HIGH-FIDELITY MODELLING OF FLOWS IN MANUFACTURING PROCESSES

1400 - MANUFACTURING AND MATERIALS PROCESSING

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ABSTRACT

The field of materials manufacturing processes has evolved considerably in recent decades, driven in particular by the numerical, energy and ecological transitions: with the support of numerical approaches, processes are targeted to consume less energy and even less raw material. This is the case of additive manufacturing processes (metallic, ceramic or polymer) which make it possible to obtain complex shaped parts, or the manufacture of composites with long or short, natural or synthetic fibres that make structures lighter. All these processes involve the dynamics of several types of fluids (or/and fusion zones), generally multiphase, giving rise to rather complex phenomena such as capillarity, the understanding of which is essential to the process optimisation. This requires high-fidelity, multi-physics and multi-scale simulations, with limited computation time, and even reaching real time. The most widely used numerical strategies which are still the subject of intensive research, include (stabilised/enriched/embedded) finite elements, phase-field and/or level-set approaches, mesh adaptation, parallel computing or computational homogenization (see e.g., Ref. [1]) among others. Nowadays, these techniques are increasingly coupled with machine or deep learning methods, allowing for example, via an off-line step, to simply generate data, reduce computation times (through reduced order model methodologies, meta-models or physically informed neural networks), or to statistically quantify the intrinsic variability of upscaling descriptors (see e.g., Gaussian processes / kriging in Ref. [2]).

The objective of this mini-symposium is to review the latest advances in the computational mechanics community in high-fidelity modelling and simulation of flows in manufacturing processes. This includes the development of numerical methods and multi-scale approaches to enrich physical models, as well as the coupling between simulations and advanced learning techniques.

REFERENCES

1 M. Shakoor, C.H. Park. Computational homogenization of unsteady flows with obstacles. *Int J Numer Meth Fluids*, 95(4): 499–527, 2023.

2 A. Geoffre, N. Moulin, J. Bruchon, S. Drapier: Reappraisal of upscaling descriptors for transient two-phase flows in fibrous media. *Transp Porous Med*, 147: 345–374, 2023.