ADVANTAGES OF THE INTRINSIC METAL-CORED WIRES PRODUCTION FLEXIBILITY TARGETED FOR WIRE + ARC ADDITIVE MANUFACTURING

ROCHA, Pedro Correa Jaeger[1]
B.E. Materials Engineer
SILVA, Regis Henrique Gonçalves e[2]
Prof. Dr. Eng.
GALEAZZI, Daniel[3]
M. Eng.
SCHWEDERSKY, Mateus Barancelli[4]
Prof. Dr. Eng.
SILVA, Rafael Gomes Nunes[5]
B.E. Materials Engineer

ABSTRACT

The principle of Additive Manufacturing (AM) lies on the fact that any object can have its digital geometrical concept sliced into layers and rebuilt using these two-dimensional layers coordinates as a material deposition path, regardless of its geometry complexity. The AM variant that combines an electric arc as thermal source and wire as feedstock is known as Wire + Arc Additive Manufacturing (WAAM) which was addressed in this work. The employment of metal-cored wires for WAAM can bring the benefit of higher deposition rates with less power consumption, however, the most useful advantage lies on its higher production and development flexibility. The most usual producing procedure used to produce metal-cored wires consists in folding a thin metal strip into a “U” shape, filling it with flux constituents, closing the “U” to form a circular section and reducing the diameter of the tube by drawing or rolling. The flux constituents in this fashion of tubular wires are predominantly alloying elements, even tough arc stabilizers (Na, K), deoxidizers (Si, Mn) and slag inducers (TiO_2, CaO) may also be present for improved weldability. An additional advantage is the likelihood of filling its core with ceramic particles, something unpracticable with solid wires. These extreme hard particles precipitates without melting in the metal matrix, forming a Cermet. Currently, only few wire manufactures are developing alloys devoted to WAAM, and in minor scale. The WAAM small market demand does not allow high production volumes due to lack of commercial appeal.

[1] Universidade Federal de Santa Catarina, Instituto de Soldagem e Mecatrônica - LABSOLDA, Florianópolis-SC, pedro.jaeger@posgrad.ufsc.br
[2] Universidade Federal de Santa Catarina, Instituto de Soldagem e Mecatrônica - LABSOLDA, Florianópolis-SC, regis.silva@labsolda.ufsc.br
[3] Universidade Federal de Santa Catarina, Instituto de Soldagem e Mecatrônica - LABSOLDA, Florianópolis-SC, daniel.galeazzi@posgrad.ufsc.br
[4] Universidade Federal de Santa Catarina, Instituto de Soldagem e Mecatrônica - LABSOLDA, Florianópolis-SC, m.barancelli@ufsc.br
[5] Universidade Federal de Santa Catarina, Laboratório de Mecânica de Precisão LMP-LASER, Florianópolis-SC, rafael.nunes@posgrad.ufsc.br

Since the production of solid wires of specific alloys is only economically feasible for large volumes, the use of metal-cored wires can be a solution for an early stage WAMM consumable boost. Therefore, the development of WAAM focused additive material is benefited by the metal-cored wire production flexibility. Small batch productions of tailormade alloys for prototypes or repairing of parts made of non-conventional alloys can easily be made with metal-core wires, compared to solid ones. This flexibility also powers the growing application of functionally graded materials, that require the gradually deposition of different compositions of materials in the same structure in order to achieve gradual material properties. This article aims to evaluate the feasibility of creating wall-like structures with the use of three different metal-cored wires of differing element basis (Fe, Ni and Co) with equipment used in the already consolidated welding industry. Both wires were overlapped sealed and had 1.2 mm of diameter. Thick Wall-like structures with 15x100x50 mm were deposit over ¼" thickness AISI 1020 substrate by a Yaskawa Welding Robot. To reach the 50 mm height, 17 to 20 layers were required, depending on the alloy. A Fronius Cold Metal Transfer (CMT) welding power source was used, along with its peripherical apparatus. As shielding gas, industrial Argon with 16 L/min was used. The wall's cross sections metallography analysis resulted in defects free weldments, confirming the feasibility of metal-cored use for WAAM, even though no specific electric wave forms was available to this welding combination of additive material, wire diameter and shielding gas.

Keywords: FCAW; Flux-Cored Wire, Functionally Graded Materials; GMAW