Electrical Performance of SOFC with Anode of YSZ Coating NiO

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Abstract: NiO-YSZ anode of SOFC is prepared by coating precipitation. The buffer solution of $NH_3 \cdot H_2O$-NH_4HCO_3 was used in the hydrochloric acid solution of Y_2O_3 added with $ZrOCl_2 \cdot 8H_2O$ and NiO for co-precipitation. XRD and TEM analysis were made to check the phase and particle size of the sample. YSZ electrolyte support planar SOFC were made of YSZ coating NiO and merchandised NiO/YSZ anode respectively and LSM cathode. The cell with the anode of YSZ coating NiO has better performance than that cell with the anode made from merchandised NiO/YSZ powder. Netlike structure was observed at the anode of YSZ coating NiO by SEM. The reason for the change was the increasing of three—phase boundary (TPB) and porosity.

Key words: solid oxide fuel cell; anode; coat; electrical performance
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Ni-YSZ cermets are most widely applied for the SOFC anode. The performance of the SOFC can be improved by the increasing of TPB of anode. The size of NiO/YSZ powder, the proportion of NiO and YSZ, the preparation technique of anode, the structure of anode all have effect on the TPB[1]. There is a new preparation method of Ni-YSZ material by YSZ coating NiO[2—3]. The YSZ coated on NiO provides the precondition for the improvement of the TPB. In this article, electrical performance of SOFC with anode of YSZ coating NiO was studied.

1 Experiment

Put NiO powder with suitable proportion (NiO: YSZ=3:2) into the mixed hydrochloric acid solution in which Y_2O_3 and $ZrOCl_2 \cdot 8H_2O$ had been dissolved by vigorous stirring. The solution of $NH_3 \cdot H_2O$-NH_4HCO_3 was dripped into the mixed solution, and filtered the precipitate powder[4]. The precipitate was washed with water and ethanol, distilled in n-butyl alcohol, then dried and calcined.

The electrolyte is a merchandised YSZ disk substrate (8% Y_2O_3-ZrO_2 8-YSZ, Tosoh Co. Ltd). The anode and cathode were all prepared by slurry coating. Multimeter was used to measure the open circuit voltage. The current across the cells was controlled by a galvanometer.

The microstructure characterization apparatus was Japan XD-3A XRD, JEM-1200EX TEM and China KYKY—2800B SEM.

2 Results and discussion

Fig. 1 shows the XRD pattern of YSZ coating NiO powders prepared. The XRD pattern indicates that the crystal phase of YSZ and NiO had been formed entirely.

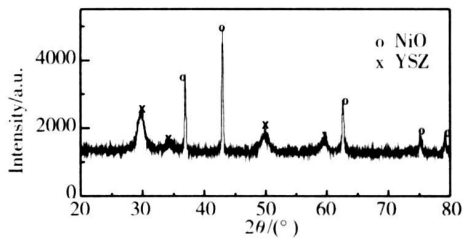

Fig. 1 The XRD patterns of NiO/YSZ powders

Fig. 2 is the TEM photograph of YSZ coating NiO prepared. The size of YSZ coating NiO is less than 20 nm compared with the size of powder prepared by Wang[3]. The black particles of NiO (about 15 nm) were homogeneous coated by off-white YSZ[5].

Fig. 3 shows the electrical performance of two electrolyte support SOFCs operated at 1000℃. The maximal power density and the limited current density of the cell with YSZ coating NiO anode are 0.185 $W \cdot cm^{-2}$ and 0.74 $A \cdot cm^{-2}$, which are 1.59 and 1.45 times of these the cell with merchandised NiO/YSZ anode re-

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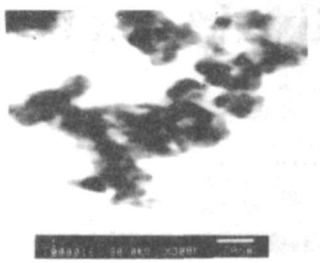


Fig. 2　TEM micrograph of YSZ coating NiO

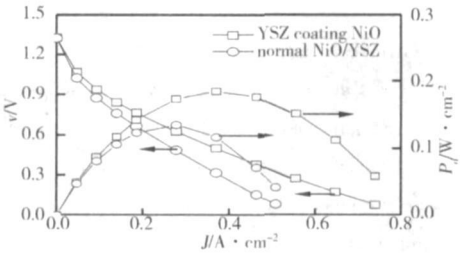
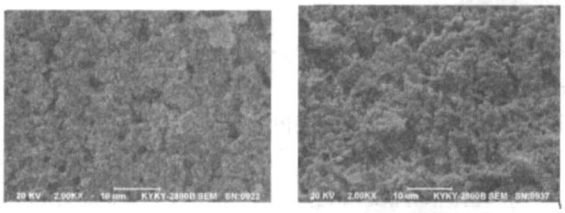


Fig. 3　The current – voltage and current – power curve



(a) YSZ + NiO　　(b) YSZ coating NiO

Fig. 4　SEM micrograph of different anode

Fig. 4 presents the SEM photograph of the anode structure of the cells. After reduced by H_2, the anode of YSZ coating NiO has netlike structure. The surface of the particles was smooth and agglomeration had been formed between some particles, and the pores are much more than merchandised NiO/YSZ.

3　Conclusion

(1) Co-precipitation was used to change the manner of YSZ and NiO mixing. The anode after sintering had netlike structure with more pores, more porosity, which can improve the electrical performance of the cell by increase the TPB and decrease polarizations.

(2) The homogeneous particles of YSZ coating NiO were obtained by controlling the pH of the buffer solution with $NH_3 \cdot H_2O$-NH_4HCO_3 instead of $NH_3 \cdot H_2O$ in the precipitation reactions. To prevent the hard agglomeration of nano particles in the process of calcine, n-butyl alcohol was used as azeotrope to dehydrate the precipitate of YSZ coating NiO.

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YSZ包覆 NiO阳极的 SOFC发电性能

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摘　要: 采用 $NH_3 \cdot H_2O$-NH_4HCO_3为缓冲溶液, 共沉淀法制备 YSZ包覆 NiO的 NiO—YSZ阳极材料, 分析了材料的物相和粒径大小。分别以 YSZ包覆的 NiO 商用 NiO/YSZ为阳极, LSM为阴极, 制作 YSZ电解质支撑的板状固体氧化物燃料电池, 进行发电性能比较。以 YSZ包覆的 NiO为阳极的电池, 功率密度高、极限电流密度大。扫描电镜观察表明, YSZ包覆的 NiO制作的阳极表面形成了的网状结构。阳极三相界面、孔隙率提高, 是电池性能提高的原因。

关键词: 固体氧化物燃料电池; 阳极; 包覆; 发电性能

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