Geometric optimisation of blade type spreaders for powder bed preparation in Additive Manufacturing

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Abstract
Powders used in Particle Bed Fusion process are spread onto compact layers and then are sintered. This process is repeated layer by layer to form the final products. The author has recently characterised the process and it is found that spreading the particles with a counter-rotating roller produces a bed with higher qualities, i.e. lower void fractions and surface roughness [Powder Technology, 306 (2017) 45–54]. This is related to particle dragging effect caused by a small contact area between powder grains and the blade. Therefore, here, it is postulated that changing the blade profile at the blade-bed contact point can significantly influence the contact dynamics and hence increase its effectiveness as a spreading device for Additive Manufacturing (AM) applications and in particular for Particle Bed Fusion. A set of computer simulations using Discrete Element Method (DEM) are performed at device scales to optimise the geometry of blade spreaders to yield the lowest void fraction and surface roughness. The blade profile is parametrised using a super-ellipse with three geometrical parameters. It is firstly demonstrated that geometric optimisation of a blade profile is an effective alternative to using more complex spreading devices. Secondly, for the proposed parametrisation, the optimum values are found using computer simulations which can generate very high quality powder beds similar to the counter-rotating roller.

Figure 1. Powder bed spreading using the optimised blade design.

Figure 2. Maximum attainable solid fraction by changing different design parameters.