Abstract

Aluminium can be a feasible alternative to copper as both materials possess almost the same electrical and thermal properties. However, at the same time, aluminium is very much less expensive than copper. Aluminium also has low density and high strength. The welding of metals like aluminium and copper has a lot of economic benefits in the electric, aerospace, chemical, electronics, refrigeration, nuclear, and transportation industries. Welding these materials poses a significant challenges they possess different chemical and physical properties, which may result in large intermetallic compounds (IMCs), residual stresses, and cracking formed during welding. Friction stir welding (FSW) is very suitable for joining materials with different physical and chemical properties than conventional fusion welding. The prior benefits are that FSW eliminates distortion, cracks, porosity, and reduce formation of IMCs as no melting occurs during this process. During FSW a non-consumable rotating tool having a specially designed pin and shoulder which has been plunged into adjoining edges of sheets or plates to be welded and moved to joint line. Functions of the tool are to generate frictional heat which leads to plastic deformation of material, movement of workpiece materials and also acts as a reservoir of the hot material under tool shoulder. Weld quality is governed by tool geometry and process parameters which includes tool traverse speed, tool rotational speed, plunge depth etc. The tool experiences different forces and torque during welding. The present work analyzes the effect of different tool geometries on joining aluminium and copper for varying tool traverse speed and rotational speed. These variations affect material flow, heat input, and formation of IMCs, interfacial layer thickness, and force and torque generation and subsequently affect metallurgical and mechanical properties. The investigation includes microstructure and mechanical characterization, and also weld quality prediction based on force and torque signal characterization.