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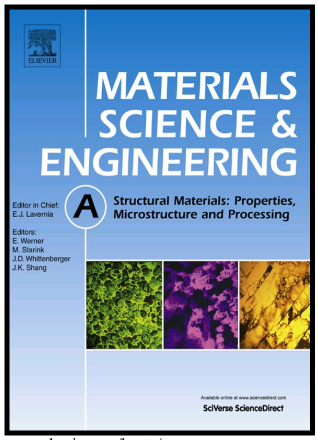

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The effect of constraint conditions on microstructure and properties of titanium alloy electron beam welding

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Abstract:

In the actual production, when the structures are welded, the weld inevitably bears the constraint stress which changes the internal stress state of the weld, and the properties of welding in actual welding structure is different from that in welding sample, so the effect of constraint stress on the microstructure and properties of electron beam welded joint is revealed by the characterization of solidification microstructure of joint under constraint conditions. The results show that the constraint conditions have a great influence on the microstructure, microhardness and properties. The unevenness of the microstructure of the weld increases, the grain size difference increases, the martensite is smaller with a lot of dislocations, and the continuous grain boundary α phase appears. The fusion zone and the heat affected zone consist of fine acicular martensite and residual α with dislocation tangles. The microhardness distribution of the weld is saddle-shaped, and the microhardness of weld metal is the highest. The tensile strength of the constraint welds is 898MPa, which is higher than conventional EBW joints, and the fracture position is located in the weld. Due to the existence of a large number of dislocations in the martensite under the constraint condition, the hardness and difficulty of slip deformation increase.

Keywords: Constraint conditions; titanium alloy; electron beam welding; microstructure and properties

1. Introduction

Titanium and titanium alloys are excellent candidates for aerospace and marine applications owing to their high strength to weight ratio and excellent corrosion resistance [1]. Titanium and its alloys can be used in various ranges of high specific strengths and are considered as one of the best engineering material for industrial application. The excellent properties of titanium and its alloy such as low density, moderately high specific strength, toughness, high fatigue life and excellent resistance to corrosion make them attractive for marine applications [2]. But the low thermal conductivity of titanium alloy makes the uneven deformation of welded structure for the large heat in local. At the same time because of the low elastic modulus of titanium alloy, deformation also easily happens under the welding stress, which seriously affects the precision of welding structure [3-4]. So titanium alloy welding needs some device to control deformation and ensure dimensional accuracy.

Due to the active chemical properties of titanium alloy, it is easy to oxidize during the welding process. While electron beam welding (EBW) is preferable to joining titanium alloys. Because of the high vacuum inside the chamber, hot metal can be shielded from contamination during the process [5-7]. However, because of high energy density, narrow heating area, fast welding speed, great temperature gradient in the weld metal and the near weld area[8-10], it is easy to cause weld metal forming large gradient microstructure and stress distribution to affect the uniformity of mechanical properties of joint.

The constraint stress has effect on the microstructure transformation in the welding cooling

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