Prog Addit Manuf (2019) 4: 431. https://doi.org/10.1007/s40964-019-00086-6

The validation of the microstructural evolution of selective laser-melted AlSi10Mg on the in-house built machine: energy density studies

Mathe, N.R. & Tshabalala, L.C.

ABSTRACT:

The additive manufacturing of aluminium alloys has become an area of interest for the aerospace industry due to the high strength-to-weight ratios of the produced components. AlSi10Mg has been explored as an alloy of choice for building aircraft parts such as heat exchangers with internal cooling channels, etc. In this study, metal powders of AlSi10Mg containing spherical particles with good flow ability for selective laser melting were used. Various process parameters were investigated on the in-house selective laser melting system or 3D printer to demonstrate the effect of high energy densities on the microstructure and hardness properties for increasing the consolidation rate. The single track analysis showed that the higher energy densities resulted in deeper penetration depth with wider track widths. The microstructures obtained from built cubes revealed built patterns representative of the laser scans after solidification of the molten powder. X-ray diffraction data analysis presented a substantial shift in the 2ϑ peak positions at the lowest energy density, indicating possible lattice expansion, known and non-indexed phases, and inherent strains in the material induced during the building process. The electron back-scattered diffraction results also showed a refined grain structures at lower energy densities with the presence of Al, Si, and Mg_2Si, and no-indexed phases which could represent possible new phase orientations. The hardness measurements obtained in this study were higher than the conventional procedures due to grain refinement experienced during the fast heating and cooling gradients of this process.