A Coupled CFD-DEM Approach to Modelling Powder Stream in Direct Energy Deposition

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Metal-based additive manufacturing (AM) is revolutionizing the production process and introducing unprecedented capabilities, which are quickly becoming indispensable across a wide range of industries [1]. Direct Energy Deposition (DED) in particular is exhibiting a high potential for space applications due to no imposed limitation on the size of manufactured objects and the ability to operate in micro-gravity conditions [2]. DED however remains hindered by poor deposition quality and reproducibility, which appear to originate in the powder stream condition [3]. Increased accuracy of the blown powder dynamics hence represents a crucial ingredient of next-generation DED models [4]. Powder stream is usually modelled with the use of computational fluid dynamics (CFD) as a two-phase flow problem involving a dispersed second phase [5]. Powder particle collisions and their interaction with the melt-pool cannot be accounted for by these models and are regularly disregarded on the account of these particles occupying a small volume fraction in the carrier gas flow [5]. This assumption was put to the test using a Discrete Element Method (DEM) model of the particle stream of a discrete coaxial nozzle. While neglecting the interaction between carrier gas and powder particles, the results showed that non-negligible portions of powder grains are involved in grain collisions with substantial rebound angles, which underlined the need to account for inter-particle interaction in DED stream models. This sparked the development of a fully coupled CFD-DEM model of powder stream in DED, the results of which will be presented at the conference.

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