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Weldability of Friction Stir Welding using Aluminium Alloy with Pure Copper

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Abstract**—***Recently many reports on Friction Stir Welding (FSW) of various dissimilar systems such as Aluminium to Copper been reported.FSW of Aluminium, Copper has captured important attention from manufacturing industries, such as Shipbuilding, Automotive, Railway and Aircraft production. Copper and its alloys are widely used in industrial applications due to their excellent electrical & thermal conductivities, good strength, corrosion & fatigue resistance. The aim of present study was analogy of the microstructures and mechanical properties of friction stir welded joint of Aluminium to Copper plates in 4mm thickness.*

Keywords— Aluminium 6061, Pure Copper, Dissimilar Materials, Microstructure, Micro hardness and Mechanical Properties, FSW.

I. 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 Aluminium, Copper. 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 tapered tool shoulder.

In friction stir welding process a non-consumable rotating tool with tapered pin and shoulder is inserted into abutting edges of plates.A non-consumable spinning tool bit is inserted into a work piece. The rotation of the tool creates friction that heats the material to a plastic state. As the tool traverses the weld joint, it extrudes material in a distinctive flow pattern and forges the material in its wake. The resulting solid phase bond joins the two pieces into one.

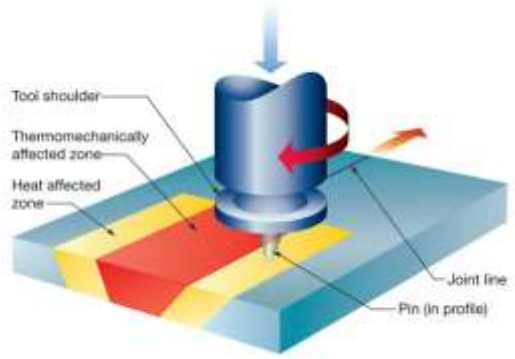

Fig.1: A Schematic Friction Stir Welding

II. EXPERIMENTAL PROCEDURE

Vertical milling machine of 9Kw is used to join the dissimilar plates .The plate size of Al6061 and pure copper are having 100mm length, 70mm width and 4mm thickness.In the present work H13 tool is used. The tool is having tapered shoulder and pin. For micro structural evaluation samples prepared by RAGHAVENDRA SPECTRO METALLRGICAL LABORATORY, Hyd and microstructure were measured on Optical Metallurgical Microscope (MET SCOPE-1).The micrographs were taken at 100x magnification. The Vickers micro hardness was measured by using HARDWOOD HWMMT-X7 micro hardness tester.

Table.1: H13 tool dimensions

Shoulder diameter(SD)	Pin diameter(PD)	Pin length (PL)
25mm	6mm	3.6mm

Table.2: Chemical composition of 6061 Aluminium, Pure Copper

6061 Al	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
Copper	Bi 0.001 O 0.04 Pb0.0005 Cu rest

Table.3: Process parameters

	Unit	Experiment 1
Rotation Speed	Rpm	710 ,900,1120
Transverse speed	mm/min	10-60
Offset	mm	1
Plunge depth	mm	3

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After welding the specimens were prepared by using Wire EDM to test the mechanical properties such as ultimate tensile strength, yield strength, % elongation and Hardness.Tilt angle as 1 degree, offset were kept constant.

Input Data

Material	Dissimilar
Thickness	4mm
Length	100mm
Width	70mm
Rotational Speed	710,900 and 1120 rpm
Feed	15-30 mm/min
Experiment 1	Aluminium to Copper

III. RESULTS AND DISCUSSIONS:

The following results were obtained after conducting the mechanical tests on FSW of Aluminium - Copper metals.

3.1 Output Data for Experiment 1 (710, 900 & 1120 rpm)

For 710 rpm	Ultimate Tensile strength	37.69 N/mm²
	Yield Strength	29.808 N/mm²
	% Elongation	0.42%
For 900 rpm	Ultimate Tensile strength	55.89 N/mm²
	Yield Strength	40.5 N/mm²
	% Elongation	0.62%
For 1120 rpm	Ultimate Tensile strength	76.80 N/mm²
	Yield Strength	60.6 N/mm²
	% Elongation	0.81%

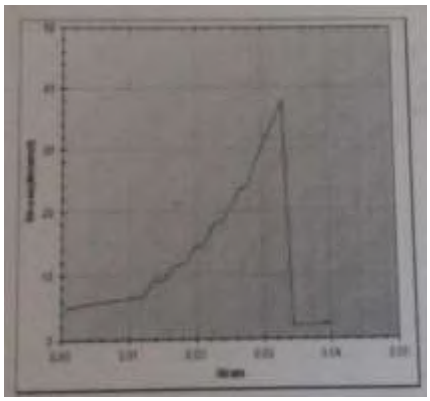

Fig.2: Graph for Al-Cu at 710rpm

3.2 Microstructure Analysis:

For Experiment 1: Microstructure of weld taken at centre of weld with or without filler materials. At the centre of weld a line mix region of aluminium and copper were found. Microstructure consists of uniformly distributed fine intermetallic particles in a matrix of aluminium solid solution. Cracks and porosity are seen. Lack of fusion more a length of the root.

Fig.4: Microstructure Distribution at centre of Weld at 100x for 710rpm

3.3 Microhardness:

The Microhardness test is evaluated by Vickers shown below.

For Experiment 1:

For 710 rpm	372HV
For 900 rpm	400HV
For 1120 rpm	460HV

IV. Conclusion

Friction Stir Welding is performed to join 4mm thick plates of 6061 Aluminium to Pure Copper with varied parameters (like, tool rotation speed (rpm), welding speed (mm/min) and the joining conditions are characterized. All welds were defect free. Microstructure of weld and Microhardness were shown at centre of weld. Tensile strength was good and Aluminium to copper.high strength

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