International Journal of Materials Science
ISSN 0973-4589 Volume 12, Number 4 (2017), pp. 601-607

http://www.ripublication.com

Study on Mechanical and Micro Structural Possessions of Friction Stir Welded AA5083 and AA6061 Alluminum Alloy Joints

Naroju. Shivaji[1], Satish kumar.P[2] and Aruri Devaraj[3]

M. Tech student[1], Department of Mechanical Engineering,
Associate professor[2] , Department of Mechanical Engineering
Associate professor[3], Department of Mechanical Engineering
[1,2,3]S R Engineering College Ananthasagar, Warangal T.S, India.

ABSTRACT

The joining of dissimilar AA5083 and AA6061 aluminum plates of 5 mm thickness was carried out by friction stir welding (FSW) technique. Optimum process parameters were obtained for joints using statistical approach. Two different tool designs have been employed to analyze the influence of rotation speed and traverse speed over the micro structural and mechanical properties. In FSW technique, the process of welding of the base material, well below its melting temperature, has opened up new trends in producing efficient dissimilar joints. Effect of welding speed on microstructures, hardness distribution of the welded joints were investigated. By varying the process parameters, defect free and high efficiency welded joints were produced. From micro structural analysis it is evident that the material placed on the advancing side dominates the nugget region as well from the Scanning electron microscope at high magnifications, generates high-resolution images and precisely measures the regions of welded material and by x-ray diffraction technique it is used in a glancing angle mode and to obtain the structure as well depth of cut of the material where the tensile test is performed.

KEY WORDS: Friction stir welding AA5083and AA6061Aluminam alloy, Coolants Liquid nitrogen and Dry ice, SEM analysis and XRD.

INTRODUCTION

Welding is a unique manufacturing method, which allows the production of complex parts from the materials that are difficult to be formed. So that individual pieces are produced separately, and then joined [1]. Aluminum is having a unique combined property of light weight and high machinability [2]. This makes Aluminum as a most popular metal. It has some attractive properties that are low density, good electrical conductivity, high corrosive resistance and low price [3]. Friction stir welding (FSW) is a solid state weld process invented in 1991, relatively new technique for making solid-state welds in aluminum alloys [4]. FSW is a specially designed rotating pin, first inserted into the adjoining edges of the sheets to be welded with a proper angle and then moved all along the joint [5,6]. FSW can be considered as a hot-working process in which a large amount of deformation is imparted to the work piece through the rotating pin and the shoulder [7]. Such deformation gives rise to a weld nugget (whose extent is comparable to the diameter of the pin), a thermo mechanically-affected region (TMAZ) and a heat-affected zone (HAZ) [8] . Frequently, the weld nugget appears to comprise equiaxed, fine, dynamically recrystallized grains whose size is substantially less than that in the parent material [9]. This paper will focus on the micro structural and mechanical properties of the welded joints of AA5083 – AA6061 aluminum alloy joints after FSW.

EXPERIMENTAL PROCEDURE

Initially a base metal (BM) sheet of 5mm thick 5083-6061 Aluminum alloy was welded as a butt joint with a rotating tool probe assembly by Vertical Milling Machine (VMM). These base metals of aluminum alloy has good weld ability, very good corrosion resistance and has the highest strength of the non-heat treatable.H13 tool steel is selected as tool material due to low wear resistance, great strength at elevated temperature and thermal fatigue resistance.

The diameter of the shoulder was 24mm and pin 8mm used. Length of the pin was 4.7mm. A constant axial force was 5 KN applied and tool onward tilt angle was20 for all the FSW experiments. Experiments were conducted with different tools (taper, circle tool with threaded pin and square tool pin profile) on 5083-6061 Aluminum alloy with a different tool rotational speeds of 710rpm, 900rpm and 1400 rpm and also welding speeds of 60, 31.5 and 40mm/min correspondingly. A cryogenic (liquid nitrogen, dry ice) is applied to the plate immediately behind the FSW tool for rapid cooling. Micro-hardness tests were carried out at the cross section of NG. Samples with a load of 5kgs and duration of 15 sec using by Vickers digital micro-hardness tester. The quality and high resolution image test was conducted with the help of a scanning electron microscopy (SEM). The average spacing between layers or rows of atoms, peaks lengths and orientation of a single crystal or grain test was conducted with the help of X-Ray diffractometer (XRD).

