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Research Article

MICROSTRUCTURAL INVESTIGATIONS ON FRICTION STIR WELDED ALUMINIUM ALLOY

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ABSTRACT

The fair of our work is to define the consequence of different tool rotational speedson friction stir welding AA 7075 -T651 all through the welding process. Six joints were ended using six variedtool rotational speeds of 500 rpm, 700 rpm, 900 rpm, 1100 rpm, 1300 rpm and 1500 rpm without fluctuating the table transverse speed of 50 mm/min and axial force of 8 KN throughout the process. Metallographic studies of friction stir welded plates exhausting optical microscopy were done. The result of these parameters is explored by its micro structure and the fractured surface of the tensile tested specimens were designated using scanning electron microscope (SEM).

INTRODUCTION

Friction stir welding aninnovative process intended in UK for joining aluminium alloys deprived of using any filler materials. (Karan, *et al*., 2014) FSW is highly valid in the areas of multiple structural claimscomprising the improvement and erection of aircrafts, marine ships. (Suresh, *et al*., 2015) premeditated the mechanical properties of alike welded AA6082 by varying the tool rotational speeds and traverse speeds and it states that the impact of these parameters designated the feat of the process. (Suresh, *et al*., 2015) reports the dissimilar welds of AA6061-8011-T6 by varying the tool rotational speed with constant axial load and traverse speed and it is found there is a greater influence in process parameters which is clearly seen in its microstructures and also there is an occurrence of tunneling defects. (Ramesh, *et al*., 2015) experimented the finite element simulation of AA7075 joints for studying its temperature distribution during the welding and it indicates that increase in temperature is due to increased rotational speed and decrease in temperature is due to increase in traverse speed. (Ramesh, *et al*., 2015) They mottled the process parameters of tool rotational speeds, welding speeds with an addition of two altered tool profiles including straight cylindrical and Straight Square, the cylindrical pin had numerous defects when compared to the square tool. Hence our dispassionate is to diverge the tool rotational speeds and to explore its microstructures and tensile fracture morphology by using the optical and scanning electron microscopy.

EXPERIMENTATION

Friction stir welding were accomplished on AA7075-T651 plates by using a specially designed welding machine. A tool with higher hardness than the aluminium was used for the varying rotational speeds in carrying out the welding process. Table traverse speed and axial force is made unceasing. Feasible limits of the parameters like table traverse speed of 50mm/min, axial load of 8KN were chosen in such a way that the friction stir welded joints

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should be free from any visible external defects as in past literatures. The welded samples are then machined to get the dog bone shape by using the wire cut EDM for doing the tensile testing to measure the tensile strength and to study its fractured surface. The samples are then polished by using the various grades of emery sheets (dry polishing) furthermore, it is then polished with diamond paste to obtain the mirror view. These samples are then executed for the optical microscopic studies to validate about the grain structures (Fig. 1).

RESULT AND DISCUSSION

Tensile fractured surfaces

Anenhancedconception and indulgent of the mechanical fracture is strongly reliant onpurposed analyses of the rupturesurfaces, as the stimulus of the microstructural morphology of the welded interfaces to be vital. The fractured surface of the welded specimens, tested under tension ensued to be covered with a comprehensive population of microscopic voids of unlike size and shape at room temperature, the material disclosed ductilityto occur contained by the fracture progression and the interpretations performed by commissioningSEM deep-rooted the presence of locally ductile mechanisms. In specific, two altered types of dimples have been perceived, those nearly close to the voids and those accompanying with the second phase coarse particlesand precipitates, which stemmed much smaller and shallower.

(Fig. 2) shows the tensile fracture surfaces of SEM images at different rotational speeds. At the speed of 500 rpm suitable bonding of material was not there and hence there was no ample heat generated to join the material. So brittle fracture ensued. The speed of 700 rpm has generated appropriate heat

Fig. 1 Tensile samples.

