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Mechanical Portrayal of Dissimilar FSW in Aluminum with Steel

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Abstract: Welding of an AA 6061-T6 with 316L stainless steel was effortlessly and effectively achieved by means of FSW. The mechanical characterization of FSWed samples have been disclosed, which is produced by diverse tool rotational speeds of 600, 650, 700, 750, 800 and 850 (in rpm) with an invariable table traverse speed and tool force. The joint potency and hardness were evaluated by a tensile testing machine and micro hardness tester.

I. INTRODUCTION

Reduction of weight in automobiles is one of the hopeful approaches for increasing fuel cutbacks. Vehicles weight has been gradually augmented for providing more performance and structural constructions accounts around one-third of the entire weight. Usually steels are used in construction and it is about 45% of the total weight in automobiles. Hence automobile weight reduction can appreciably perk up the fuel and it possible by the idea of construction by multi-material. In this concept, steel workings are replaced by lesser weight and higher strength materials. For this aluminium alloys are more prominent and are easy to form but there is a difficulty of this dissimilar joining through fusion welding process.

Current studies showed that FSW is a probable applicant for unification to weld like and unlike materials. From the application point of view it is significant for the exploration on FSW of automobile structures and little works on FSW of Al alloys and steels are reported in the literature. [1] Liu et al. (2014) investigated the outcome of processing parameters like tool revolving rate, welding speed and tilt angle of tool on FS butt welding of TRIP 780/800 steel.

The welding trials were carried out at different welding with two different tool revolving speed of 1200 and 1800 rotation per minute. The authors accomplished that speed rate of welding has no sway on the composition of the layer formed. When compared to FSW of Al alloys, the heat input requirement in FSW of Al alloys and steels is significantly high. [2] Dehghani et al. (2013) used FSW tool with 18 mm shoulder diameter, for 3 mm thick plates in their trials and reported that defects free joint with good joint strength over a range of FSW parameter values.

Thus, in the present investigation FSW tool with 18 mm shoulder diameter is selected. [3, 4] performed dissimilar welding in aluminium alloys and steel with brass and their properties are studied. [5] Made the finite element analysis of friction stir welding in aluminium alloys through software. Hence the endeavor of this present exertion is to explore the mechanical properties such as hardness test using Vickers micro hardness testing machine and tensile strength using ultimate tensile strength testing machine and to examine the fractured tensile surfaces using Scanning Electron Microscope.

A. Experimental Procedure

The base materials AA6061 and Stainless Steel 316L were engraved into 100 x 50 x 6 millimeters dimension. The emery papers were used for mechanically polishing to make sure gap free contact among edges and cleaned the samples using acetone. The welding tool used in this work is Tungsten Carbide with the pin length and pin tip diameters were maintained at 5.7 mm and 5 mm respectively.

The tensile samples were primed as per ASTM standards. Instron universal tester is used for finding ultimate tensile strength. Samples are cultured and carved with Nital and Keller's reagent. Fractography of the fractured tensile samples is studied through FESEM. Micro hardness is estimated using Mitutoyo hardness tester with 500 gram force pro 10 seconds. Figure 1 displays the FSWed plates.

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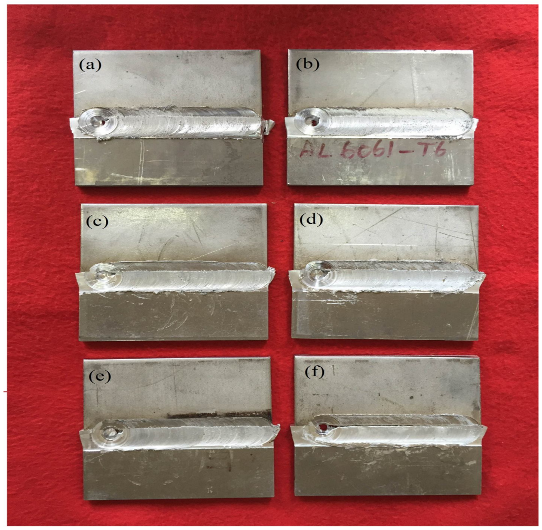

Figure 1 Friction Stir Welded plates at diverse tool revolving speeds (i) 600 rpm, (ii) 650 (iii) 700 (iv) 750 (v) 800 and (vi) 850 in rpm with a constant table traverse speed and axial force.

