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Microstructure Analysis of TI-6AL-4V Friction Stir Welded Joints

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Abstract : The Friction Stir Welding process uses an inert rotating mandrel and a force on the mandrel normal to the plane of the sheets to generate the frictional heat. The heat and the stirring action of the mandrel create a bond between the two sheets without melting the base metal. As matter of fact, the use of a solid state welding process limits the insurgence of defects, due to the presence of gas in melting bath, and avoids the negative effects of materials metallurgical transformation strictly connected with the change of phase. The industrial importance of Ti-6Al-4V alloy is well known. It provides an exceptional good balance of strength, ductility, fatigue and fracture properties together with good corrosion resistance and good metallurgical stability. In this paper, the authors analyze the microstructure of friction stir welded joints of Ti-6Al-4V processed at the same travel speed (35 mm/min) but at different rotation speeds (300-500 rpm). The microstructure of base material (BM), as result from both optical microscope and scanning electron microscope analysis is not homogenous. It is characterized by distorted α/β lamellar microstructure together with smashed zone of fragmented β layer and β retained grain boundary phase. The BM has been welded in the-as received state, without any previous heat treatment. Even the microstructure of the transverse and longitudinal sections of joints is not homogeneous. Close to the top of weld cross sections a much finer microstructure than the initial condition has been observed, while in the center of the joints the microstructure is less refined. Along longitudinal sections, the microstructure is characterized by equiaxed grains and lamellae. Both the length and area fraction of lamellas increases with distance from longitudinal axis. The hardness of joints is higher than that of BM. As the process temperature increases the average microhardness slightly decreases.

Keywords : friction stir welding, microhardness, microstructure, Ti-6Al-4V
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