Table 1: AA5083, AA606 material chemical composition

CHEMICAL ELEMENTS	Mn	Fe	Cu	Mg	Si	Zn	Cr	Ti	Al
AA5083 %	0.40-1.0	0.4max	0.10max	4.0-4.9	0.4max	0.25max	0.05-0.25	0.15 max	Balance
AA6061 %	0.15	0.0-0.7	0.15-0.4	0.8-1.2	0.4-0.8	0.0-0.25	0.04-0.35	0.0-0.15	Balance

RESULTS AND DISCUSSIONS

Microstructure observation

In this investigation was employed after friction stir welding to reduce the grain size and improve the mechanical properties of friction stir weld AA5083 and AA6061 aluminum alloys. On the basis of micro structural characterization of grains and precipitates, three different zones have that are heat affected zone (HAZ), thermo mechanically effected zone(TMAZ), and nugget zone(stirred). It was observed that the joints made by circular with threaded tool pin profile resulted in very smaller equiaxed grain compared to a base material as shown in fig.1.

HAZ is affected by the heat generations during the welding process in which coarse grain was observed and TMAZ consist of a slightly elongated grain structure due to affect of heat and heavier plastic deformation. The grain sizes of the welded joints are made by circular with threaded profiled tool exhibits very finer than the base material.

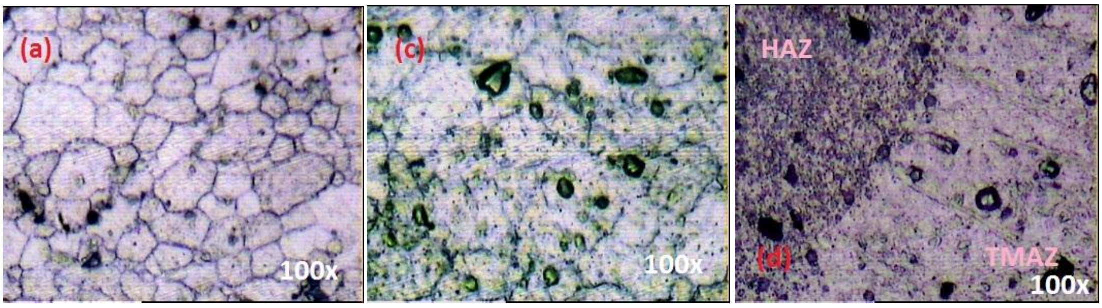


Figure 1: Micro structure images of different tools at (710,1400,900) rpm and (60,40.31.5)mm/min respectively.

Micro hardness

The hardness variation across the perpendicular to the weld face to base metal region is surveyed. For the micro hardness using Vickers micro hardness machine and the average values shown in table 2, in that the optimum value was obtained with square tool which was 82.8(HV) shown fig.3. The base metal 5083 hardness is 75(HV), it was more than of base metal.

