Nucleation Mechanisms in Powder Bed Fusion Additive Manufacturing

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ABSTRACT

We investigated the microstructure evolution of the nickel based superalloy Inconel 718 by selective electron beam melting (SEBM) in experiments and numerical simulations. With various process parameters it is possible to obtain either equiaxed, columnar or single crystalline structures. However, it is still not clear how these structures can be controlled. Especially, equiaxed structures are challenging to obtain.

The common microstructure for Inconel 718 in SEBM is columnar. For the transition to equiaxed microstructures nucleation is necessary. Beside classical equiaxed to columnar transtions, increased nucleation can be obeserved close to the melt pool borders during solidification [1,2,3,4]. Here, numerical simulations are applied, because it is nearly impossible to investagte this mechanism with experiments. Based on the findings a nucleation model suited for powder bed fusion (PBF) processes can be derived. Having a consistent and reliable nucleation model possesses the possibilty to predict the microstrucure before the actual build.

We will firstly present current experimental investigations for the melt pool border nucleation mechanism from [4]. Then we give an overview over current modeling of nucleation during PBF. A critical reflection of using existing models for PBF will be done. Possible influences that are often not considered in these models will be adressed and discussed by using results from our in-house software SAMPLE^{2D}[5]. Finally, a recommendation for a nucleation model for PBF is given.

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