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PROCESS DEVELOPMENTS AND MATERIALS CHARACTERIZATION IN FSW/P

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Abstract

FSW and processing have largely evolved in recent years in terms of process knowledge, materials processed and industrial applications. This paper aims at presenting some applications involving FSW and variants of this in distinct applications.

Considering process developments friction stir has been studied in an hybrid welding process associated with electric current for welding Al based alloys. In this variant a temperature increase due to Joule effect was seen to improve the viscoplasticity of base material without affecting metallurgical characteristics, reducing lack of penetration which is detrimental for fatigue resistance [1,2].

Diffusion welding triggered by FSW, named friction stir diffusion welding (FSDW) has also been investigated to join materials with very distinctive properties as copper to stainless steel preventing the formation of brittle intermetallics and improving joining efficiency using downward force of 5500 N, rotation speed of 1800 rpm and travel speed of 90 mm/min. The same variant was tested to produce sandwich materials as Al reinforced with NiTi ribbons taking advantage of the high conductive soft Al material and the damping capacity and high mechanical resistance shown by NiTi. A good embedment of the reinforcing material under appropriate processing conditions was seen due to the viscoplastic material flow around the NiTi.

The possibility to produce surface composites and functionally graded materials by FSP and friction surfacing is another interesting field of research [3,4]. These find applications in components where high surface wear and corrosion resistances are a requirement. The introduction of SiC particles in Al based alloys allowed to produce orthogonal gradients of hardness and high surface resistances. Friction surfacing has also been studied aiming the two applications mentioned: to produce FGMs in non ferrous alloys and to manufacture high resistance coatings in steel. A very remarkable result is the high hardness observed in steel coatings much superior to those obtained with conventional heat treatments, as quenching. A hardness of 700 HV was measured in AISI H13 coatings due to both the rapid quenching of high temperature material and severe plastic deformation of the process [5].

This solid state materials processing technology also demands for new nondestructive techniques to assess the materials integrity and characterize the processed area. Thus, eddy currents have been studied and showed to map the microstructures of distinct zones, as well as, to identify LoP defects [6,7].

Keywords: FSW, FSP, diffusion joining assisted by FSW, friction surfacing, Eddy currents, composites

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