XII International Conference on Coupled Problems in Science and Engineering, COUPLED 2027
June 27-30, 2027, Palma de Mallorca, Spain

COMPUTATIONAL STRATEGIES FOR THE DESIGN OF INNOVATIVE MATERIALS IN MULTIPHYSICS ENGINEERING APPLICATIONS

NICOLA FERRO[1], JULIÁN NORATO[2] AND SIMONA PEROTTO[3]

[1]Department of Molecular Sciences and Nanosystems, Ca' Foscari University of Venice, Campus Scientifico, Via Torino 155, Venezia Mestre, 30170, Italy
nicola.ferro@unive.it

[2]School of Mechanical, Aerospace and Manufacturing Engineering, University of Connecticut, 191 Auditorium Road, U3139, Storrs, 06269, CT, United States
julian.norato@uconn.edu

[3]MOX-Department of Mathematics, Politecnico di Milano, Piazza L. da Vinci 32, Milano, 20133, Italy
simona.perotto@polimi.it

ABSTRACT

The design of innovative architected materials is increasingly central to tackling engineering challenges involving coupled and multiple length scales physical phenomena, together with stringent performance requirements. For instance, lattice materials, cellular solids, metamaterials, and composites make it possible to tailor mechanical and multifunctional properties across scales. Advances in additive manufacturing have made these approaches more practical, enabling the fabrication of complex geometries that were previously unattainable.

A broad range of mathematical, numerical, and computational techniques is being developed to support the design of advanced materials in multiphysics and multiscale settings. These include density-based, level-set, phase-field, and homogenization-based topology optimization methods, data-driven and AI-assisted strategies for exploring large design spaces, dedicated approaches for the optimization of triply periodic minimal surface (TPMS)-based architectures. To be effective, these design workflows must integrate material architecture, structural performance, manufacturability, robustness, and uncertainty quantification. Relevant applications span diverse engineering fields, from lightweight structures and energy absorption systems to thermal management devices, biomedical components, and architected materials with tailored mechanical, thermal, acoustic, fluidic, and multifunctional properties.

For this invited session, we welcome contributions presenting recent advances in the computational design of innovative materials and structures to promote exchange on emerging methodologies, computational challenges, and applications in engineering practice. Topics of interest include (but are not limited to): topology optimization, TPMS-based and lattice materials, multiscale and multiphysics modeling, concurrent material and structural optimization, data-driven design, uncertainty-aware optimization, and additive manufacturing-oriented design strategies.