Electrical Property of Mixed Conductor $BaIn_{1-x}Co_xO_{3-\delta}$

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<INTRODUCTION> $Ba_2In_2O_5$ has a characteristic structural transition at approximately 930℃ [1]. It shows high oxide ionic conductivity only above the transition temperature. Various attempts to stabilize the high temperature phase have been made to date [2], and it has been clarified that doping with Ga, Gd or La retains high electric conductivity even at low temperatures [3-5]. In this study, we attempted to synthesize mixed ionic-electronic conductors by means of partial substitution for In in Ba2In2O5. Doping $Ba_2In_2O_5$ with Co may be effective for the production of a mixed ionic-electronic conductor. In the present study, $BaIn_{1-x}Co_xO_{3-\delta}$ is synthesized and its electrical property is investigated [6].

<EXPERIMENTS> $BaCO_3$, In_2O_3 and $2CoCO_3 \cdot 3Co(OH)_2$ were mixed in various ratios, and heated at 1200 or 1300℃ in air. The products were ground and analyzed by X-ray diffraction (XRD). After the XRD, the product powder was shaped into a disk. This disk was pressed by a cold isostatic press in 392 MPa and sintered under the same condition as above. The sintered product was cut into a rectangular prism for the measurements of electric conductivities.

Total electrical conductivities were measured in the temperature range 600-1000℃ by the DC four-probe method. Oxygen transport numbers were estimated from EMF of concentration cells in the temperature range 600-1000℃.

<RESULTS AND DISCUSSION> $BaIn_{1-x}Co_xO_{3-\delta}$ (x = 0-0.8) was identified as a brownmillerite structure at x = 0 and 0.1, and a perovskite structure in the range $0.2 \leq x \geq 0.8$ by XRD.

Total electric conductivities (σ t) were shown in Fig.1. For x = 0 and 0.1, σ t changed steeply around 930℃ and 750℃, respectively. These samples probably underwent the structural transition. On the other hand, in the range $0.2 \leq x \geq 0.8$, the samples kept high values at low temperature without the steep change. These results indicate that the structural transformation seemed to disappear in this composition range.

Oxygen transport numbers (t_{O2-}) for x = 0.1 changed abruptly around 750℃. In contrast, for x = 0.2 and 0.3, t_{O2-} changed gradually with increasing temperature. The values of t_{O2-} suggest that these samples have mixed ionic-electronic conduction.

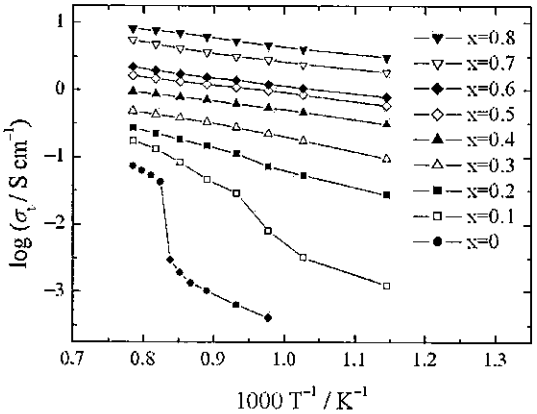

Fig.1 Arrhenius plots of total electrical conductivities for $BaIn_{1-x}Co_xO_{3-\delta}$

<CONCLUSION> $BaIn_{1-x}Co_xO_{3-\delta}$ was found to have a brownmillerite structure for x = 0 and 0.1 and a perovskite structure for x = 0.2 - 0.8. $BaIn_{1-x}Co_xO_{3-\delta}$ showed both high oxide ionic conductivity comparable to the original $Ba_2In_2O_5$ and electronic conductivity. It is concluded that a mixed ionic-electronic conductor with high oxide ionic conductivity can be produced by doping $Ba_2In_2O_5$ with Co.

REFERENCES

[1] J. B. Goodenough, J. E. Ruiz-Diaz, Y. S. Zhen, Solid State Ionics 44, pp.21 (1990).
[2] T. Kobayashi, H. Watanabe, M. Hibino, T. Yao, Solid State Ionics 176, pp.2439 (2005)
[3] T. Yao, Y.Uchimoto, M. Kinuhata, T. Inagaki, H. Yoshida, Solid State Ionics 132, pp.189 (2000).
[4] Y. Uchimoto, T. Yao, H. Takagi, T Inagaki, H. Yoshida, Electrochemistry 68, pp.531 (2000).
[5] K. Kakinuma, H. Yamamura, H. Haneda, T. Atake, Solid State Ionics 140, pp.301 (2001).
[6] T. Kobayashi, Y. Senoo, M. Hibino, T. Yao, Solid State Ionics, in print.