

Energy storage in thin film solid oxide fuel cell anodes

The power output of a solid oxide fuel cell quickly decreases to zero when the fuel supply is interrupted. Materials that could store energy during the fuel cell operation and reconstitute this energy when the fuel supply is interrupted would enable using solid oxide fuel cells in unique autonomous systems. This could also be assisted by the ongoing research trend to reduce the operating temperature of solid oxide fuel cells without significant loss of power density.

We synthesized vanadium oxide thin film anodes by RF magnetron sputtering on thin film solid oxide fuel cells. The electrolyte was nanostructured yttria stabilized zirconia (YSZ) deposited by RF magnetron sputtering and the cathode was porous platinum deposited by DC sputtering at high Ar pressure. It is well known that the oxidation state of vanadium oxide can vary depending on the ambient conditions, thus providing the ability to store energy electrochemically. Furthermore, hydrogen insertion has been reported in the various vanadium oxides, providing an additional pathway for energy storage.

Compared to reference porous platinum anode thin film solid oxide fuel cells (Pt/YSZ/Pt SOFCs), the vanadium oxide anode SOFCs (VOx/YSZ/Pt) provide energy much longer once the fuel supply is interrupted. The time during which the Pt/YSZ/Pt fuel cells delivered energy was always about 15 seconds once the fuel supply was interrupted. Our vanadium oxide anode SOFCs delivered energy up to 210 seconds after the fuel supply was interrupted, depending on the current density and the vanadium oxide thickness.

Regarding their performance during regular fuel cell operation, the VOx/YSZ/Pt SOFCs had lower open circuit potentials and maximum power densities compared to the reference Pt/YSZ/Pt SOFCs. This is thought to be due to the poorer catalytic properties of vanadium oxide for hydrogen oxidation compared to platinum.

To conclude, we have developed vanadium oxide anodes for thin film solid oxide fuel cells with performance slightly lower compared to porous platinum anode thin film solid oxide fuel cells operated at identical temperatures. These new type of anodes are capable of storing energy for when the fuel supply is interrupted.