# Intermediate temperature solid oxide fuel cells directly utilizing alcohols as the fuel

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Solid oxide fuel cell (SOFC) is an efficient device which can convert the chemical energy of fuel into electricity directly. As a widely used fuel for SOFC, hydrogen with its low mass energy density faces problems on storage and transportation which limits its industrial utilization. Non-hydrogen fuels are able to avoid these problems, and have a higher overall efficiency. Thus they have drawn a lot of attention. Commonly used nickel cermet anode has a high activity to hydrocarbon fuels, but it suffers serious carbon deposition which leads to anode inactivation and performance degradation.

In this work, a chemically stable perovskite material $Sr_2Fe_{1.5}Mo_{0.5}O_{6-\delta}$ (SFM) has been examined as the anode material of SOFC for direct electrochemical activation of alcohols. A single cell was also constructed and tested.

SFM powder was synthesized via a combined citrate-EDTA complexing method. For characterizing the structure and phase stability of SFM, several samples were also prepared. Its precursors were calcined at different temperature in air, and its powder was treated in reducing atmosphere.

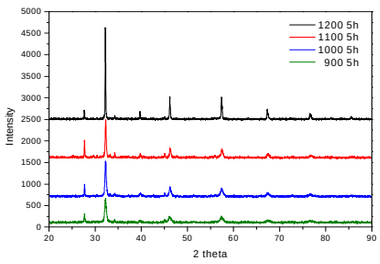


Fig.1. Effects of calcination temperature for SFM on phase formation

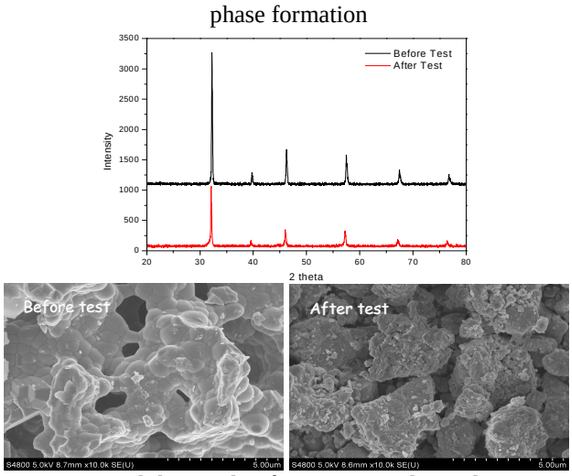


Fig.2. Stability study of SFM material in reducing atmosphere: XRD (up) and SEM (down) of powders calcined in $H_2$ at 800°C for 10h

After calcining SFM precursors at 1200°C, a pure perovskite phase of SFM can be formed. Also the material can be stable in both oxidizing and reducing atmosphere.

Using SFM as anode material, $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ (BSCF) perovskite prepared by EDTA-citric acid complexing method as cathode material and $La_{0.8}Sr_{0.2}Ga_{0.83}Mg_{0.17}O_{3-\delta}$ (LSGM) perovskite prepared by solid-reaction method as electrolyte material, a single cell with a configuration of SFM|LSGM|BSCF is fabricated by screen-printing electrodes on an electrolyte supporter. The single cell was tested using hydrogen, methanol and ethanol as fuels, respectively.

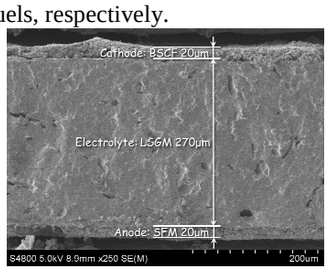


Fig.3. SEM of single cell: single cell

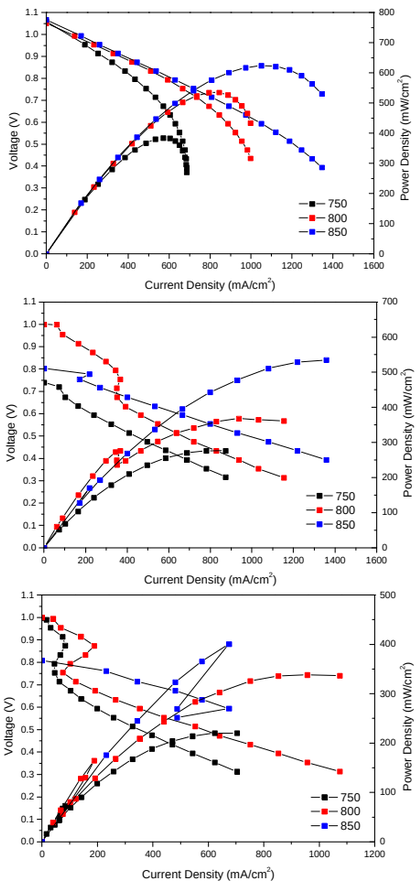


Fig.4. Discharging performances: $H_2$ (up), $CH_3OH$ (middle), $C_2H_5OH$ (down) as fuel

Using hydrogen as the fuel, the cell exhibited maximum power densities ($P_{max}$) of 624, 535 and 385 mW $cm^{-2}$ at 850°C, 800°C and 750°C, respectively.

For methanol and ethanol as the fuel, the $P_{max}$ of the single cell reached 535, 368, 277mW $cm^{-2}$ and 400, 338, 220mW $cm^{-2}$ at 850°C, 800°C and 750°C, respectively.

The structure of single cell should be optimized in order to further improve its performance, and the mechanism that how SFM actives alcohols also needs further study.

References

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