

Abstract

This doctoral dissertation addresses additive manufacturing using the Wire Arc Additive Manufacturing (WAAM) method with 316LSi wire, which is similar in composition to 316L steel. Due to its excellent corrosion resistance, 316L stainless steel is used in many industries. Parts made of this material are most often produced using plastic working and casting techniques, supported by welding and machining. This material has good welding properties, so printing methods that use an electric arc as a heat source can be used for additive manufacturing. In contrast to welding, WAAM printing is always multi-layered. Repeated heating of the material with limited heat dissipation causes structural changes that modify its mechanical and chemical properties. In 3D printing, especially of thin-walled elements, the surface condition after processing and the repeatability of the shapes obtained are important because they determine the cost of additional processing.

Current state-of-the-art knowledge indicates that it is possible to obtain WAAM prints from 316LSi electrode wire that have properties similar to 316L steel. However, the properties of the prints are sensitive to changes in technology and process parameters. The low linear energy of the process, necessary for thin-walled prints, has the potential to improve mechanical properties with a slight reduction in corrosion resistance. This study employed the CMT (cold metal transfer) method with the lowest possible process parameters, limiting the amount of heat introduced into the material, to produce thin-walled structures.

As part of a doctoral dissertation, attempts were made to produce structures from ER316LSi welding wire using WAAM. A range of technological parameters that ensure process stability at low linear energy was identified, and to evaluate the impact of electrode outlet length and current intensity on structure, geometry, mechanical properties, and corrosion resistance tests were conducted. The influence of the geometry of the weld base on the stresses in the base-weld system was also investigated.

Keywords: additive manufacturing, WAAM, CMT, 3D printing, 316L steel, 316LSi