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Characterization of perovskite-type anode materials, $Sr_2Fe(Mo_xW_{1-x})O_{6-\delta}$ for SOFCs

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ABSTRACT

An Ni/YSZ cermet has been used as an anode for SOFCs. But the sample was not considered it was perfect. In this study, we focused on the perovskite-type oxide, $Sr_2Fe(Mo_xW_{1-x})O_{6-\delta}$ (SFMWO). The samples were synthesized by the solid-state reaction and characterized by XRD, electrical conductivity measurements and the power generation. As a result, the perovskite-type oxide, SFMWO is obtained to expect as an novel anode for SOFC superior to Ni/YSZ cermet.

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INTRODUCTION

An Ni/YSZ(yttria stabilized zirconia) cermet has been used as an anode for Solid Oxide Fuel Cells (SOFCs). In spite of the highly efficient characteristics, the limited reaction field only in the three-phase boundary (Ni/YSZ/H2) zone and large discrepancy in thermal expansion coefficient between Ni and YSZ sometimes bring the limitation of the performance.

In last decade, perovskite-type oxides have been watched as the alternative anode candidate because, in addition to the high catalytic activity from the included transition metal elements, some have high oxide ion (O2-) conductivity which enables the oxidation reaction(H2+O2- →H2O+2e-) to proceed even in the biphasic interface between H2 gas and perovskite oxide surfaces.

In this study, we focused on the perovskite-type oxide, Sr2Fe(MoxW1-x)O6-δ (SFMWO) which is stable under the reduced atmosphere of hydrogen gas and also a good electrical conductor.

Experiment:

The samples were synthesized by the solid-state reaction. A mixutre of SrCO3, Fe2O3, MoO3 and WO3 was pressed into pellets and calcined at temperatures in the range of 800 to 1000℃for 10 to 12 h in a flow of H2 (2%) / Ar(98%) mixed gas. ALL of products after calcination were pulverized, pressed into pellets, and heated at 1200℃for 12 or 24 h in a flow of H2 (2%) / Ar(98%) mixed gas.

The crystalline phase study was conducted by X-ray diffraction (XRD) analysis using Cu Kα radiation at room temperature.

After XRD analysis, electrical conductivity measurements was done. The measurements of electrochemical characteristic and the power generation were carried out using electrolyte supporting single cells.

RESULTS AND DISCUSSION

XRD analysis:

For all the range of $0 \leq x \leq 1$, all of the samples were single phase of $Sr_2Fe(Mo_xW_{1-x})O_{6-\delta}$(Fig,1), and the peak position shifted to lower angle with "x" because of lattice size is changed (Table,1).

Reason for peak position shift is considered that Mo and W ion radius are Mo^{6+} = 62 Å, Mo^{4+} = 66 Å,W^{6+} = 66 Å.

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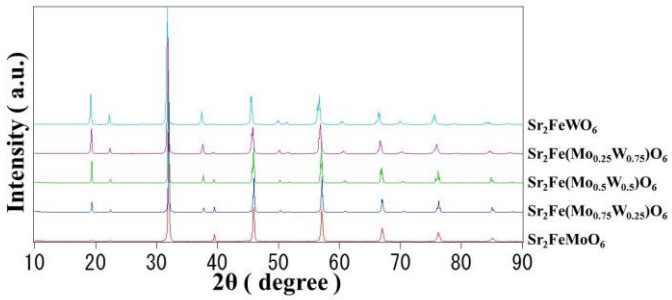

Fig.1: XRD patterns of SFMWO.peak shift was showed.

Table 1: lattice size of SFMWO

composition	Lattice size
$Sr_2FeWO_{6-\delta}$	7.939
$Sr_2Fe(Mo_{0.25}W_{0.75})O_{6-\delta}$	7.923
$Sr_2Fe(Mo_{0.5}W_{0.5})O_{6-\delta}$	7.910
$Sr_2Fe(Mo_{0.75}W_{0.25})O_{6-\delta}$	7.892
$Sr_2FeMoO_{6-\delta}$	7.886

Electrical Conductivity:

Temperature is raised sending fixed current (10mA). The electrical conductivity measurements in the atmosphere of Ar+H_2 (2%) indicated that these materials show metallic temperature dependence and higher electrical conductivity than that of Ni/YSZ (50vol%) cermet (Fig. 2).

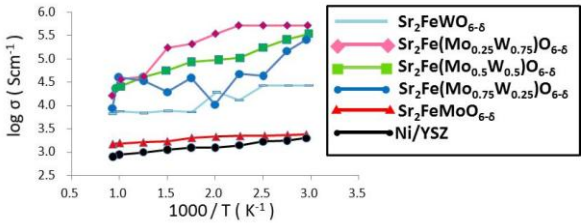

Fig. 2: Electrical conductivity for all samples showed good performance.

