International Journal of Management, IT & Engineering
Vol. 9 Issue 6, June 2019,
ISSN: 2249-0558 Impact Factor: 7.119
Journal Homepage: http://www.ijmra.us, Email: editorijmie@gmail.com
Double-Blind Peer Reviewed Refereed Open Access International Journal - Included in the International Serial Directories Indexed & Listed at: Ulrich's Periodicals Directory ©, U.S.A., Open J-Gage as well as in Cabell's Directories of Publishing Opportunities, U.S.A

EFFECTS OF FRICTION STIR WELDING TOOL ROTATIONAL SPEED ON MICROSTRUCTURE AND HARDNESS OF THE INDUSTRIAL ALUMINUM

Abhijeet Maurya*
Anjali Maurya*
Dhreej Verma*

Abstract

Friction stir Welding is the type of welding used as a solid state joining process for materials because it deflects the common problems obtained in conventional welding processes. The reality that joining of alloys could be usually faced problems in many sectors that includes automotive, aerospace, ship building industries, electronics etc. where fusion welding is not possible due to large difference in physical and chemical properties of the components to be joined. Industrial Aluminum 2xxx Series is widely used in aerospace industry. In the Friction Stir Welding, the rotational speed of tool effects on Industrial Aluminum Microstructure and Hardness of welded zone.

Keywords:
Friction Stir Welding;
Rotational Speed;
Hardness;
Microstructure;
Industrial Aluminum.

* **Research Scholar, Department of Mechanical Engineering, MUIT Lucknow, India,**

1.Introduction

The increasing demand of lightweight and durability makes advanced high strength industrial Aluminum (0.4%Cu, 0.5%Mg, 0.5%Mn, 0.3%Si,and 0.2 Fe with the remainder being aluminum) attractive for future aerospace and Marine Industry application. In this study 6mm thick Al sheet welded by FSW and the effect of welding speed on weld hardness properties was investigated. FSW is relatively new solid-state technique developed by the welding institute for joining of Aluminum alloys. In this welding Process, a rotating tool is inserted into the joint line of two adjoin material and translated along the interface. This study focuses on the effects of rotational and welding speeds on the hardness of joints in friction stir welded. Welds were achieved under low heat input conditions at rotational and welding speeds of 1200, 1000 and 500 rpm and 300 mm/min. In order to characterize the obtained welds, Brinell hardness measurements were taken on the weld cross sections. The objectives of this study are to clarify the appropriate welding conditions for sound welds, the detail of microstructures and Hardness properties, and the correspondence between the hardness properties and micro structural changes in a wide range of the welding parameters.

2.Experimental Procedure

The material used in this study was a Industrial Aluminum. Bead-on-plate welds were made by a single-pass FSW to find out the optimum conditions and associated mechanical properties. The dimensions of the weld specimens were 300 mm × 150 mm × 6 mm. These specimens were clamped tightly to a thick backing plate of low carbon steel. The tilt angle for all welds was kept constant at 3°. Welding trials were conducted at tool rotational and welding speeds of 1200,1000 and 500 rpm and 300 mm/min after Welding Industrial Aluminum fig.1,fig2,fig.3



fig.1 fig .2 Fig. 3

Microstructure changes from the weld zone examined with an optical microscope (OM). For optical microstructure observations, the cross section of weldments was polished and then etched with a solution distilled water 190ml, Nitric acid 5ml, Hydrochloric acid 3ml and Hydrofluoric Acid 2ml etching time 10-60 second.

The Brinell micro hardness profiles of the weld zone were measured on a cross section perpendicular to the welding direction using a 100 Kgf load.

3.Results and Discussion

The bead appearance of the sound welds. It can be seen that no observable defect was formed on weld surfaces .The cross-sectional macrographs of the welds associated with the welding conditions of this work. Depending on processing parameters, different shapes of weld nugget, which are basically categorized as basin-shaped and the elliptical, have been observed.

Based on micro structural observations, three distinct zones were detected as stir zone (SZ), thermo mechanically affected zone (TMAZ), and base metal (BM).The variation in microstructures in the SZ associated with all welding conditions. It can be seen that grain size decreases as the rotational speed decreases or welding speed increases. The size of re-crystallized grains in the SZ depends on two factors such as degree of deformation and the peak temperature obtained during FSW. A decrease in degree of plastic deformation causes the re-crystallized grain size to increase, and the decrease in peak temperature decreases the grain size of the SZ. The peak temperature of weld thermal cycle may be the dominant factor in determining the grain size. These findings are in conformance with the literature.

The total heat input generated by the FSW, which affects the grain size, can be simply expressed through the following equation

$$Q = \frac{4}{3}\pi^2 \frac{\eta \mu R_s P r^3}{W_s},$$

where Q is the heat input, η is heat efficiency, μ is friction coefficient, P is vertical pressure, r is radius of the shoulder, R_s is rotational speed, and W_s is the welding speed. According to this equation, as W_s is decreased or R_s increased, Q increases, and therefore, higher peak temperature at lower welding speed (and or higher rotational speed) is resulted, which in turn causes coarser grain size in the SZ.

