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Mixed Proton and Electron Conductors as SOFC Anodes

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INTRODUCTION

Solid Oxide Fuel Cell

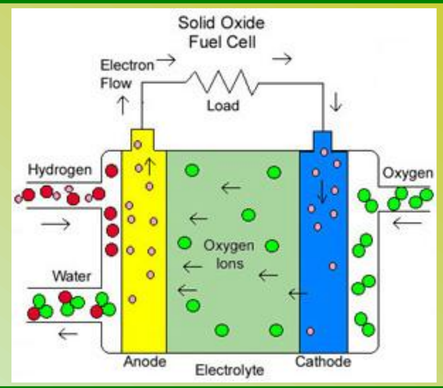
- **High efficiency of conversion from chemical energy into electrical energy plus heat.**
- **Only by-products include water and heat, which can be used to heat up our homes!**
- **SOFC will continue to produce electricity as long as the fuel is present.**
- **High flexibility in terms of fuel due to its high operational temperature.**

Challenges

- **The current Ni-YSZ anode is very unstable in Carbon and Sulphur containing atmospheres.**
- **Y_2O_3-doped $BaCeO_3$ (BCY) anode has poor chemical stability in CO_2 containing atmospheres and in high levels of humidity.**

Objectives

- **Synthesize an SOFC anode with high chemical stability in Carbon and Sulphur containing atmospheres with high conductivity.**



RESULTS AND DISCUSSION

Structural Analysis

- **Phase**
- **Stability**

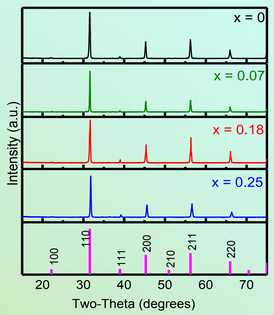


Fig. 1

Figure 1 shows the PXRD patterns of $SrZn_{0.33+x}Nb_{0.67-x}O_{3-\delta}$, which could be indexed on a simple cubic (~ 4 Å) perovskite structure.

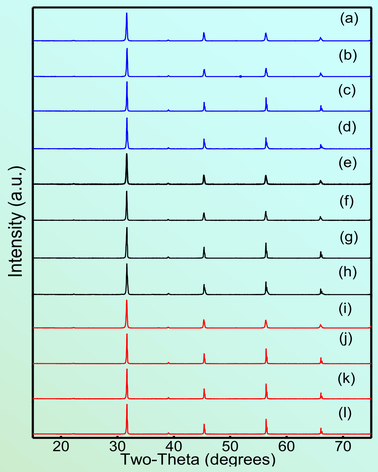


Fig. 2

In Figure 2, (a)-(d) corresponds to the PXRD of x = 0, 0.02, 0.06 and 0.08 treated with CO_2 at 700°C for 24 h, (e)-(h) show the corresponding samples treated with H_2O at 100°C for 24 h and (i)-(l) correspond to 30 ppm H_2S treated samples at 800°C for 24 h. Excellent stability was found in all mediums.

Microstructure Analysis

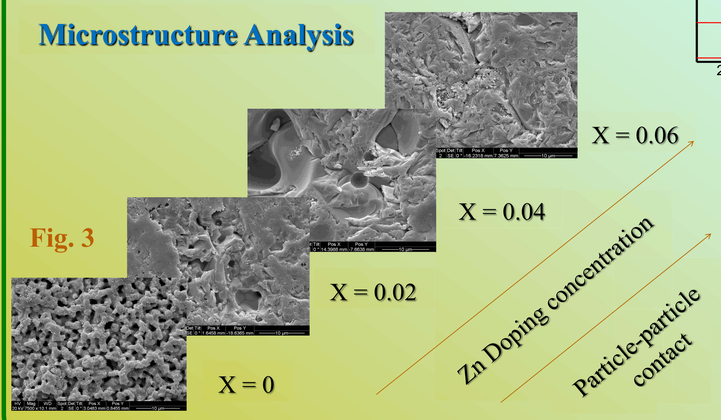


Fig. 3

Fig. 3 shows the SEM images of as-prepared $SrZn_{0.33+x}Nb_{0.67-x}O_{3-\delta}$ for x = 0, 0.02, 0.04 and 0.06.

