



Ali Dolatabadi, University of Toronto

Progress in modelling solution precursor thermal spray

Abstract:

Understanding the drying behavior of solution-precursor droplets is essential for controlling the final structure and morphology of the resulting particles, and consequently the coatings produced in solution precursor thermal spray processes. In this work, CFD simulations are first used to resolve the plasma or HVOF gas-flow field and to extract local gas-phase conditions—temperature, velocity, and pressure—along droplet trajectories. These conditions are then incorporated into a droplet-to-particle framework that captures five sequential stages: solvent evaporation, solute precipitation, boiling/dry-out, thermal decomposition, and melting under steep thermal gradients and high heat-transfer rates. Across these stages, the interplay between evaporation-driven mass loss and in-droplet solute diffusion governs shell formation and ultimately determines particle morphology, including whether particles become hollow or dense. To more accurately represent SPPS and SP-HVOF conditions, the model incorporates spatial pressure variations obtained from the CFD field rather than assuming a uniform ambient pressure, thereby accounting for their influence on saturation, boiling, and vapor transport. Because high-fidelity simulations over broad operating ranges are computationally prohibitive, the resulting CFD-informed dataset is used to train machine-learning surrogate models for rapid prediction.

Biography:

Ali Dolatabadi is a Professor in the Department of Mechanical and Industrial Engineering and Associate Chair - Research and also Associate Director of the Centre for Advanced Coating Technologies at the University of Toronto. Dr. Dolatabadi is a leading researcher and educator in the field of Multiphase flows and surface engineering. His research on multiphase flows develops fundamental understanding of sprays for thermal spray processes, and of droplet dynamics, heat transfer and phase change for the development and characterization of novel functional coatings. His research group has developed electro-catalytically active electrodes for hydrogen evolution, micro filtration membranes, superhydrophobic, icephobic, and slippery coatings. He has published more than 150 journal articles and 100 conference papers. Professor Dolatabadi served as President of the Canadian Society for Mechanical Engineering (CSME) from 2014-2016 and as President of the Engineering Institute of Canada (EIC) from 2020-2022. He is currently the Chair of NSERC-Discovery Grant Evaluation Committee for Mechanical Engineering. He has received multiple awards for his research and teaching.