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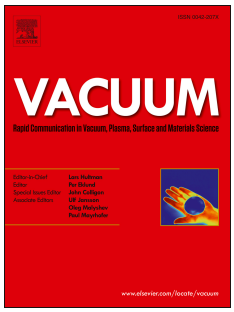

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Study on microstructure and impact toughness of TC4 titanium alloy diffusion bonding joint

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Abstract

TC4 titanium alloy was diffusion bonded under small axial pressure of 0.5 MPa to restrain the deformation. The sample surfaces, prior to bonding, were finely polished to Ra 0.3 μm. The bonding temperatures were used as 860, 890 and 920 °C with holding time of 1 hour. The joint microstructure was examined. Tensile test and Charpy impact test were conducted to evaluate the joint strength and toughness. Two parts of the 860 °C bonded sample were then held in 920 °C for 90 min and 180 min, respectively. The results show that the 920 °C joint with high bonding ratio (~ 98 %) fractured at the base metal during tensile test showing excellent strength of the joint. However, the impact toughness was 14.99 J/cm^2 that is much lower than 27.3 J/cm^2 of the base metal. The heat treated 860 °C samples had 100% bonding ratio and impact toughness of 15.81 and 20.02 J/cm^2 for the 90 and 180 min sample. The microstructure analysis indicates that the joint toughness was affected by the void defects remained and the interface grain boundary migration at the bonding interface.

Key words: TC4; Diffusion bonding; Impact toughness; Microstructure

1. Introduction

Titanium alloys that have high strength, excellent corrosion resistance, relatively low density and good creep resistance play an important role in the field of aero-engine applications such as turbine fan blades [1-3]. Such applications usually have complex structure and work under dynamic loading conditions [4]. Solid state diffusion bonding is a suitable method for manufacturing such parts that have complex structures, because there is no melting and limited macroscopic deformation that ensures the structural and mechanical properties [5].

The mechanical properties of diffusion bonding joints are dependent on the microstructure that is effected by bonding parameters. A joint is considered to have a strong bond when there is no metallographic evidence of the bond line. The elimination of the bond line is achieved by grain boundary migration caused by recrystallization and grain growth [6]. Charpy impact test is considered to be the most sensitive test to assess the quality of diffusion bonding joints. The impact toughness of Ti-6Al-4V diffusion bonding joint depends on bonding ratio effected by the bonding pressure and holding time [7]. The bonding ratio can be improved by increasing bonding stress, temperature and holding time [8]. The effect of holding time on the interface grain boundary migration ratio of 1Cr11Ni2W2MoV steel diffusion bonding joints is studied [9]. As the holding time increases