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Integrated Multiscale Unified Phase-Field Modellings (UPFM)

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ABSTRACT

For a long time, the phase-field method has been considered as a mesoscale phenomenological method lacking physical accuracy and unable to be associated with the mechanical/functional properties of materials, etc. Some misunderstandings existing in these viewpoints need to be clarified. Therefore, it is necessary to propose or adopt the perspective of "unified or unifying phase-field modeling (UPFM)" to address these issues, which means that phase-field modeling has multiple unifications. Specifically, the phase-field method is the perfect unity of thermodynamics and kinetics, the unity of multi-scale models from micro- to meso- and then to macroscopic scale, the unity of internal and external driving forces characterized by order parameters, the unity of multiple physical fields, and thus the unity of material composition design, process optimization, microstructure control, and performance prediction. It is precisely because the phase-field approach has these unified characteristics that, after more than 40 years of development, it has been increasingly widely applied in materials science and engineering.

KEYWORDS

Unified phase-field modelling; thermodynamics and kinetics; multiscale/multiple order parameters; driving force of potential gradient; multi physical fields; entire manufacturing process

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