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New Catalysts and Electrode Structures for Polymer Electrolyte Fuel Cells

Polymer electrolyte fuel cell performance is limited mainly by the cathode, where poor oxygen reduction reaction (ORR) kinetics and slow transport of O₂ to active sites lead to large overpotentials. State-of-the-art high surface area Pt alloy catalysts also suffer from poor durability due to loss of surface area (particle growth) and leaching of base metals. We have recently demonstrated that the use of intermetallic nanoparticle catalysts such as L10-PtCo can enable significant improvements in long-term performance due to improved stabilization of base metal in the ordered lattice. New catalysts based on the L10 structure have shown excellent durability in fuel cell membrane electrode assemblies (MEAs), meeting DOE targets for accelerated stress tests (30K voltage cycles in MEA) with minimal performance degradation. Recent results and future directions for this catalyst research will be discussed. While kinetic performance and durability of these catalysts is promising, performance at high power densities continues to be limited by slow O₂ transport. Several factors, including slow diffusion through ionomer films, Knudsen diffusion through micropores, and pore blockage by liquid H₂O contribute to these transport limitations. Design of unconventional electrode structures that can minimize these limitations is needed to enable full utilization of cathode catalysts. New hierarchical electrode structures capable of reducing these transport losses will be presented.

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