II. RESULTS AND DISCUSSION

A. *Micro Hardness Survey*

Figure 2 displays the allotment of micro hardness for weld joints carried out at different tool rotational speeds and it is clear that when the rotational rate is 850 rpm the value of hardness tends to decrease which is owing to amplified temperature production, due to higher rotational speed. Also at 800 rpm it tends to have an increasing pattern in hardness when compared to 850 rpm. Similarly, lower rotational speeds improved the hardness value which is due to lowering of heat input because of reduced tool rotational speed.

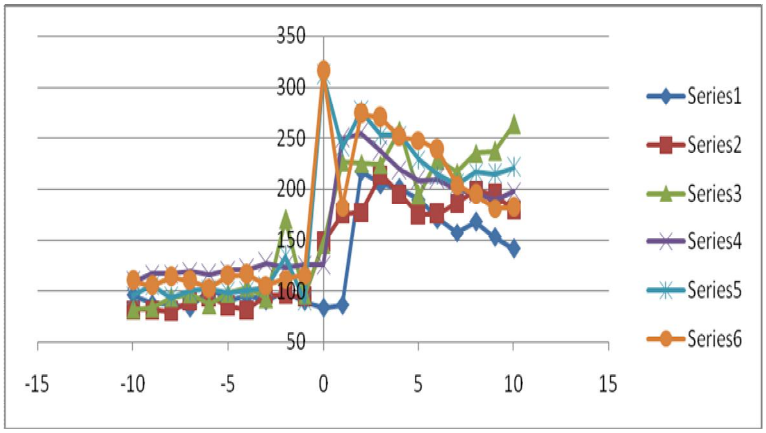

Figure 2 Micro hardness distribution.Series 1 – 850 rpm, Series 2 – 800 rpm, Series 3 – 750 rpm, Series 4 – 700 rpm, Series 5 – 650 rpm, Series 6 – 600 rpm.

B. *Tensile Test*

The average tensile measurements and percentage of elongation of the dissimilar aluminum/steel joints are 163, 198, 182, 166, 154 and 141 MPa and 6%, 8%, 6%, 5%, 4% and 1% respectively. Better mechanical properties were got from the weld also the fracture has not occurred in the nugget region fashioned with a tool speed of 650 rpm. The samples obtained from 800 and 850 rpm are abortive in the nugget region and the cause for this is the non-homogeneous plastic warp of the welded joints owing to trivial improvement of hardness in the stir region.

C. *Fractography*

At 800 and 850 rpm there is a formation of intermetallics which made the weld ruptured in brittle mode. Simultaneously, at 700 and 750 rpm, it is experiential to have ruptured failures of both ductile and brittle mode. The ruptured mode attained for 600 and 650 rpm is ductile. Fig. 3 displays the tensiled fractography of the specimens produced by diverse rotational speeds.

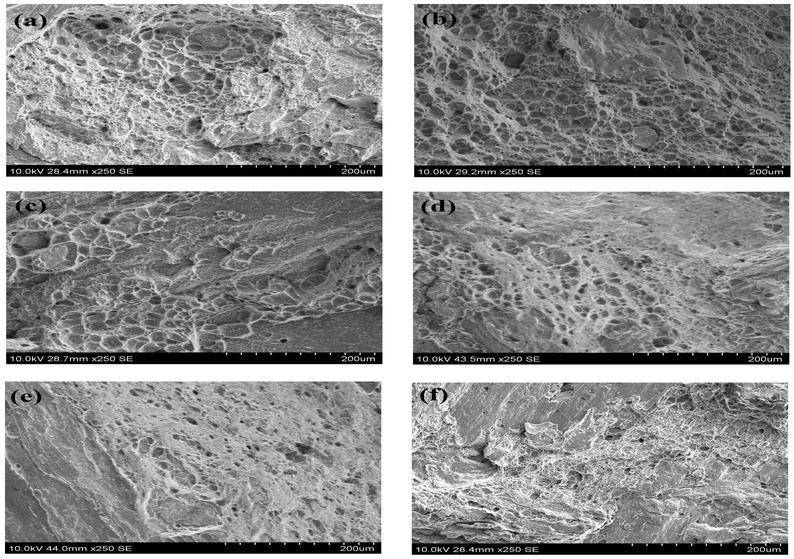

Fig. 3 Ruptured surfaces at a range of tool revolving speed (i) 600 (ii) 650 (iii) 700 (iv) 750 (v) 800 and (vi) 850 rpm.

III. CONCLUSIONS

FSW was productively functional in fusion of aluminium with steel. Maximum joint recital is from the rotational speed of 650 rpm. Amongst six welding, the FSW performed at 650 rpm is look in to be preeminent welding. From characterization, it is evident that rupture tended to arise between the interface of steel fragments and AA6061-T6.

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