ABSTRACT:

Insights into Advances in Manufacturing of Solid Oxide and Protonic Ceramic Cells

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Solid oxide and protonic ceramic electrochemical cells are promising technologies for efficient conversion between electricity, hydrogen, fuels and chemicals. Their performance, durability and scalability depend strongly on materials selection, cell architecture and manufacturing processes. This presentation provides an overview of recent advances in the manufacturing of solid oxide fuel and electrolysis cells (SOFC/SOEC) and protonic ceramic fuel and electrolysis cells (PCFC/PCEC). Different cell architectures, including electrolyte-supported, anode-supported and metal-supported cells, will be discussed together with their materials, processing requirements and performance. Conventional manufacturing methods, particularly tape casting and screen printing, will be compared with emerging approaches such as 3D printing, inkjet printing and thin-film fabrication. The opportunities offered by advanced manufacturing for controlling layer thickness, porosity, microstructure and cell geometry, as well as challenges related to sintering, interfaces, reproducibility and scale-up, will be highlighted.
Recent developments in protonic ceramic cells will be presented as an example of advanced manufacturing. Our work combines extrusion-based 3D printing and inkjet printing to fabricate multilayer and single-layer ceramic fuel cells. Through optimization of materials, microstructure and processing, printed cells have achieved peak power densities approaching 1 W cm^{-2} at 550 °C. Finally, progress toward scalable solid oxide electrolysis will be discussed in the context of the Europe Horizon – Clean Hydrogen Partnership ThunderStack project, which integrates advanced materials, cell manufacturing, stack development and durability studies.
[1] B. Bilbey, S. Pandey, J. Zamudio-Garcia, A. Savikko, M. Khoshkalam, V. Esposito and M.I. Asghar, WIREs Energy Environ, 14: e70010 (2025).