Chromium Poisoning of SOC Oxygen Electrode and Its Mitigation Strategies

Xingbo Liu
West Virginia University
Morgantown, WV 26506

Chromium (Cr) poisoning is a major degradation mechanism in solid oxide electrochemical cells (SOCs). This work summarizes strategies to mitigate Cr-related performance loss. A sodium carbonate-coated alumina tube method was developed to accurately quantify Cr evaporation from metallic components under SOC conditions, minimizing interferences and enabling better correlation with degradation rates.

For Cr-tolerant oxygen electrodes, high-entropy perovskites (HEPs) incorporating multiple rare-earth, alkaline-earth, and transition metals showed high conductivity (~100 S/cm) and excellent stability. Notably, LSCF exhibited only 0.25%/kh degradation over 41 days in a Cr-containing environment, with no measurable Sr segregation.

Protective coatings for metallic interconnects were developed via electroplating and electrophoretic deposition (EPD). Mn/Co electroplated layers reduced scale growth and thermal mismatch, improving long-term stability. Optimized $(Mn,Co)_3O_4$ spinel coatings via EPD resisted Cr penetration after prolonged exposure.

Alumina-forming austenitic (AFA) steels for balance-of-plant components reduced Cr evaporation by up to 35× compared to chromia-forming alloys and minimized SOC voltage degradation in extended tests.

These integrated approaches—precise Cr quantification, advanced cathode materials, protective coatings, and optimized alloys—offer a pathway toward durable, high-performance SOC operation in both fuel cell and electrolysis modes.