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Accurate but rapid AM process simulation approaches

Simulation of additive manufacturing processes in a competitive industrial manufacturing environment requires as well the fast provision of results as maintaining their accuracy in order to correctly predict possible challenges and derive effective mitigations.

Applying the well-known inherent strain method for powder bed processes is one effective approach to fulfill both antagonistic targets. While the speed of this method is still unrivaled, the accuracy is evidentially good. Nevertheless, the basic approach can be extended to gain accuracy throughout the entire build space of a machine. This again requires a proper calibration of direction and spatial dependent inherent strains.

A further effective approach is to utilize a simplified thermo-mechanical model that is based on the thermal energy input rather than calibrated strains. Though calculation times are unsurprisingly longer, there is the additional benefit of getting global temperature information of the process. In addition, certain process characteristics can be better captured and the linked manufacturing challenges can be predicted more precise. Unfortunately, the simplifications of the approach still make it advisable to perform thermal and mechanical calibration to tune the model and get best results.

Finally, there are also applications where usual simplifications like element layer-wise analyses cannot be applied. This is the case for simulations that need to follow the energy source like a scan path simulation of powder bed processes in order to obtain correct local temperature histories, which enable to derive results for the microstructure and the properties of the material. But also on a much larger scale in direct energy deposition processes, this approach needs to be followed making the simulation very time-consuming and impractical for industrial use. But also here are possibilities to speed up the analysis time while maintaining a good result quality.

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