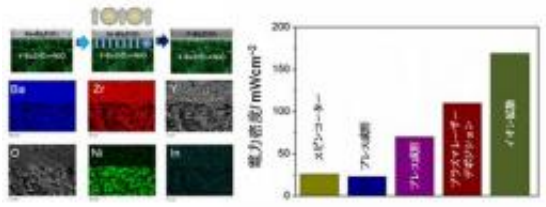
Success in developing groundbreaking electrolyte materials

November 24 2010



Upper left: Schematic diagram of the procedure for preparing an anode supported BZY electrolyte film. Lower left: Elemental mapping, confirming the In3+ ions evaporation and Y3+ ions migration from the anode to the electrolyte layer, to occupy the In3+ sites. Right: Fuel cell performance of electrode-supported cells using BZY electrolytes prepared by different methods and measured at 600oC in the literature reports (spin-coating cell was tested at 800oC) as well as in the present study, indicating that the BZY cell in the present study shows the largest power density

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SOFCs are environmental-friendly and efficient energy production devices. Reducing the operating temperature of SOFCs below 700°C is needed for a wide practical application of these devices. Yttrium-doped barium zirconate (BZY) is now considered as an alternative to the

oxygen-ion conductor electrolytes conventionally used in SOFCs due to its higher bulk proton conductivity at low temperatures. BZY has not been exploited until now despite its excellent chemical stability because, when prepared as a ceramic polycrystalline material, it suffers from difficult sintering and proton conductivity is decreased by grain boundaries, which have a blocking effect.

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One is yttrium-doped barium zirconate with 10 mol% of praseodymium (BZPY). The addition of Pr improves the sinterability of BZY and dense samples are obtained after sintering at 1500°C for 8 hours. This material showed very high proton conductivity (above 0.01S/cm at 600˚C), comparable to the proton conductivity of BCZY, now proposed for proton conductor electrolyte, but with significantly better chemical stability, thereby resulting in realistic applicability in fuel cell devices.

The other material is indium-doped barium zirconate (BZI) on a NiO-BZY anode substrate. During sintering at 1450^{o}C, a dense electrolyte film is formed and simultaneously indium evaporates, being substituted by yttrium. The final result is the achievement of a dense BZY electrolyte film on a NiO-BZY anode, which cannot be obtained at the same temperature with direct processing. The fuel cells using this electrolyte film showed the largest fuel cell performance, 0.169 W/cm^2 at 600^{o}C, ever reported for BZY-based electrolytes. The BZY film made by this method shows excellent chemical stability, indicating its potential for long-term operation.

These two materials are promising electrolyte materials for SOFC operating in the intermediate temperature range, 500 to 650°C, which allows reducing SOFC fabrication and operation costs, and thus

accelerating their commercialization. The previous work of the group, published in Nature Materials on September 20th, introduced high-performance materials that show very high proton conductivity at even lower temperatures, but it was fabricated by using a special technology called pulsed laser deposition. In these new studies, high-performance electrolyte materials were obtained by simple co-pressing and subsequent sintering in the air, which is suitable for mass-production. This indicates the aforementioned results could accelerate the commercialization of SOFCs.

Provided by National Institute for Materials Science