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RESEARCH ARTICLE

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STUDIES ON FRICTION STIR WELDING OF AA 7075-T6 AND AA 8011 DISSIMILAR METALS

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ABSTRACT

Friction stir welding (FSW) is a relatively new solid-state joining process. This joining technique is energy efficient, environment friendly, and versatile. In particular, it can be used to join high-strength aerospace aluminum alloys and other metallic alloys that are hard to weld by conventional fusion welding. In this work, dissimilar friction stir welding between 7075-T6 aluminum alloy and 8011 aluminum alloy was investigated. The Friction stir welding between these two dissimilar metals were produced at different tool rotational speeds with constant feed rate. The tool rotational speed was varied between 700 and 1500 rpm. The visual inspection and the x-ray radiographic testing techniques were conducted on the welds to ascertain the joint integrity before characterization to have an idea of the quality of the welds. Chemical analysis was carried out to attain the chemical composition at the weld nugget. Tensile and hardness tests were also conducted and the results were obtained.

Keywords: Friction stir welding, Al7075 T6, Al8011, Nondestructive testing, Mechanical and Microstructural properties.

INTRODUCTION

Friction-stir welding (FSW) is a solid-state joining process (meaning the metal is not melted during the process) Friction stir welding also produces a plasticized region of material, but in a different manner. A non-consumable rotating tool is pushed into the materials to be welded and then the central pin, or probe, followed by the shoulder, is brought into contact with the two parts to be joined. The rotation of the tool heats up and plasticizes the materials it is in contact with and, as the tool moves along the joint line, material from the front of the tool is swept around this plasticized annulus to the rear, so eliminating the interface. **Esther T. Akinlabiet al.,[1]** have studied non-destructive testing conducted on dissimilar friction stir welds between 5754 aluminium alloy and C11000 copper.The visual inspection and the x-ray radiographic testing techniques were conducted to ascertain the joint integrity before characterization to have an idea of the quality of the welds. **R.I. Rodriguez et al.,[2]**have studied the microstructure and mechanical properties of friction stir welded dissimilar butt joints of6061-to-7050 aluminum alloys were evaluated.**Sadeesh P et al.,[3]** have studied the joining of dissimilar AA2024 and AA6061 aluminium plates of 5mm thickness was carried out by friction stir welding (FSW) technique.**M. Ilangovan et al.,[4]** have studied the microstructure and tensile properties of friction stir welded

dissimilarAA606 and AA5086 aluminium alloy joints. **A. K. M. Patel et al.,[5]** have studied the influence of Friction Stir Welding Parameters on Tensile Strength of AA8011 Aluminium. **S. M. Bayazida et al.,[6]** have investigated the friction stir welding parameters of 6063-7075 Aluminum alloys by Taguchi method.

EXPERIMENTAL DETAILS

The friction stir welds have been carried out by a vertical milling machine (kodi 40). The direction of welding is normal to the rolling direction. Single pass welding procedure has been followed to fabricate the joints. The plates having 3mm thickness, AA7075-T6 and AA8011 has been cut into the required size (100×50×3mm) by power hacksaw cutting, butt joint was configured. Before welding the plates were weld side and edge are prepared to fabricate FSW joints.

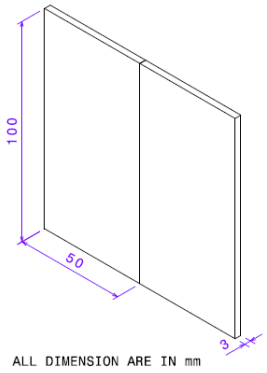

Figure 1. Dimension for Butt joint

The plates used in the present study were AA7075-T6 having thickness 3mm and AA8011 having thickness 3mm.The parameters selected and levels for FSW process are shown in table 1.

Table 1. Welding parameters and levels

Parameters	Level 1	Level 2	Level 3
Spindle speed(rpm)	700	1000	1500
Welding speed(mm/min)	130	130	130

RESULTS AND DISCUSSIONS

NON DETRUCTIVE TESTING

The visual inspection and the x-ray radiographic testing techniques were conducted on the welds to ascertain the joint integrity and weld quality.

a)Visual testing: Presence of crack was identified in friction stir weld of 7075-T6 aluminium alloy and 8011 aluminiumalloy produced at 700rpm and 130mm/min is shown in figure 2

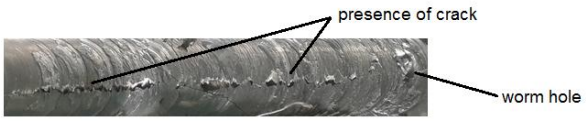

Figure 2 Visual Test Specimen 1

Figure 3 Visual Test specimen 2

Figure 4 Visual Test specimen 3

Presence of wormhole defect was identified in friction stir weld of 7075 aluminium alloy and 8011 aluminiumalloy produced at 1000rpm and 130mm/min is shown in figure 3.

No defect was identified in friction stir weld of 7075-T6 aluminium alloy and 8011 aluminiumalloy produced at 1500rpm and 130mm/min is shown in figure4.

b)Radiography Testing : Presence of crack was identified in friction stir weld of 7075-T6 aluminium alloy and 8011 aluminiumalloy produced at 700rpm and 130mm/min is shown in figure 5.