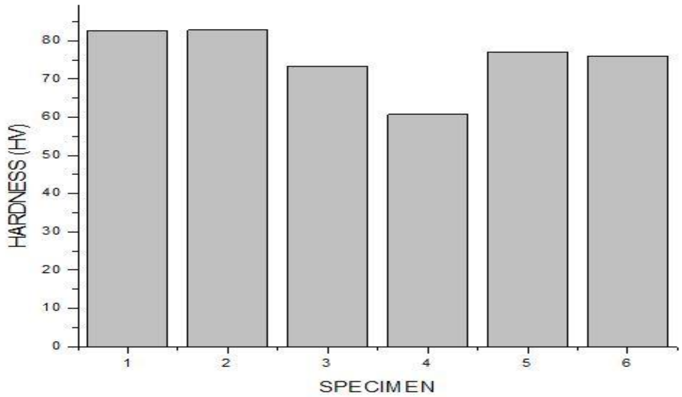
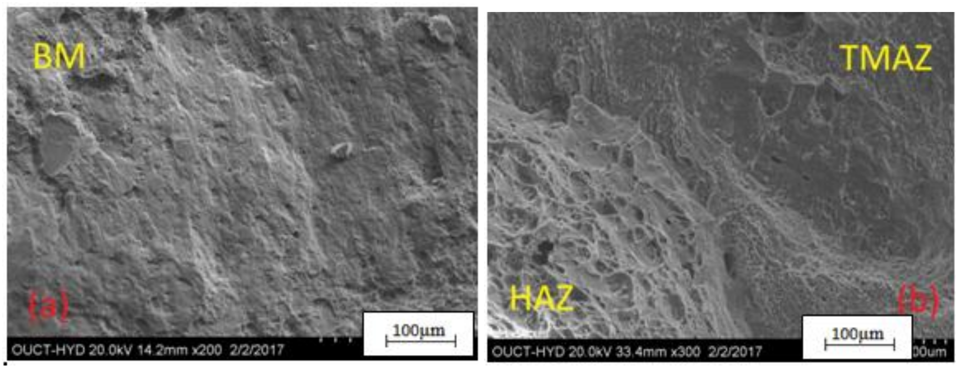


Figure 2: Vickers hardness graph

Specimen no	1	2	3	4	5	6
Hardness(HV)	82.7	82.8	73.3	60.7	77.03	75.9

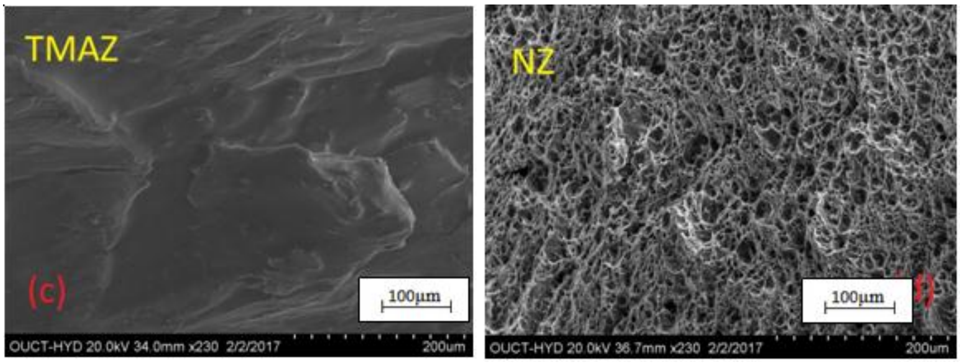
Figure 3: Vickers Hardness values.

SEM analysis



(a) Base metal, (b) Two zones combination with

TMAZ and HAZ



(c) Thermo mechanically affected zone (TMAZ), Nugget zone (NZ).

Figure 4: SEM micrographs of welded joint AA5083-AA6061 aluminum alloy.

The characterization of material structures with high resolution images of the sample by scanning electron microscope (SEM). The fracture surfaces of tensile specimens characterized by SEM. The tensile fractures of AA5083-AA6061 presented 45^0 angle impact fractures along the tensile axis, while base metal and friction stir welded joints 90^0. The fracture surface of AA5083-AA6061 showed (fig.4) obvious plastic deformation except the base metal AA6061. The micrographs reveal dimple fracture pattern with teared edges full of micro pores. Observed the dimples were various sizes and shapes compared to BM, AA5083-Aa6061 had deeper dimples and thinner teared edges. Therefore, the AA5083-AA6061 exhibited much better mechanical properties than the base metal AA6061.

