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

MULTIPHASE MICROFLUIDICS AND FLOW IN COMPLEX MEDIA

MOSTAFA S. SHADLOO [1], TOMISLAV MARIC[2] , MATHIS FRICKE [3], MOHAMMAD R. HASHEMI[4] AND PAVEL RYZHAKOV[5]

[1]INSA Rouen Normandie, CORIA Lab. CNRS-UMR 6614, France, msshadloo@coria.fr
[2]Technical University of Darmstadt, Germany, tomislav.maric@tu-darmstadt.de
[3]Focused Energy GmbH, Germany, mathis.fricke@focused-energy.co
[4]International Centre for Numerical Methods (CIMNE), Spain, mhashemi@cimne.upc.edu
[5]Universitat Politècnica de Catalunya BarcelonaTech (UPC) / International Centre for Numerical Methods (CIMNE), Spain, pavel.ryzhakov@upc.edu

ABSTRACT

Multiphase flows in microfluidic and porous media systems are central to many natural and industrial processes, including Lab-on-a-Chip devices, energy systems, and subsurface transport. At small scales, interfacial effects such as surface tension and contact line dynamics dominate the flow behavior, making accurate prediction and control of droplet motion, breakup, and coalescence a key challenge.

From a modeling perspective, these phenomena are studied across multiple scales, ranging from molecular dynamics and phase-field methods to continuum-based CFD approaches. Each level provides complementary insights, particularly for complex geometries and moving interfaces where capillary effects are significant.

Recently, data-driven and machine learning techniques have emerged as powerful tools to enhance multiphase flow modeling, enabling improved interface reconstruction, reduced-order modeling, and efficient prediction of droplet dynamics. However, robust coupling between physics-based models and learning methods remains an open challenge.

This mini-symposium brings together researchers working on experimental, numerical, and data-driven approaches to multiphase microfluidics and complex flow systems. The focus is on advances in modeling, simulation, and emerging AI-assisted methods for understanding interfacial flow phenomena.

Keywords: Multiphase flows, microfluidics, contact line dynamics, capillarity, porous media, computational fluid dynamics, machine learning