The hardness tends to increase with decrease in rotational speed see fig 8. It is considered that the variation in hardness is related to the micro structural changes in the SZ induced by welding conditions. The lower rotational speed leads to the formation of smaller grains in the SZ. This is the reason why the hardness monotonically increases by welding rotational speeds. Variation in hardness with grain size was identified to follow the Hall-Petch relationship.

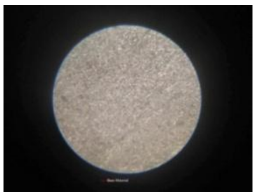
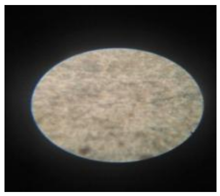
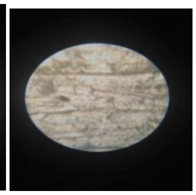
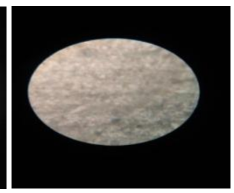

fig.4 fig.5 Fig.6 Fig.7

Microstructure of base metal fig.4 and after FSW Microstructure of weld metal of 1200,1000,500 rpm and 300mm/min welding speed respectively fig5, fig.6 and fig.7.

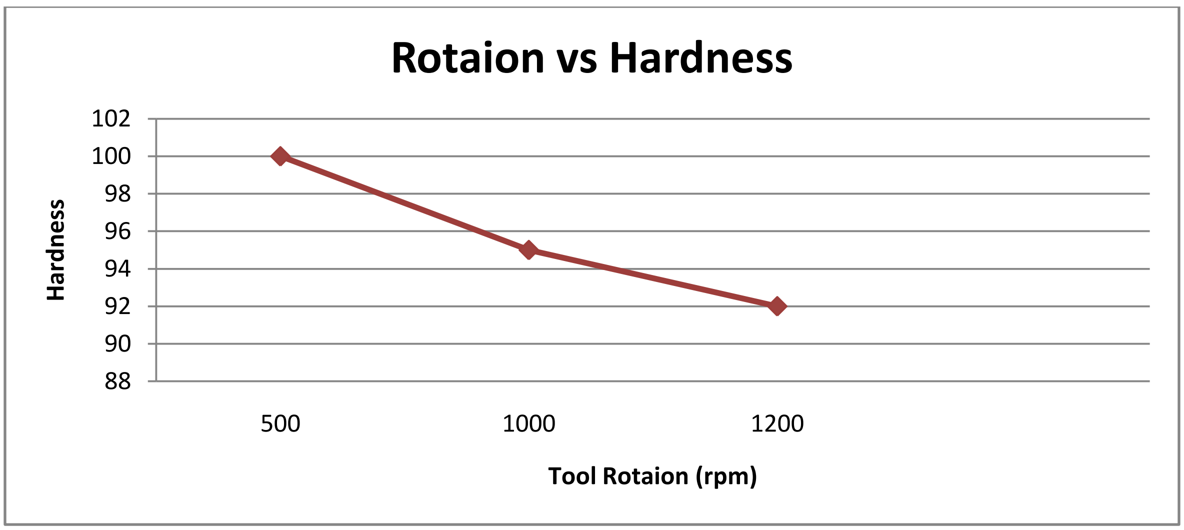

Fig.8:Hardness vs Tool Rotaion(rpm)

4.ACKNOWLEDGEMENT

The authors are extremely thankful to Dr. Mohd Zaheer Khan Yusufzai , Associate Professor IIT ,BHU and Er. Virendra Misra Workshop Superintendent Central Workshop FOE University of Lucknow for their appreciable support during the experimental work.

5.REFERENCES

1- Xue, P.; Xiao, B.L.; Wang, D.; Ma, Z.Y. Achieving high property friction stir welded aluminium/copper lap joint at low heat input. Sci. Technol. Weld. Join. 2011, 16

2- American Welding Society (2001), Welding Handbook , Welding Science And Technology, 9th ediction ,AWS ,Miani,Florida

3-.Kishore , Dr. IsrarM, Dr. Chandel JD(2018) Clad line pipe to combat the corrosion in pipeline, IJRASET,6(3),pp.50-55

4- Sanjay Kumar Gupta, Avinash Ravi Raja, Meghanshu Vashista and M.Z.Khan Yusufzai (2018)"Effect of heat input on microstructure and mechanical properties in gas metal arc welding of ferritic stainless steel . Materials Research Express, 2018https://doi.org/10.1088/2053/aaf492

5- R.S. Mishra, Z.Y. Ma, Friction stir welding and processing, Materials Science and Engineering R 50 (2005) 1–78.

6- R. Nandan, T. DebRoy, H.K.D.H. Bhadeshia, Recent advances in friction-stir welding – Process, weldment structure and properties, Progress in Materials Science, 53, 2008, 980–1023

7- Omar S. Salih , Hengan Ou, W. Sun, D.G. McCartney, A review of friction stir welding of aluminium matrix composites, Materials and Design 86, 2015, 61–71

8- Murray W. Mahoney, Mechanical Properties of Friction Stir Welded Aluminum Alloys, ASM International, 2007, 71-110