Determination of dwelling time strategy in additive manufacturing using FEM simulation for SS316L

Abstract

Additive manufacturing (AM) is a layer-by-layer deposition process and has rapidly developed in the last decades. The interlayer temperature (IT) is an important parameter in the AM processes and can influence the products significantly. To keep the IT in an acceptable range (around 150℃) dwelling time was introduced in this study. Previous research revealed that a constant dwelling time is not an optimal strategy for a multilayer AM process, because at the beginning of the welding, only a shorter dwelling time, such as 30s, is needed, while with the layers increasing the heat accumulates then more dwelling time is needed. The relationship between dwelling time and IT was studied using numerical simulation (ANSYS software) for a 20-multi-layer AM process. Then the dwelling time strategy was deduced according to this relationship. The study revealed that the efficiency of the dwelling time for reducing the temperature will reduce with layers increasing, so in a constant dwelling time strategy, 210s can control the IT around 150℃, and the total dwelling is 3990s. With the dwelling strategy, 2-10 layers (90s), 11-16 layers(150s), and 17-20 layers (210s) the IT can be controlled around 150℃, but the total dwelling time is 2400s, which is 60% of the constant dwelling time. An experiment with this strategy was applied using a Fanuc welding robot, and the 3D structural product showed a better appearance than using a constant dwelling time in the same total dwelling time. Therefore, the dwelling strategy is an efficient way to increase the manufacturing speed and accuracy of the AM process.