Green Ammonia for Solid Oxide Fuel Cells

Abstract: Ammonia is emerging as a promising carbon-free energy carrier and fuel, particularly for applications where hydrogen storage and transportation remain challenging. With a higher volumetric energy density than liquid hydrogen and an established global production, storage, and transportation infrastructure, green ammonia offers an attractive pathway for large-scale renewable energy storage and utilization. However, the cost and energy requirements of the ammonia supply chain, including synthesis, storage, transportation, and distribution, remain important considerations for its adoption as an energy fuel. This talk will discuss the potential of green ammonia for solid oxide fuel cell (SOFC) applications, with particular emphasis on the differences between indirect and direct ammonia SOFC systems. In indirect ammonia SOFCs, ammonia is first cracked using heat recovered from the SOFC to produce a hydrogen–nitrogen fuel mixture. While this approach benefits from thermal integration, the additional cracker and heat exchanger increase system size and complexity. Direct ammonia SOFCs, in contrast, feed ammonia directly to the fuel electrode, offering a more compact system but introducing significant challenges in anode activity, nitridation, and nitrogen oxide formation. The talk will present recent experimental results on direct ammonia SOFCs using FeCo-based anodes and high-entropy alloy (HEA) anodes, highlighting their electrochemical performance, ammonia conversion, and potential for improving direct ammonia utilization. Key technical challenges and opportunities for further development will also be discussed. The author will conclude by taking the opportunity to share a brief overview of his research journey and contributions to hydrogen and fuel cell technologies over the past 35 years.