VI International Conference on Simulation for Additive Manufacturing, SIM-AM 2027
September 13-16, 2027, Weimar, Germany

ADVANCES IN 3D/4D PRINTING OF SMART AND MULTIFUNCTIONAL MATERIALS

SARA GARZON-HERNANDEZ[*], FRANCISCA MARTÍNEZ-HERGUETA[†]

[*] Universidad Carlos III de Madrid
Av. de la Universidad, 30, 28911, Leganés, Madrid
E-mail address: sgarzon@ing.uc3m.es

[†] University of Edinburgh
School of Engineering — Institute for Infrastructure and Environment, The University of Edinburgh, Edinburgh EH9 3JL, UK
E-mail address: francisca.mhergueta@ed.ac.uk

ABSTRACT

Inspired by the ability of biological systems to adapt and respond to environmental stimuli, 4D printing enables the additive fabrication of smart structures that can change shape, properties or functionality over time, representing the fourth dimension [1]. Depending on their nature and composition, these materials respond to different external stimuli, including temperature, humidity, light and electric or magnetic fields, among others. Some of these materials, such as shape memory polymers and alloys, and piezoelectric or magneto-responsive materials, are attracting growing interest in various fields, including aerospace, bioengineering [2], or soft robotics. The convergence of these smart materials with AM represents a critical leap forward, enabling the spatial programming of their behaviour through complex geometries, finally bridging the gap between synthetic structures and the advanced functionalities of the natural world. However, manufacturing smart materials through AM introduces new challenges, as coupled, non-linear, and time-dependent multiphysics phenomena govern their response. Consequently, developing advanced modelling and simulation design tools to tailor mechanical, physical, and functional properties is essential to advancing the field.

This Invited Session focuses on recent advances in the design, modelling and simulation of smart and multifunctional materials and structures manufactured through AM. The session provides a forum for researchers from different disciplines to discuss current challenges and emerging opportunities in 4D printing. Topics of interest include, but are not limited to:

- Modelling and computational simulation of 4D printing processes.
- Process–structure–property–performance relationships, including process monitoring, control, and optimisation for tailored functionalities.
- Development of novel materials, methodologies, and additive manufacturing technologies for smart and multifunctional materials fabrication.
- Design, modelling, and optimisation of smart and multifunctional structures manufactured by additive manufacturing.

- Experimental characterisation, numerical model validation, and emerging applications of 4D printed smart and multifunctional materials and structures.

REFERENCES

[1] Delbart, R., Roumy, L., Harcourt, M., Robert, C., Touchard, F., Truong-Hoang, T. Q., & Martinez-Hergueta, F. (2024). 4D-printed composite actuators. In *Additive Manufacturing of Polymer-Based Composite Materials* (pp. 147-183). Woodhead Publishing., Vol. 15 (21), 11641, 2025.

[2] Lopez-Donaire M.L., de Aranda-Izuzquiza G., Garzon-Hernandez S., Crespo-Miguel J., Fernandez-de la Torre M., Velasco D., Garcia-Gonzalez D., *Computationally Guided DIW Technology to Enable Robust Printing of Inks with Evolving Rheological Properties*, Advanced Materials Technologies, Vol. 8 (3), 2201707, 2023.