Numerical Simulation Of Gradient Material Coating Using A Dual-Layer Slot Die System

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Abstract

Solid Oxide Electrolysis Cells (SOEC) have gained significant interest as high-performance energy conversion devices. However, one of the bottlenecks affecting the mass production of SOECs is their high demand for rare earth elements (REE). To solve this problem, the European project NOUVEAU was launched to develop alternative and innovative electrode coating methods, such as coatings with optimally tailored material gradients to reduce the amount of REE in production.
The dual-layer slot die coating method offers the potential for achieving composition gradient via the precise deposition of two distinct layers simultaneously. However, designing an efficient slot die system requires a thorough understanding of the fluid dynamics and the interaction between the two layers.
In this study, we present a numerical approach based on computational fluid dynamics (CFD) simulation of multiphase flow during coating process via a dual-layer slot system. Through iterative simulations and design modifications, the optimization of the dual-layer slot die system is performed to achieve the desired coating characteristics and performance for SOEC manufacturing. Factors such as slot dimensions, flow rates, material properties, and rheological behavior of the fluid are considered during the optimization process. The simulation results provide valuable insights into the impact of design parameters on the coating uniformity and material gradient formation. The optimized design and coating parameters will be implemented into the coating pilot lines of Coatema Coating Machinery GmbH to enable the industrial production of innovative SOECs with reduced REE content as part of the NOUVEAU project.