55.118 N/mm^2.

Figure 3: Tensile Test Specimen before and after Test

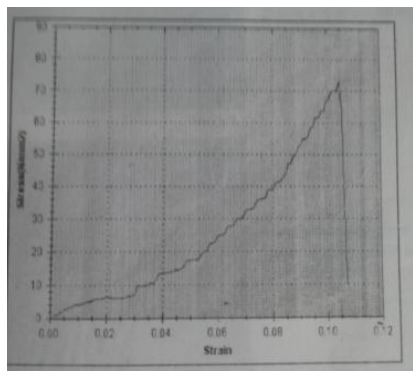

Figure 4: Graph for Tensile Test

Microstructure Distribution

The nature of test Microstructure has been conducted on MET SCOPE-1, SL.NO:CM01495.
The 100x magnification has been carried out at weld nugget and as well as at HAZ (Heat affected Zone). At weld nugget dendrites of brass solid solution with fine particles of grains are seen. Blow holes and cracks are observed and HAZ shows fine grain particles are seen in brass solution.

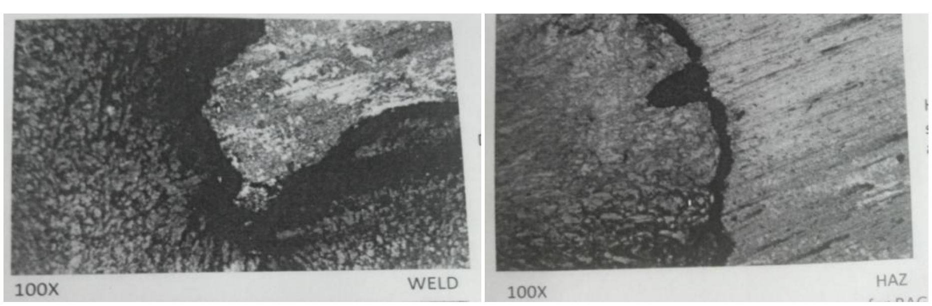

Figure 5: Microstructure Distribution at Weld Area or Nugget and at HAZ

Conclusion

Friction Stir Welding is performed to join 4mm thick plates of 6061 Al and brass (CuZn30) with varied parameters (like, tool rotation speed (rpm), welding speed (mm/min) and the joining conditions are characterized. The modification of conventional milling machine to manufacture welded joint process using FSW technique is another innovation to those who involve with new invention in welding technology. With low cost of money to invest they will experience in long term, saving labour cost and material waste during welding process. Also, brass has high strength rather than aluminium, sample 2 parameters has sufficient heat generation and good strength.

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