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Authors: Haiping Yu, Haiqing Dang, Yanan Qiu

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Interfacial microstructure of stainless steel/aluminum alloy tube lap joints fabricated via magnetic pulse welding

Haiping Yu[1,2], Haiqing Dang[2], Yanan Qiu[2]

(1. National Key Laboratory for Precision Hot Processing of Metals, Harbin Institute of Technology, Harbin 150001, China)

(2. School of Materials Science and Engineering, Harbin Institute of Technology, Harbin 150001, China)

Abstract: Magnetic pulse welding was utilized to join 5A02 aluminum alloy and SS304 stainless steel tubes under a discharge voltage of 15-17 kV and 1.75 mm radial gap. SEM, TEM, and EDS analyses are performed to assess the interface microstructure of the transition zone joint. The interface with the transition zone is composed of an amorphous matrix comprised mostly of Al with relatively less Fe, plus irregular nanocrystalline second phases embedded within the amorphous phase matrix. The magnetic pulse welding interface with the transition zone essentially forms a fused interface and the base metals on both sides of the transition zone maintain the deformed structure exhibiting severe plastic deformation, grain refinement, and an increased hardness near the interface.

Keywords: magnetic pulse welding; aluminum alloy; stainless steel; interface; transition zone; microstructure

1. Introduction

Aluminum and its alloys have poor weldability; further, aluminum and steel have very different physical and chemical properties and distinct compositions (Kapil and Sharma, 2015). In the process of welding aluminum and steel, if both metals are in a molten state, the weld joint produces a large amount of brittle intermetallic compounds rendering a reliable joint very difficult to obtain. This makes welding the two metals much more complicated than welding the same kind of metal, and makes joining quality difficult to guarantee (Zhang and Liu, 2011; Song et al., 2009). In order ot realize actual joining of aluminum alloy and stainless steel, appropriate joining methods are necessary.

Some researchers have attempted to resolve this problem. Song et al. (2009) used an aluminum-silicon eutectic solder to achieve an aluminum/stainless steel TIG melting-brazing connection. This interfacial layer, unequal thickness at different position, was made up of three kinds of intermetallic compound layers, and the resulting joint strength is not up to that of aluminum alloy. Direct diffusion bonded joint of aluminum alloy 5A02 and stainless steel 304 was obtained without