

MODELLING AT DIFFERENT SCALES OF PROCESSES INVOLVING MELTING AND SOLIDIFICATION OF METALS

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ABSTRACT

In this Mini Symposium, our focus is on the modelling of manufacturing processes that involve the melting and solidification of metals, such as Additive Manufacturing (AM), Casting, or Welding. Despite their differences, these processes share common thermomechanical aspects that significantly influence the final material properties on a macroscale level. Addressing the multiscale and multiphysics phenomena involved at various levels of significance is imperative when characterizing the key factors that impact the resulting part properties. For instance, understanding the influence of cooling rates on microstructure (including phase formation and grain texture) and their subsequent effect on macroscopic properties is an essential requirement. Additionally, modelling heat sources in processes like AM or welding, as well as employing more complex multiphysics approaches that consider fluid flow, solid mechanics, gas or plasma interaction, and species transport, become crucial in predicting the occurrence of defects such as porosity, segregation, or cracks. Evaluating their influence on local properties and part behaviour is equally important. Modelling these coupled phenomena at different scales presents a significant challenge, therefore giving way to the use of different approaches traditionally used in multidomain problems, such as level-set or phase-field methods. Moreover, recent advancements in model order reduction and data-driven methodologies provide additional avenues to explore and could be addressed in this symposium.

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