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A multicomponent evaporation model for selective beam melting processes

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Powder-based additive manufacturing technologies such as selective laser melting and selective electron beam melting hold great promise for producing high-value metal components with customized geometries. Development of scanning strategies and prediction of optimal process parameters thereby remain key factors for the fabrication of high-quality products without local inhomogeneities in alloy composition or porosity. Especially in selective electron beam melting very high melt pool temperatures can be reached which leads to local depletion of volatile alloying elements, for instance aluminium in titanium alloys. In order to understand how the element loss and distribution is influenced by process parameters simulations were conducted on a mesoscopic scale that include meltpool hydrodynamics, thermodynamics and the mass- and energy loss as well as recoil pressure due to evaporation [1].

The relation between energy input, evaporation and residual porosity are numerically studied and different melting strategies are investigated. The line energy is of central importance, regarding evaporation losses, as it strongly affects peak temperatures during processing. Numerical simulations as well as experiments demonstrate that significant reductions in evaporation losses can be achieved by application of a suitable beam scanning strategy.

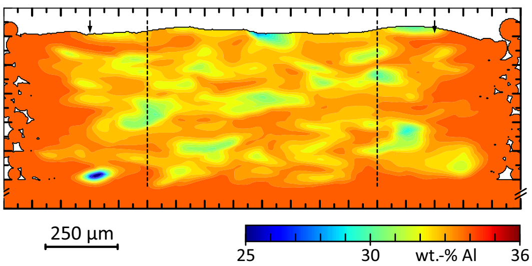

Figure 1: The picture shows a concentration distribution of a part of Ti-48Al-2Cr-2Nb build by electron beam melting with a beam power of $P = 600\text{W}$ and beam veloctiy $v = 3\frac{\text{m}}{\text{s}}$ as an example.

References

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