Thermal Modeling of Laser Melting of SS 17-4 PH and Ti6Al4V

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ABSTRACT

During Selective Laser Melting (SLM) the evolution of the temperature field is the main factor defining the microstructure and residual stresses induced in the printed part. However, it is seemingly impossible so far to measure the temperature field under the surface. The classical way to estimate the temperature field is through modeling of the heat flow into the piece, an approach significantly studied and developed by the welding community. Perhaps the most critical difference between welding and SLM, as with other metal additive manufacturing technologies, is that the time and length scales of the resulting melt pools are much smaller, leading to significantly larger cooling rates and temperature gradients, and hence microstructures.

In this presentation we will show our first steps towards building predictive numerical models of the heat flow for SLM. We focused on finding sets of parameters that would give rise to melt pools in which heat flow through conduction and mild convection is dominant, avoiding momentarily the more complex keyholing regime. We show (a) that convective effects on the melt pools of 17-4PH are nearly impossible to ignore, and (b) that the experimentally-measured melt pool boundary of each individual experiment can be fit remarkably well by a wide set of results of the numerical model, and that only by looking at collection of experiments can we increase the confidence on the numerical predictions of the induced thermal field.