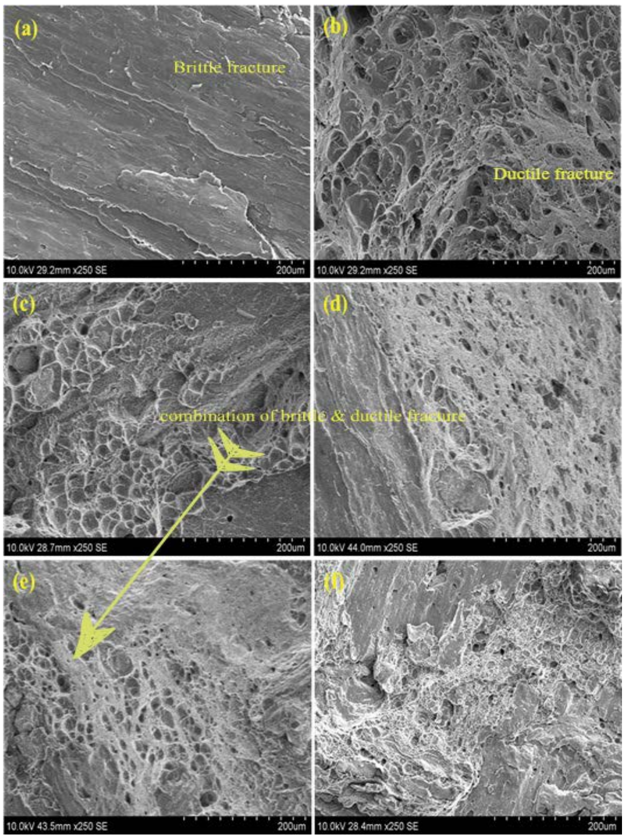

Fig. 2 SEM images of the tensile fractured surfaces (a) 500 rpm, (b) 700 rpm, (c) 900 rpm, (d) 1100 rpm, (e) 1300 rpm and (f) 1500 rpm.

for proper bonding, therefore the mode of failure was in ductile mode. At 900 rpm, 1100 rpm, 1300 rpm the temperature perceived was very high and this distresses the tensile property of the welds. Therefore in certain areas brittle mode and ductile mode of fracture was witnessed.

The heat input was enormously very high at the speed of 1500 rpm and this roots the zinc to dissolve from welded joint and the fracture obtained was in brittle mode.

Microstructural analysis

Among the micrograph elongated grains of aluminium, andcertain fine precipitates of Mg_2Si were seen. (Fig. 3) shows a photo-micrograph of the interfacejunction of the AA7075-T6 alloy on one side and theweld FSW zone. On the other side, the track of the grainsreformed due to the whirling action of the tool inAA7075-T651 alloy. The left side of the weld metal that has bitty particles of Mg_2Si. Microstructures are taken at the crossing pointflanked by the stir zone and thermomechanically affected zone as in (Fig. 3). It is experiential that, at higher speeds more grain growth was observed in thermomechanically

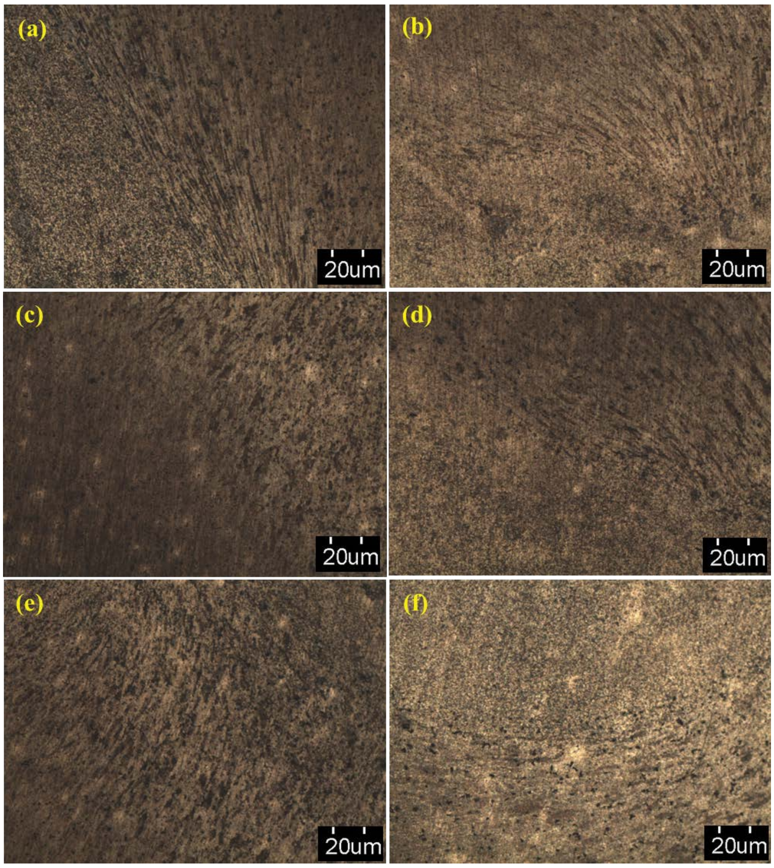

Fig. 3 Microstructure of the welded joints in the stir zone and thermo mechanically affected zone (a) 500 rpm, (b) 700 rpm, (c) 900 rpm, (d) 1100 rpm, (e) 1300 rpm and (f) 1500 rpm.

affected zone which is due to high heat input. The grain size of the welded joint prepared at 700 rpm had fewer grain size as equated to other welded joints carried out at diverse rotational speeds. The decline in grain size clues to improve the tensile property of the welded joints.

CONCLUSION

Microstructuresweretaken concerning the crossing pointof stir zone and thermomechanically affected zone. From the studies it is pragmatic that, at higher speeds more grain growth were detected in TMAZ which is owing to high heat input. The grain size of the welded joint done at 700 rpm have the scarcer grain size as compared to other welded joints carried out at different rotational speeds.

From the results of tensile fracture morphology the speed of 700 rpm has engenderednecessary heat for proper bonding, therefore the mode of failure was in ductile mode. In other rotational speeds the temperature observed was very high therefore in some areas brittle mode and ductile mode of fractured surface were observed.

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