Corrélation "microstructures-traitement thermiques-propriétés mécaniques" de pièces en 316L obtenues par fabrication additive

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Abstract

In the last ten years, metal additive manufacturing has achieved significant success across various industrial sectors. According to the 2020 Wohlers associates Inc. report, in the healthcare and automotive sectors alone, the growth rate of additive manufacturing ranged between 15% and 25%. In response to this growing interest in metal additive manufacturing, the Centre de Ressource et Technologique Analyses et Surfaces initiated this thesis work to build expertise in this technology and provide valuable support to its customers. This work presents a comparative study between a 316L stainless steel produced using the Laser Powder Bed Fusion (L-PBF) process and a conventional 316L (rolled and annealed). The study focuses on three main areas : the impact of the manufacturing process, the influence of thermal treatments (homogenization at 1150°C and tempering at 600°C and 800°C), and a digital simulation component. The effects of the manufacturing process and heat treatments on the microstructure, mechanical properties (hardness and tensile strength), and pitting corrosion resistance were analyzed. The aim of the simulation was not to use the model as a predictive tool, but as an aid to understanding, helping to highlight phenomena that might not be directly observable experimentally but could be further investigated through new experimental analyses. The results show that in the as-received state, 316L L-PBF has superior mechanical properties compared to 316L rolled material, as well as better corrosion resistance. The thermal treatments modify the microstructure of 316L L-PBF, leading to a decrease in both mechanical strength and corrosion resistance. However, the heat-treated 316L L-PBF does not show any regression compared to the conventional grade. The digital simulation results demonstrated the relevance of the model used and its ability to account for the anisotropic nature of the L-PBF material.