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NUMERICAL MODELING OF WELDING AND PROCESSING

N. DIALAMI* AND M. CHIUMENTI*

*Universitat Politècnica de Catalunya (UPC),
Centre Internacional de Mètodes Numèrics en Enginyeria (CIMNE), Campus Norte UPC,
08034 Barcelona, Spain
Narges.Dialami@upc.edu; Michele.Chiumenti@upc.edu

ABSTRACT

The invited session on Numerical Modeling of Welding and Processing aims to gather contributions that enhance our understanding, prediction, and optimization of welding and joining operations through advanced computational approaches. Numerical modeling has become an essential part of welding research and engineering, helping to improve productivity, ensure joint quality, and reduce the need for extensive experimental work. By simulating the effects of process parameters, heat transfer, and material behavior, these models offer valuable insight into weld pool evolution, phase transformations, and the resulting mechanical and metallurgical properties.

Welding and joining involve complex, coupled physical phenomena, including melting and solidification, material flow, microstructural evolution, and residual stress formation. To tackle these challenges, the session invites work employing multiphysics and multiscale modeling strategies based on various numerical techniques such as finite element, finite volume, smoothed particle hydrodynamics, Monte Carlo, and phase-field methods. These approaches make it possible to predict process behavior across different length and time scales from overall thermal and mechanical fields to local grain growth and defect formation.

The session covers a broad range of joining technologies, including fusion and solid-state processes such as friction stir and friction deposition welding, as well as brazing, soldering, adhesive, and mechanical joining. Contributions are encouraged in areas such as:

- Characterization and modeling of heat sources
- Transport phenomena and weld pool dynamics
- Phase transformations and microstructure-property relationships
- Constitutive and frictional behavior
- Defect prediction and mitigation strategies
- Sensing, control, and automation in welding and joining
- Integration of AI, machine learning, and digital twins for process optimization and real-time monitoring
- Joining of advanced and dissimilar materials, including lightweight alloys, plastics, and composites.