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On the impact of cohesion on the bulk properties of a powder bed in Additive Manufacturing using Discrete Element Method (DEM) simulations

Haeri S.[1], D. Bailey[1], M. Calder[1], B. Clark[1], A. Rogalsky[2], E. Toyserkani[2]

[1] James Weir Fluid Laboratory, Department of Mechanical and Aerospace Engineering, University of Strathclyde, Glasgow G1 1XJ, UK.
[2] Department of Mechanical and Mechatronics Engineering, University of Waterloo, Waterloo, ON N2L 3W8, Canada

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In powder based Additive Manufacturing (AM) a uniform and compact spread of particles is required which can then be accurately fused layer by layer to form final products. As powders are spread, several parameters control the quality of the final powder bed layer; namely, spreader type, powder grain shape, powder characteristics and ambient manufacturing conditions. Utilising discrete element method (DEM) simulations this paper investigates the effect of cohesion on the quality of the powder bed post spreading. However, only cohesion due to the formation of liquid bridges as a result of moisture content of the powder is considered in this work. Simulations are run with a realistic spreader (geometry of which was created from data points from manufacturing equipment used within industry), alongside realistic particle shapes created via Multi-Sphere Approximations (MSA) of models derived from powder X-ray microtomography images, see Figure 1. A random selection of powder particles is chosen and used within simulations, with the resolution of these particles being controlled via a surface smoothing factor [1] to ensure an acceptable balance of accuracy and computational cost. Simulations are run with an appropriate subset of the total number of particles to yield a statistically accurate representation of the grain population to identify the effects of cohesion on the final quality of the powder bed layer.
In this paper for the first time, the relationship between the moisture content and powder bed quality is investigated and the simulation results indicate that the cohesion has a strong effect on the powder bed quality which is quantified via a surface roughness parameter and powder's bulk density.

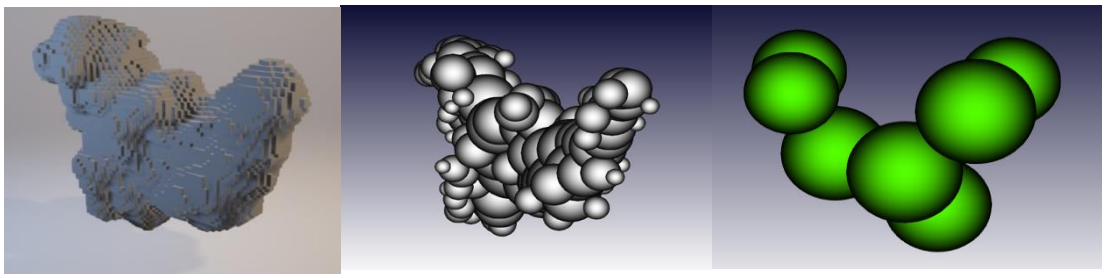

Figure 1: A 70µm Particle - 3D Model (Left). High Resolution MSA (Centre). Low Resolution MSA (Right).

REFERENCES

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