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Role of friction stir welding – Traveling speed in enhancing the corrosion resistance of aluminum alloy

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HIGHLIGHTS

- Corrosion properties of FSW 6061 aluminum alloy have been studied.
- An increase of FSW – traveling speed improves the corrosion resistance.
- FSW-traveling speeds play a major role on the corrosion resistance of 6061 alloy.

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ABSTRACT

The effect of friction stir welding (FSW) – traveling speed on the corrosion properties of 6061 aluminum alloy has been studied. The electrochemical tests indicate that an increase of FSW – traveling speed improves the corrosion resistance due to increased film and charge transfer resistances. In addition, the increase of FSW – traveling speed recrystallizes and refines the mean grain size from the initial 54.3 to 24.0 μm as well as increasing the homogeneity in microstructure.

1. Introduction

AA6061 aluminum alloy is employed in the aircraft fittings, couplings, marine fittings, electrical fittings and connectors, brake pistons, hydraulic pistons, appliance fittings, valves and bike frames [1–3]. It has high strength, good workability and high corrosion resistance. Severe plastic deformation processing has been developed to produce submicron and ultrafine-grained metals for example by equal-channel angular pressing [4,5], high pressure torsion [6], dynamic plastic deformation [7] and accumulative roll bonding [8]. Such processed method has superior mechanical properties and high ductility as compared to coarse grained metals. It can be used for light weight construction and also used for various industrial applications [9,10]. Unfortunately, these manufacturing processes such as accumulative roll bonding technique, have limited the size and shape which restricts their use in many industrial applications. In addition, 6061 alloy is not suitable for making reliable soldered joints, due to oxidation of the heated metal surface that prevents soft solder from adhering. Among the joining technologies, friction stir welding (FSW) is one of the best

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Table 1
Chemical compositions of the base metals examined by optical emission spectroscopy.

Sample	Composition (wt.%)								
	Si	Mg	Mn	Fe	Cu	Cr	Ti	Zn	Al
6061	0.691	1.131	0.113	0.299	0.212	0.154	0.011	0.011	Bal.

methods to join fine-grained metal matrix like 6061 alloy which prevents occurrence of porosity, solute redistribution, solidification cracking and liquation cracking during the process. It also produces a low level of defects and is highly tolerant to variations in parameters and materials. Furthermore, a number of FSW benefits have been identified such as good weld appearance, good mechanical properties, and the absence of toxic fumes, low environmental impact, no consumables, simple milling machines and operation at all positions [11]. FSW is also one of the most desirable joining methods for aluminum alloy as it provides excellent mechanical properties [12,13]. FSW can form a fine recrystallized grain structure and a novel texture in the weld zone due to severe plastic deformation and heating. Numerous studies have characterized the mechanical properties and microstructure developed during friction stir welding and have systematically examine the variations in grain structure and texture across the weld [14–18]. However, there have no studies about improving corrosion resistance that has been reported for FSW for 6061 alloy. Therefore, the aim of this work was

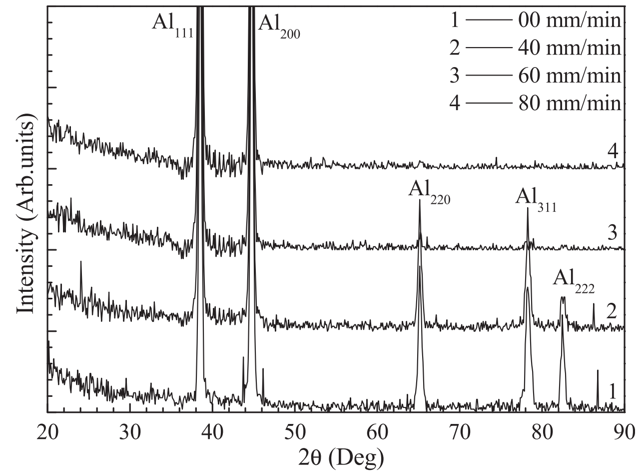

Fig. 1. XRD patterns of the AA6061-T6 aluminum alloy with different friction stir welding – traveling speed from 0 to 80 mm/min.

