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COMPUTATIONAL MODELING, SIMULATION AND DESIGN OPTIMIZATION FOR 4D PRINTING

TRACK NUMBER 1000 - MANUFACTURING AND MATERIALS PROCESSING

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ABSTRACT

4D printing synergistically combines the capabilities of additive manufacturing (AM) to fabricate objects with complex shapes and topologies using multiple and advanced, functional materials to create active, stimuli-responsive structures that can change their shape after being manufactured. In recent years, 4D printing has emerged as a frontier in the advancement of both 3D printing and stimuli-responsive material researches, and several types of 4D printing mechanisms have been developed based on external stimuli such as temperature, moisture, light, pH, electric or magnetic fields and functional materials such as shape memory polymers and alloys, swelling hydrogels, thermo- and photo-responsive materials etc.

Various backgrounds, ranging from manufacturing technology to material science, and from mathematical modelling to thermo-mechanical testing, are currently contributing to the advancement of this field of research. To bring 4D printing technologies closer to application, computational modeling, simulation, and design optimization are of particular importance. However, this represents a fundamental, but challenging and currently under-developed topic due to the tight connection between process, material functionalities, and the final design. In particular, simulation and design of 4D printed structures often requires mechanical modelling of large deformations, nonlinear and viscous constitutive behavior, transient deformation, multi-physical (such as thermo-, hydro-, or photo-mechanics) and process-dependent multi-scale material behavior of inhomogeneous material distributions.

This Minisymposium is intended to cover the latest advances in simulation-based design for 4D printing. We aim to bring together specialists from different disciplines to exchange ideas on stimuli-responsive material modelling, process physics and simulation, computational techniques for modeling, design and optimization, experimental characterization and validation, and applications.

Some of the challenges, topics and techniques to be addressed within this Minisymposium will include, but will be not limited to:

- Constitutive modeling of functional materials at different scales
- Thermo-mechanical process modeling for AM of stimuli-responsive, smart materials
- Computational simulation and discretization methods
- Topology and design optimization for shape-changing structures
- Experimental characterization and validation methods
- Assisted-design for applications

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