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Eutectic Al-Ni alloy for laser powder bed fusion

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The success of laser powder bed fusion (PBF-LB) of metallic alloys is closely related to advances in developing suitable materials for Additive Manufacturing [1]. Further advances in this area should not solely take the processability of specific alloys into account, but also make use of the special processing conditions during generation of components to fully benefit from PBF-LB. During PBF-LB high thermal gradients occur inside the material [2]. They can be utilized to generate fine eutectic microstructures inside the material when solidification takes place [2, 3]. The refinement of this microstructural characteristic is accompanied by improved mechanical and thermal properties of the generated component [4]. There are few aluminium alloys commonly used for PBF-LB, e. g. AlSi10Mg or AlSi12 [5]. To make use of the behaviour of eutectic microstructures and to broaden the spectra of usable aluminium alloys suitable for PBF-LB the eutectic composition of the binary aluminium-nickel system (Al-6.1Ni) is chosen for an investigation of its processability in PBF-LB process and for elucidating the resulting microstructures in dependence of its processing conditions [6].

Experimental and analytical efforts in finding suitable processing parameters and analysing the resulting microstructures will be supported by analytical and numerical models to speed up the optimization process and to compare the results obtained by the different methods used. This way occurring differences between the methods can be identified and used for improving these methods. Therefore, an analytical model will be formulated based on the thermo-physical properties of the alloy, which will ensure adaptability to arbitrary alloys. This model will be able to predict the heat distribution during processing in a simplified manner in areas relevant for determining the resulting microstructure. Furthermore, high fidelity numerical melt pool simulations and microstructural simulations regarding the resulting microstructure from solidification will be carried out. By analysing the eutectic microstructure exhibited by the used alloy the solidification circumstances can be determined. This knowledge can generate a deeper understanding of the transient heat distribution and the related process and solidification dynamics of PBF-LB and therefore present a pathway to generate components with a spatially optimised microstructure for their respective application.

References

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