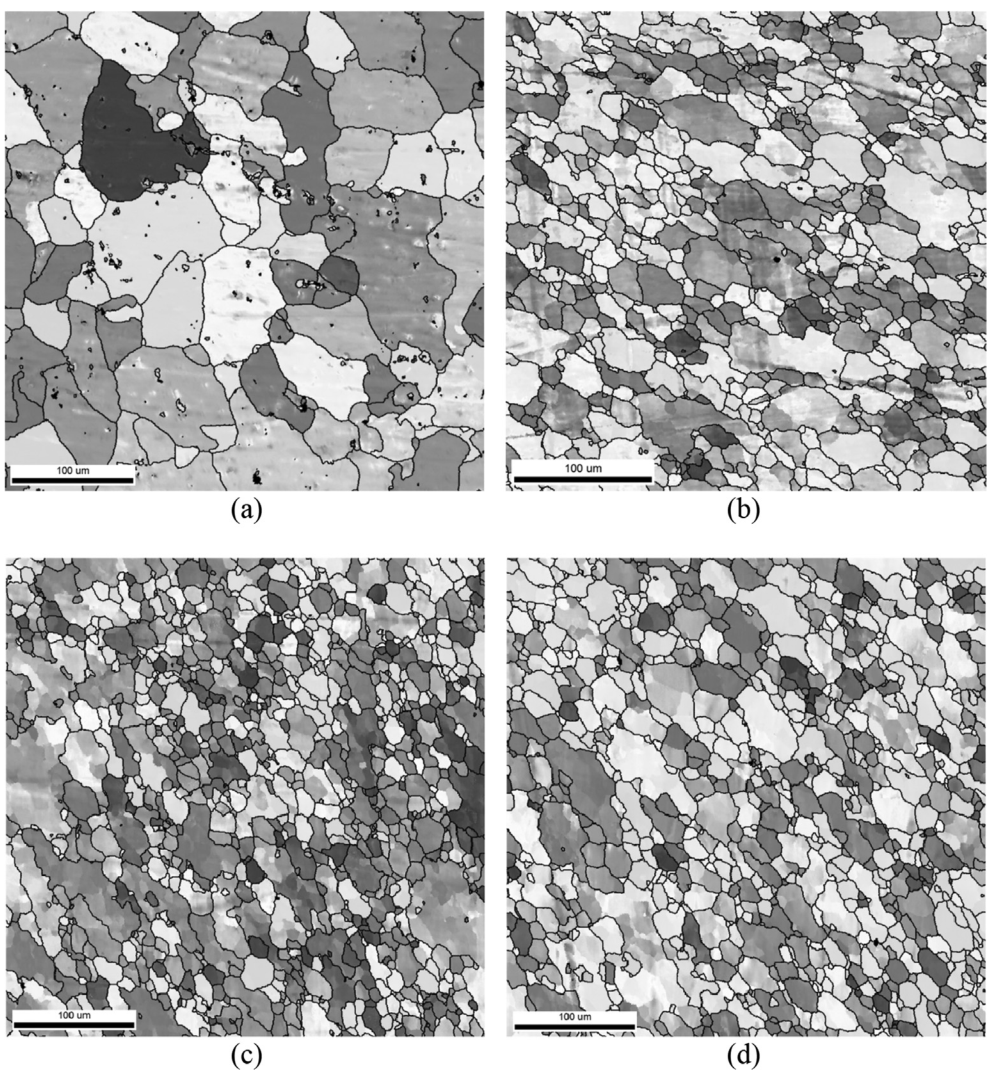

Fig. 2. EBSD results of (a) base material and friction stir welding – traveling speed of (b) 40, (c) 60, and (d) 80 mm/min.

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