Linking Rheological Properties of Metal Powders to Spreadability for Powder Bed Based Additive Manufacturing Process Optimization

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ABSTRACT

Metallic powders are widely used in powder bed based Additive Manufacturing (AM) processes, with for example Selective Laser Melting (SLM) and Selective Laser Sintering (SLS). During such operations, successive thin layers of powder are created with a ruler or with a rotating cylinder and then partially sintered with an energy beam. The layer thickness defines the vertical resolution, a thin layer leads to a better resolution. Moreover, the spatial homogeneity of the layer is a key parameter to ensure good quality of the built parts. Consequently, the spreadability of the powder must be good enough to obtain homogenous successive layers.

Visual observation of layer homogeneity is usually the only way for operators to quantify the spreadability of powders during the recoating. However, relating the powder characteristics to its spreadability beforehand should provide a more cost-effective way to classify and select the optimal powder and recoating speed combinations. The aim of the present study is to show how powder flowing behavior can be related to its real performance in the printer.

Powders flowing properties have been characterized by the rotating drum measurement principle, allowing to assess the powder spreadability without applying a compressive load during the powder testing what fits with the conditions seen by powder in the AM processes.

Four metallic powders (AlSi7Mg06, Scallmaloy®, Inconel®, Inconel® fine) commonly used in AM have been selected. Powders flowability has been determined with the GranuDrum (GranuTools) instrument, a rotating drum enabling to quantify the influence of cohesion, shear-thinning/shear-thickening as well as thixotropic behavior. These measurements have been correlated to the powder spreadability in a SLM 3D printer, where a CCD camera is used to take several snapshots at different recoater speed. An image processing software (GranuLayer) has been specifically developed to quantify the homogeneity of the powder layer after each recoating process. The obtained results demonstrate the good correlation between the cohesive index measure provided by the GranuDrum and the spreadability of the powder.

INTRODUCTION