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Keynote: High performance ceramic anode materials with structure decoration

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ABSTRACT

A solid oxide fuel cell (SOFC) is an energy conversion device that produces electricity by electrochemically combining a fuel and an oxidant across an ionic conducting oxide electrolyte. It is one of the cleanest and most efficient energy technologies due to its modular, scalable, and efficient features. Significant efforts have been devoted to developing high-performance electrode materials with the aim of increasing the power density of SOFC stacks. Ceramic anode materials have many advantages over the traditional Ni/YSZ (yttrium stabilized zirconia) in terms of reaction active site, structural stability, carbon deposition and sulfur poisoning. To enhance the electrochemical activity of ceramic anode, in situ exolution of highly catalytic nanoparticles and lattice tailoring strategies are employed in this work to realize excellent performance of anode materials.

A series of double perovskites $Sr_2FeMo_{0.65}M_{0.35}O_6$ (SFM*M*, *M* = Co, Ni) with outstanding performance are developed. Through *in situ* exsolution, several metallic nanoparticle catalysts decorated ceramics were prepared. The maximum power densities (MPD) of electrolyte supported single cells with SFMCo and SFMNi anodes reach 820, and 960 mW cm^{-2} in wet H_2 at 850 °C, respectively. The SFMNi anode also shows good coking resistance in wet CH_4. A novel double perovskite $Sr_2FeMo_{2/3}Mg_{1/3}O_{6-\delta}$ with anti-site defects was designed and prepared. The formation of anti-site defect promotes the generation of oxygen vacancy and facilitates the oxygen ion migration in the lattice, leading to an enhanced electrode reaction kinetics. In an electrolyte (300 μm) supported single cell, the $Sr_2FeMo_{2/3}Mg_{1/3}O_{6-\delta}$ anode demonstrates excellent cell performance with MPD of 1038 and 1316 mW cm^{-2} at 850 and 900 °C, respectively. The designed double perovskites are attractive anode materials for SOFCs.

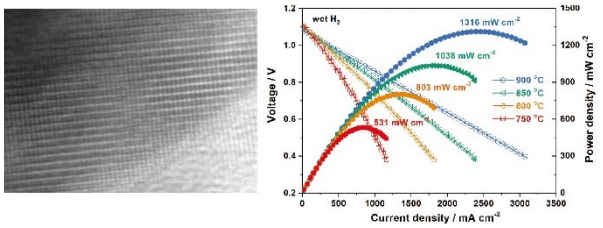

Figure 1. Anti-site defect and single cell performance of $Sr_2FeMo_{2/3}Mg_{1/3}O_{6-\delta}$ anode material.