Electrical Characterization

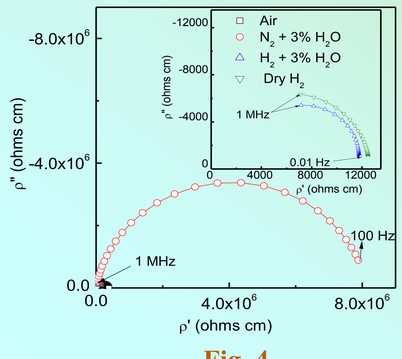


Fig. 4

Typical AC impedance plots for $SrZn_{0.33}Nb_{0.67}O_3$ at 500°C shows lowest resistivity in wet H_2.

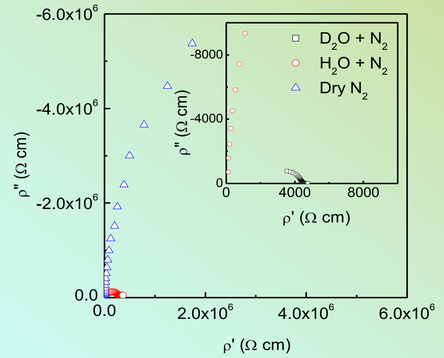


Fig. 5

Presence of electron conductivity in $SrZn_{0.33}Nb_{0.67}O_3$ confirmed by D_2O analysis showing lowest resistivity in D_2O + N_2.

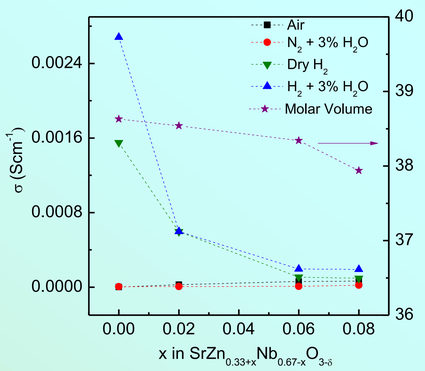


Fig. 6

The conductivity decreased with increasing x value in $SrZn_{0.33+x}Nb_{0.67-x}O_{3-\delta}$ in H_2 medium. An opposite trend was observed in air and wet N_2 mediums.

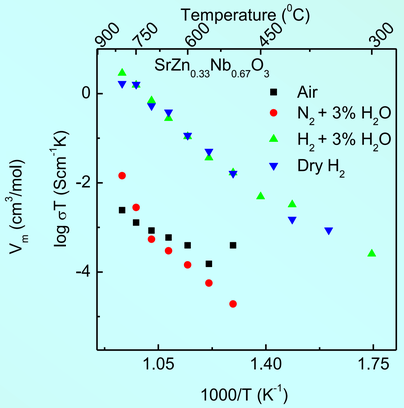


Fig. 7

The conductivity in H_2 mediums was higher than air and N_2.

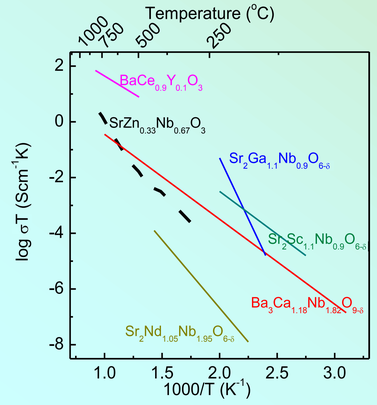


Fig. 8

$SrZn_{0.33}Nb_{0.67}O_3$ was only about 1.5 orders of magnitude lower than the well known $BaCe_{0.9}Y_{0.1}O_3$ in conductivity.

CONCLUSIONS

- **Excellent structural stability in $SrZn_{0.33+x}Nb_{0.67-x}O_{3-\sigma}$ (x = 0, 0.02, 0.06 and 0.08) in CO_2, H_2O and H_2S mediums for a long period of time.**
- **Negligible grain boundary contribution to total resistance.**
- **Higher conductivity in H_2 medium compared to air and wet N_2.**
- **D_2O + N_2 medium displayed higher conductivity compared to dry N_2.**

ACKNOWLEDGEMENTS

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