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Influence of TiC Surface Functionalization on physical and rheological properties of AA2017 powders for Laser Powder Bed Fusion

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The addition of ceramic particles to aluminum alloy powders for Laser Powder Bed Fusion (L-PBF) has shown great potential to lead to a columnar-to-equiaxed microstructure transition in aluminum alloys produced by L-PBF. This strategy presents significant importance to high-strength aluminum alloys such as 2xxx, 6xxx, and 7xxx series that exhibit an extensive solidification interval, which results in hot cracking during solidification in L-PBF. Different ceramic particles have been used with aluminum alloy powders for L-PBF, but there is a lack of studies that investigate the influence of the addition of the ceramic particles to the aluminum powder characteristics, such as particle size distribution, apparent density, and flowability. Those powders' properties are important to guarantee a good surface finish and density of the as-built L-PBF samples. Based on this, TiC with three different mean particle sizes (45 nm, 4 ?m, and 44 ?m) in three different contents (1 wt.%, 2 wt.%, and 4 wt.%) was added to AA2017 powders produced by gas atomization. The morphology particle size distribution, apparent and skeletal density, flowability, microstructure, and phase composition of the powders were analyzed. The nano-TiC particles were attached and homogeneously distributed on the surface of the AA2017. With the increase in the TiC particle size to 4 ?m, the distribution became more heterogeneous. A continuous increase in the TiC particle size to 44 ?m leads to a very heterogeneous distribution of the particles, that in general are not attached to the AA2017 powder surface, but distributed within the metal powder. A similar particle size distribution is seen in these powders, with a mean particle size (d50) of about 31 ± 2 ?m. On the contrary, the TiC particle size and content have a significant influence on the apparent density and flowability of the metal powder. The apparent density increases by adding TiC particles and is followed by a decrease when the TiC content is increased. Regarding the flowability, it is improved when 1 wt.% of TiC is added, followed by a deterioration when TiC content is increased. The powder with the addition of TiC with a particle size of 44 ?m presented the best flowability. The microstructure of the powders consisted of an Al matrix with copper-rich Al-Cu precipitates at the grain boundaries. TiC phase was identified in the powders where TiC ceramic particles were added. Finally, the laser reflectance and rheological properties of the powders have been characterized through UV-NIR-IR spectrophotometry and an FT4 rheometer, respectively.