Influence of process parameters and heat treatment on porosity of additively manufactured AlSi10Mg

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ABSTRACT

Material which is produced by the additive manufacturing technology laser powder-bed fusion (L-PBF), tends to build pores, depending on the process parameters. So does the highly used alloy AlSi10Mg. These pores can either be round or irregular shaped due to different formation processes. Round pores are mostly influenced by e.g. evaporation, hollow powder particles, remaining H_2O content or a high laser power. Whereas influencing factors on the formation of irregular shaped pores are e.g. instability of the keyhole, oxides in the powder, large layer thickness, large scan space or an uneven upper powder surface.
However, this contribution only focusses on the influence of variations in the process parameters, but also a subsequently performed heat treatment. Therefore a statistical design of experiments with a face-centered central composite design (CCD) was performed. The parameters studied, are Laser Power P, Scan velocity v and Hatch spacing h. All three are varied in three stages each, resulting in 16 samples using the above mentioned CCD plan. A second set of 16 samples, with the same variation in parameters is additionally heat treated at 300 °C for 2 hours after the manufacturing process. For a simplified view of the results, the influencing parameters are combined into one factor, the volumetric energy density (VED) which is calculated as follows $VED = \frac{P}{v \cdot h \cdot d}$.
The results are showing that there is a non-linear progression of the relative density, a measure of the overall porosity in a part, as function of the VED. For low, but also high VED the relative density is quite low. While an optimum of the relative density could be achieved for VEDs between 36,46 J/m³ and 46,62 J/m³. However, the comparison of the heat-treated and non-heat-treated samples revealed that on average the relative density is lower for the heat-treated ones. Namely ρ(nHT)=99,36% compared to ρ(HT)=98,82%. An additionally metallographic examination showed the shape but also the distribution of the pores in the manufactured parts.