X-Ray Diffractometer

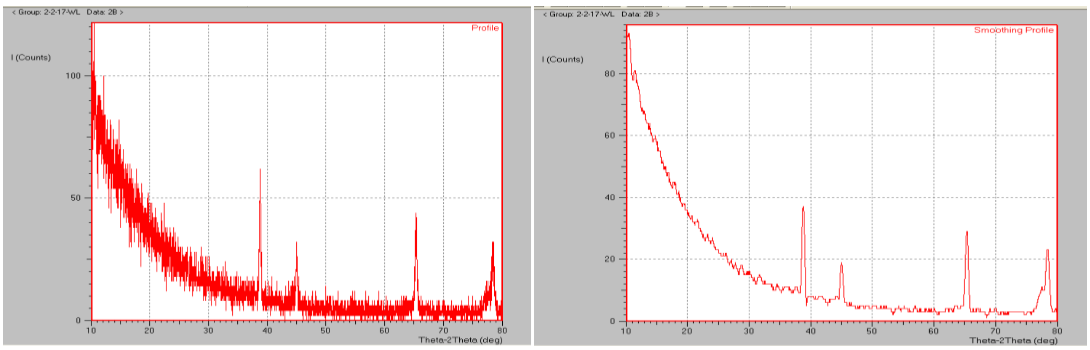


Figure 6: The XRD diffraction patterns profile & smoothing profile in WN zone of FS welded for A5083/AA6061.

The mixed regions of AA5083 alloy and AA6061 alloy was observed at joint interfaces in all joints. In this region, a AA5083-AA6061 aluminum alloy intermetallic compound was detected by XRD. However, no other intermetallic compounds were detected using XRD. The X-ray diffraction results in WNZ exactly correspond to the addition of diffraction patterns of AA5083 and AA6061. This indicated that there are no new AA5083-AA6061 intermetallics formed in WNZ of FS weld for 5083/6061 dissimilar materials as shown in the fig.5 and fig.6. However, since the metal AA5083 and AA6061 experienced a period of larger plastic deformation and stress-strain in WNZ, the lattice structure of AA5083 and AA6061 was distorted. Therefore, a minor deviation of diffraction peak existed between the WNZ and base metals. The analysis results of phase constituents indicate that there was no new intermetallic compounds generated, which would influence the mechanical properties of FSW joint when joining 5083/6061 dissimilar materials.

CONCLUSION

The present review has demonstrated the extensive research effort on understanding the affect of process parameters of FSW on AA5083-AA6061 aluminum alloy.

As per my experimental review, I will conclude that.

- The grain size and mechanical properties of FS Welded AA5083-AA6061 Al alloy was successfully studied, and the weld has a good weld quality and is free of cracks and porosity.
- From the experimental results, the better performance was achieved by the circular with threaded tool pin profile followed by square tool pin profile.
- The optimum value of hardness was 82.5 (HV), which was obtained by square tool pin is higher value than the base metal AA5083 hardness 75 (HV).
- It was concluded that, no cracks occur in the region of the weld nugget zone.
- The XRD analysis indicated that there were no new AA5083-AA6061 alloy intermetallics in the weld nugget zone. As a result, the structure of weld nugget zone was mainly plastic diffusion combination of AA5083-AA6061.

ACKNOWLEDGEMENT

University college of Technology Laboratory, Osmania University, Hyderabad for providing the facilities to carry out this work and we also thank to the Principal, mechanical staff and Management of S R Engineering College, Warangal for their continuous support during this work.

REFERANCES

[1] Gurel Cam and Selcuk Mistikoglu, JMEPEG (2014) 23:1936–1953 _ASM International DOI: 10.1007/s11665-014-0968-x.

[2] J. Adamowski a,*, M. Szkodo b, VOLUME 20 ISSUES 1-2 January-February 2007.

[3] Aruri Devarajua*, V Kishanb, Materials Today: Proceedings XX (2016) XXX–XXX.

[4] H.J. Zhang, H.J. Liu ⇑, L. Yu, Materials and Design 32 (2011) 4402–4407.

[5] M.A. Sutton *, B. Yang, A.P. Reynolds, R. Taylor, Materials Science and Engineering A323 (2002) 160–166.

[6] Livan Fratini*, Gianluca Buffa, International Journal of Machine Tools & Manufacture 45 (2005) 1188–1194.

[7] Mohammad Hasan Shojaeefard a, Reza Abdi Behnagh b, Mostafa Akbari c, Mohammad Kazem Besharati Givi d, Foad Farhani e, Materials and Design 44 (2013) 190–198.

[8] K.V. Jata and S.L. Semiatin Air Force Research Laboratory, Materials and Manufacturing Directorate, AFRL/MLLM, 2230 Tenth Street, Wright-Patterson AFB, OH 45433-7817 USA, Scripta mater. 43 (2000) 743-749.