The Power Generation Indicator:

Sinple cells was made to investigate the power generation indicate. The simple cells constructed with LSCF / YSZ / $Sr_2Fe(Mo_xW_{1-x})O_{6-\delta}$. Investigation was done at 700 to 900°C in a flow of H_2. $Sr_2FeMoO_{6-\delta}$ showed higher power density than $Sr_2FeWO_{6-\delta}$ at high temperature (Fig,3).

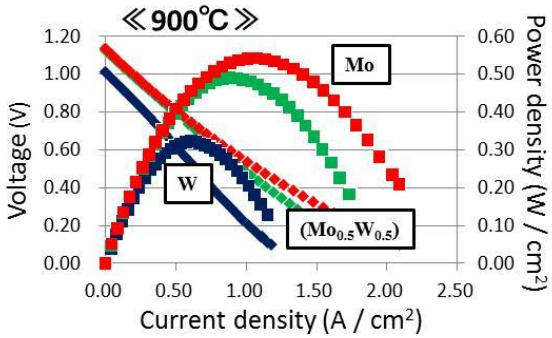

Fig. 3: Power generation at high temperature $Sr_2FeMoO_{6-\delta}$ showed higher power density

$Sr_2FeWO_{6-\delta}$ showed higher power density than $Sr_2FeMoO_{6-\delta}$ at low temperature (Fig,4).

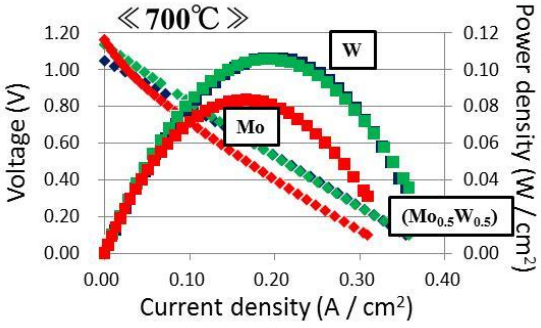

Fig. 4: Power generation at high temperture.$Sr_2FeWO_{6-\delta}$ showed higher power density

Good performance is expected and, in fact, the simple cell constructed with LSCF / YSZ / $Sr_2FeMoO_{6-\delta}$, showed maximum power density of 0.41 W/cm^2 in wet H_2 at 800ºC and 0.16 W/cm^2 in wet H_2 at 700 ºC. The corresponding performance of the Ni/YSZ (50vol%) cermet anode prepared in our laboratory was 0.37 W/cm^2 and 0.13 W/cm^2, respectively.

The perovskite-type oxide, SFMWO is expected as an novel anode for SOFC superior to Ni/YSZ cermet (Fig,5).

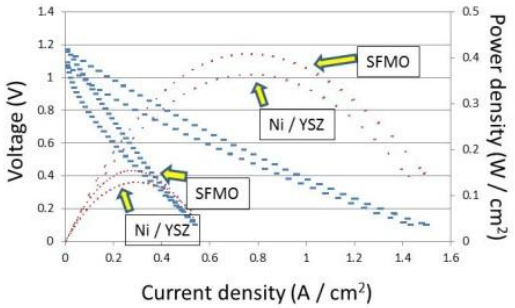

Fig. 5: Current-voltage and power density curvesat 700°Cand 800°Cby comparison SFMO and Ni/YSZ

Conclusion:

In conclusion, we have investigated the characterization of $Sr_2Fe(Mo_xW_{1-x})O_{6-\delta}$ (SFMWO) as an anode for SOFCs.

All of the samples synthesized by the solid-state reaction process and the measurements of electrochemical characteristic and the power generation were carried out using electrolyte supporting single cells.

According to XRD analysis, a lattice size is becomes larger as W is increased.

Measurements of electrochemical characteristic in the atmosphere of Ar+H_2 (2%) shows higher electrical conductivity than that of Ni/YSZ (50vol%) cermet.

The power generation indicate, $Sr_2FeMoO_{6-\delta}$ showed higher power density than $Sr_2FeWO_{6-\delta}$ at high temperature and $Sr_2FeWO_{6-\delta}$ showed higher power density than $Sr_2FeMoO_{6-\delta}$ at low temperature.

All of temperatures in the range of 700 to 800℃, $Sr_2FeMoO_{6-\delta}$ showed higher power density than Ni/YSZ. So $Sr_2Fe(Mo_xW_{1-x})O_{6-\delta}$ is expected on novel anode for SOFCs

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