Enhancing Resistance to Solidification Cracking and Mitigation in TIG Welding of Al7075 Alloy

Abstract: Due to one of the highest strength-to-weight ratios among aluminum alloys, Al7075 is popular in the automotive and aerospace industries. However, the widespread application of this precipitation- hardened alloy is significantly hindered by limitations in manufacturing processes, such as casting and
fusion welding, mainly due to the presence of high amounts of alloying elements.
During the solidification of this alloy, different phases solidify at different temperatures, creating a wide solidification range, which eventually leads to the formation of solidification cracks. Several investigations have been conducted to mitigate this issue by optimizing welding parameters during fusion welding and post-weld heat treatments or adopting a solid-state welding process instead. Recently, several studies reported crack-free joints after
fusion welding using nanoparticle infusion, but the governing mechanisms of this crack prevention are not yet clearly understood. This study investigated experimentally the mechanism(s) behind the elimination of solidification cracks during fusion arc welding of Al7075. Subsequently, a
modified physical model was developed to elucidate these mechanisms, leading to a
new adapted approach for fusion arc welding of
Al7075. The experimental findings highlight the crucial roles of (i) the fusion zone
grain morphology alternation from dendritic to equiaxed and (ii) secondary phase morphology change in solidification crack elimination. The proposed modification to the RDG model suggests that altering the fusion zone grain
morphology ensures consistent maintenance of positive total pressure between grains at any temperature during solidification, leading to decreased solidification crack susceptibility. Ultimately, through a comprehensive understanding of the micro-mechanisms driving the elimination of solidification cracks, achieved via experimental investigation and physical modelling, a novel adapted approach in TIG welding of Al7075 is established. This advancement facilitates the fabrication of crack-free joints in Al7075, which improves its applications in various industries.

Biography

Alireza Abdollahi is a Materials and Mechanical Engineer with over a decade of experience in metallurgy. As a Ph.D. candidate, he is a dedicated researcher in the field of solidification crack elimination
and pioneering welding methodologies. His proficiency covers a wide range of physical and
mechanical properties assessment techniques such as metallography, SEM, EDX, XRD, wear, impact, tensile, and
hardness testing. Alireza had hands on various materials used in transportation and oil sectors, including steel, aluminum, titanium, and copper. Alireza's extensive contributions include multiple peer-reviewed publications, distinguished awards, and a strong commitment to advancing engineering practices.