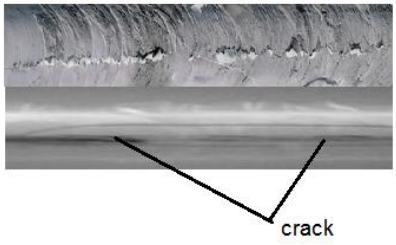

Figure 5 Radiography Test specimen 1

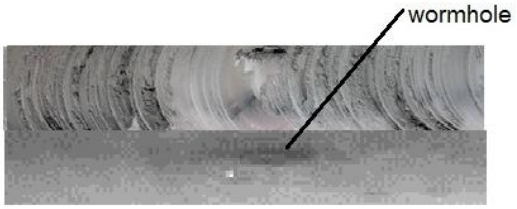

Figure 6 Radiography Test specimen 2

Figure 7 Radiography Test specimen 3

Presence of wormhole defect was identified in friction stir weld of 7075 aluminium alloy and 8011 aluminium alloy produced at 1000rpm and 130mm/min is shown in figure 6.No defect was identified in friction stir weld of 7075-T6 aluminium alloy and 8011 aluminium alloy produced at 1500rpm and 130mm/min is shown in figure 7. Based on the Non destructive testing it is identified that the best weld obtained at the higher tool rotational speed of 1500rpm and at the feed rate of 130mm/min. this specimen is subjected to the destructive testing to identify its characteristics.

MICROSTRUCTURAL ANALYSIS

As seen in the figure 8 it is clearly seen that the two dissimilar metals(AA7075-T6 and AA8011) completely fused together and have mixing and metallurgical bonding between them.

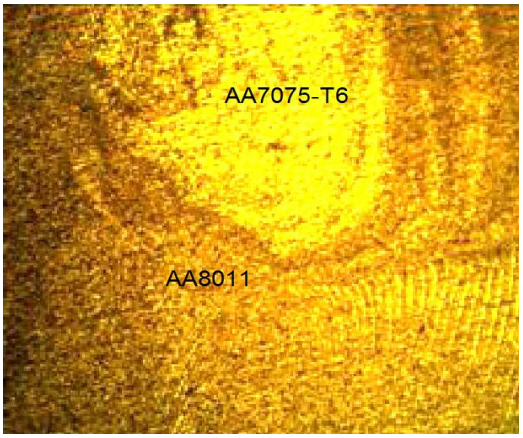

Figure 8 Microstructure of AA7075-T6 and AA 8011 at the welded region

TENSILE TEST

Table 2 Tensile properties of specimen

Sample	Ultimate tensile load (N)	Ultimate tensile stress (N/mm^2)
Test specimen 3	7552	184.6

The specimens are prepared according to ASTM- E8 standards.The results were tabulated above.

HARDNESS TEST

Table 3 Hardness properties of specimen

Sample	**No of trials**	**Observed Rockwell hardness value**	**Average**
Test specimen 3	**1**	**32**	**50.2HR15T**
	2	**33**	
	3	**62**	
	4	**60**	
	5	**64**	

From the above table 3 indicates that the no of trials has been carried out and the observed values are tabulated. Hardness profile reveals that a decrease in hardness occurs at the weld interface. It shows that the hardness is less than that of the parent metals.

CHEMICAL ANALYSIS

The chemical composition at the welded joint are tabulated

Table 4 Chemical composition at the welded joint

Elements	Results in %	Elements	Results in %
Silicon (Si)	0.57	Calcium (Ca)	0.00003
Iron (Fe)	0.57	Boron (B)	0.003
Copper (Cu)	0.13	Zirconium (Zr)	0.004
Manganese (Mn)	0.20	Vanadium (V)	0.016
Magnesium (Mg)	0.19	Beryllium (Be)	0.00004
Zinc (Zn)	0.27	Strontium (Sr)	0.00003
Titanium (Ti)	0.063	Cobalt (Co)	0.017

Nickel (Ni)	0.011	Cadmium (Cd)	0.0007
Lead (Pb)	0.02	Antimony (Sb)	0.006
Tin (Sn)	0.012	Gallium (Ga)	0.013
Sodium (Na)	0.00003	Phosphorous (P)	0.002
Chromium (Cr)	0.028	Aluminium (Al)	Bal

Chemical analysis reveals the chemical composition at the weld nugget.it shows the mixing and bonding of welded joint between the aluminium alloy 7075 and aluminium alloy 8011.

CONCLUSION

- From the study it is concluded that we can effectively weld dissimilar AA 7075-T6 and AA 8011 using friction stir welding.
- Friction stir welding between the two dissimilar metals(AA 7075-T6 and AA8011) were on sample specimens at three different tool rotational speeds with constant feed rate.
- Non-Destructive tests such as visual inspection and x-ray radiography were successfully conducted on the welded joint to detect the defects present in the welds.
- An optimum rotational speed for producing defect-free welds between AA 7075-T6 and AA 8011 was found to be 1500rpm.
- Microstructure of the specimen obtained at 1500rpm indicates that there is good bonding and mixing of the two dissimilar metals.
- The ultimate tensile strength of the weld joint is found to be 184.6 MPa, which is higher than that of aluminium alloy 8011.
- Hardness profile reveals that a decrease in hardness occurs at the weld interface.
- Chemical analysis reveals the chemical composition at the weld nugget and indicates the mixing and metallurgical bonding between aluminium alloys.

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