Title: Porosity control in CuCrZr–316L multi-material PBF-LB/M: Simulation guided process optimization

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Laser-based powder bed fusion (PBF-LB/M) can also be used to create multi-material components, enabling the combination of advantageous properties of different alloys, such as the high thermal conductivity of copper alloys and the corrosion resistance and strength of stainless steels. However, the different thermal properties of these alloys lead to melt pool instability and porosity formation. The effect of process parameters on porosity have been studied with experiments, but because of the dynamic material composition at the bimetallic interface, trends remain difficult to identify, making prediction and prevention of defects in multi-material parts challenging.

This study investigates melt pool behaviour and porosity formation during PBF-LB/M of CuCrZr alloy powder on a 316L substrate, using computational thermo-fluid dynamic (CFD) melt pool simulation, validated against experimental samples. The simulation model is used to identify mechanisms and process parameter dependence of porosity formation at the bimetallic interface and subsequent mixed-material layers. Simulations show that the relationship of process parameters and porosity varies as a function of material mixing gradient. The results of this study aid in optimizing multi-material PBF-LB/M processes for improved productivity and density, by introducing distinct process regimes for the bimetallic interface layers. Improved repeatability and defect rates are critical for unlocking high-performance multi-material AM components for demanding applications.