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ORIGINAL ARTICLE

Dissimilar welding of aluminum alloys 2024 T3 and 7075 T6 by TIG process with double tungsten electrodes

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Abstract
The aim of this work is to study the metallurgical and mechanical properties of dissimilar assemblies of 2024 T3 and 7075 T6 structural hardening aluminum alloy by the TIG twine electrode arc welding process. It will include a weld performed according to optimized welding parameters followed by a study of the macroscopic and microscopic evolution of the dissimilar assembly (2024-7075) using optical and scanning electron microscopy (SEM); in addition, the phase compositions were analyzed with an energy dispersive spectrometer (EDS). Tensile and microhardness tests were performed. The tensile fracture was observed by SEM. This paper suggests that when the double tungsten electrode TIG welding is used, a stable arc has been formed with a good bead appearance. The heat dissipated by the arc generates several zones (molten zone (WZ), bonding zones (LZ), heat-affected zones (HAZ)) with different microstructures or precipitates of the type θ (Al_2 Cu), S (Al_2 Cu, Mg) and η (Mg Zn_2), S (Al2 Cu Mg) are formed in the heat-affected zone (HAZ) of base metals 2024 and 7075 respectively. The microhardness is lower in the molten zone and higher in the heat-affected zone of 7075 T6 alloy, which cried out an embrittlement and a 44% and 37% drop in the tensile strength of 7075 T6 and 2024 T3 base metals respectively.

Keywords 2024 and 7075 aluminum alloy · Aluminum with structural hardening · Microstructure · Double electrode TIG processing · Dissimilar welding

1 Introduction

Today, the search for new designs allows either to fulfill a new function or to lighten existing structures [1]. Aluminum and its alloys are some of the most widely used materials in the industry, especially in the aeronautics and aerospace industry.

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The structural hardening alloys of the 7xxx and 2xxx series are the most widely used alloys; they are characterized by high mechanical strength and high corrosion resistance [2]. However, the assembly of these materials by welding is a challenge [3] for manufacturers and technologists, especially for heterogeneous assemblies. The difficulty stems from the high chemical reactivity of oxygen to aluminum, which produces a refractory layer of aluminum oxide and the high solubility of hydrogen, which generates porosities (blowholes). In addition, the high thermal conductivity generates lime cracks and deformations during welding, etc. [4–6]. For this reason, research has been carried out to study the feasibility of heterogeneous joining of aluminum alloys using TIG, MIG, high-energy LASER beam, and lately FSW.

Bai et al. [7] found that TIG and MIG arc sources are more advantageous than high-energy beams due to their efficiency and economy. Laser-arc hybrid welding processes are considered an efficient welding process; however, the deposition rate of the welding wire cannot be controlled independently of the welding current [8]. The FSW process allows several heterogeneous assemblies such as AA5754-AA7075 [9], AA2024-AA7075 [10], AA2219-AA5083 [11], and AA7075-AA6061