Metallogr. Microstruct. Anal. (2016) 5:476–485
DOI 10.1007/s13632-016-0315-8

TECHNICAL ARTICLE

Effect of Friction Stir Welding Process Parameters on Microstructure and Mechanical Properties of Dissimilar AA6061-T6 and AA7075-T6 Aluminum Alloy Joints

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Received: 10 March 2016 / Revised: 11 October 2016 / Accepted: 12 October 2016 / Published online: 4 November 2016

Abstract Dissimilar friction stir welding (FSW) of aluminum alloys has paved way for the manufactures to explore the possibilities of using cost-effective materials. This paper investigates the microstructural characteristics and mechanical behavior for joining AA6061-T6 and AA7075-T6 aluminum alloys by FSW technique. A total of 20 joints were fabricated by varying the ranges of tool rotational speed (*N*), welding speed (*S*), axial load (*L*) and tool shoulder diameter to pin diameter ratio (*R*). The effects of these parameters are evaluated by varying one parameter within the range and keeping all other parameters constant. Macro-, microstructural and fractographic studies for each joint were presented in detail. The variation in tensile strength, hardness, and grain size for each joint was analyzed and presented. Fractographic analysis clearly shows that the failure has occurred due to ductile fracture. It was found that at rotational speed of 1100 RPM, welding speed of 26 mm/min, axial load of 7 kN, and a tool shoulder diameter to pin diameter ratio of 3 quality welds with higher tensile strength and hardness can be obtained. A greater reduction in grain size can be seen in stir zone was the reason for increase in mechanical behavior.

Keywords Friction stir welding · Dissimilar aluminum alloy · Microstructure · Tensile strength · Hardness

Introduction

Joining of dissimilar aluminum alloys has numerous applications in aerospace and shipbuilding industries. Most of the traditional welding processes involve local melting along the joint line, and successive solidification leads to formation of a joint which affects their strength significantly [1]. The main advantages of joining dissimilar aluminum alloys by FSW are greater reduction in cost, avoidance of the formation of solidification cracking, porosity, and tailored mechanical properties of the part [2]. Many authors have studied the feasibility of joining different dissimilar aluminum alloys and their effects on the material flow and mechanical behavior of AA2024-T3 and AA7075-T6 [3], fatigue and microstructural properties of dissimilar AA5083-H111 and AA6082-T651 [4], the effect of process parameters for joining AA5574/AA7075 [5], and the effect of pin profile and tool rotational speed on mechanical properties of the joints for joining AA5083-H111 and AA6351-T6 [6].

Rodriguez et al. [7] examined the microstructure of the cross-sectional area of the dissimilar joint of 6061–7050 aluminum alloy and found distinct lamellar bands and different degree of mixing of materials was associated with the tool rotational speed. The rupture took place at AA6061 side for all joints. Further, they concluded that at low tool rotational speed, due to inadequate material intermixing

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