WAAM of high strength 7075 Al alloy: challenges, microstructural and mechanical characterization

Matthieu Lezaack[1*], Rafael Nunes[2], Wim Verlinde[2], Grzegorz Pyka[1], Aude Simar[1]

[1] Institute of Mechanics, Materials and Civil Engineering (iMMC), Université catholique de Louvain, 1348 Louvain-la-Neuve, Belgium

[2] Belgian Welding Institute, Technologiepark-Zwijnaarde, 9052 Zwijnaarde (Gent), Belgium

[*] Corresponding author: matthieu.lezaack@uclouvain.be

Abstract

Wire Arc Additive Manufacturing (WAAM) of aluminum alloys, particularly high-strength alloys like 7xxx series, presents significant challenges. This study, part of the Win2Wal WAALU project, focuses on the challenges associated with WAAM of 7075 Al alloy, including issues related to defects, microstructure, mechanical performance, and post-deposition heat treatments.

The present work discusses the impact of wire quality, WAAM deposition strategies, and manufacturing conditions on the performance of the resulting structures. WAAM is performed using a 6-axis Kuka robot coupled with a Fronius welding source. The initial filler metal consists of ER7075 aluminum wires with diameters of 1.6 mm and 1.2 mm. Post weld heat treatments are applied to achieve the peak-aged T6 state for the ER7075 WAAM manufactured parts.

X-ray tomography is used to identify internal defects in the printed structures. By correlating these defects with the WAAM deposition conditions, the study provides valuable insights into the key factors influencing print quality. Guidelines for successfully printing 7075 aluminum alloy using WAAM are proposed. Hot cracking is mitigated through careful management of the deposition strategy and heat input, while porosity is minimized by using higher-quality feedstock wire and efficient thermal control.

The optimized WAAM conditions are further explored by evaluating the tensile strength and fatigue life of the printed ER7075 parts. These results are compared to those of equivalent wrought EN AW 7075 plates in the peak-aged T6 condition. The findings of this work contribute to advancing the industrial application of WAAM for high-strength aluminum alloys.

Keywords: WAAM, high strength Al alloys, microstructure, mechanical properties, X-ray tomography.