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SHAPE MEMORY BY DESIGN: BRIDGING THE GAP BETWEEN MANUFACTURING, MATERIAL AND NUMERICAL SIMULATION

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ABSTRACT

Shape memory alloys offer distinctive opportunities for adaptive structures, actuators and energy dissipation through their shape memory effect and superelasticity, both leading to the evolution of inelastic, so-called transformation strains. From the start, models describing shape memory alloys have been tightly coupled to computational plasticity, with transformation surfaces and flow rules governing phase transformation.

Recent advances in manufacturing, especially additive manufacturing, have opened new areas of application ranging from solid-state cooling to patient-specific biomedical implants. At the same time, the process-induced heterogeneity of the microstructure, porosity, local defects and a non-trivial coupling of printing parameters, printed geometry and material behaviour pose a challenge to classical modelling techniques. Together with well-known challenges such as non-proportional loading, functional degradation under cyclic loading and the interaction between the superelastic response and plasticity, the accurate prediction of superelastic material behaviour under practically relevant conditions requires interdisciplinary research on manufacturing processes, constitutive modelling and numerical simulation, as well as the experimental characterization of shape memory alloys.

Contributions are consequently invited from both communities, working experimentally or numerically on shape memory alloys and focusing on process-material relations, thermodynamically consistent constitutive formulations, finite strain approaches or robust numerical algorithms. By integrating advances in computational plasticity with manufacturing and experimental evidence, the mini-symposium seeks to clarify the interplay between recoverable transformation strains and irreversible deformation, identify outstanding modelling challenges, and advance the reliable simulation and design of shape memory alloy components.