Abstract

The joining of dissimilar materials such as AA6061-T6 and AISI34 has the potential for tailoring the properties of a structure. However, because of the differences in the mechanical and metallurgical properties of AA6061-T6 and AISI304, there exist several challenges in fabrication. Friction stir welding (FSW) is an advanced solid-state welding technique having the potential to produce a sound weld between aluminum and steel substrates. Microstructure, intermetallic compounds (IMC), crystallographic texture, corrosion, and weld defects are the main factors controlling the mechanical and metallurgical properties of the welds. These factors rely on process parameters and weld media. Scanty literature is available on the effect of process parameters on the FSW of AA6061-T6 and AISI304 in air and water media. This study utilizes FSW to join 1 mm thin sheets of AA6061-T6 and AISI304 with varying process parameters which includes tool rotational speed (ω), welding speed *(v),* plunge depth (PD) and tilt angle (α). Two media for weld fabrication have been utilized namely, air (CFSW) and water (UwFSW). A vertical milling machine has been used for weld fabrication. This machine is equipped with a piezoelectric dynamometer through which the force prevailing during welding is being acquired. K-type thermocouples were inserted into the workpieces for monitoring the temperature during welding. During welding in CFSW, α has been optimized based on the obtained tensile strength and defects in the welds. With the obtained optimized value of α, and varying other process parameters, welds have been fabricated in UwFSW. Post weld characterizations have been carried out to investigate on the variation in weld strength, micro-hardness, weld defects, microstructure, and IMC. Weld strength and deformation have been found to be primarily dependent on the weld defects, grains and crystallographic texture. Evolution of microstructure and their growth affects both strength and deformability. In this study, stop and action technique has been used to study the recrystallization mechanism in the weld zone. A detailed study has been performed on microstructure and crystallographic texture in case of optimized welds of CFSW and UwFSW. From corrosion analysis, weld structures of AA6061-T6 and AISI304 have been found to be highly susceptible to corrosion in the electrolytic medium.

Keywords: Underwater friction stir welding, Microstructure, Crystallographic texture, Intermetallic compounds, Corrosion