Phase Evolution and Electrical Conductivity of Strontium-doped $YMnO_3$

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SOFCs (solid oxide fuel cells) is a very efficient electrochemical device for electricity generation. Sr-doped $LaMnO_3$ is the state of art cathode material. However, La would react with yttria-stabilized zirconia (YSZ) electrolyte and formed $La_2Zr_2O_7$. $YMnO_3$ may be a potential cathode material since Y is already present in YSZ. But, $YMnO_3$ has a low electrical conductivity of $9.17*10^{-6}$ s/cm at 293 K. In order to enhance the conductivity of yttrium manganite, the substitution of alkaline-earth elements for Y ions is expected to create electron-hole defects, leading to the enhancement of the electrical conductivity. In this work, the phase evolution and conductivity in Sr-doped $YMnO_3$ was examined by XRD, SEM and conductivity measurement after sintering at 1400 ℃ for 6hr.

Fig. 1 shows the XRD patterns of the samples based on the formula of $Y_{1-x}Sr_xMnO_3$ where x is 10% increment in step. As seen in Fig. 1(a) and (k), all reflections for the sintered $YMnO_3$ and $SrMnO_3$ were indexed in hexagonal setting with the space group $P6_3cm$ and $P6_3/mmc$, respectively. Their lattice parameter measured was a_R=6.137 °A, a_H= 11.372 °A for $YMnO_3$ and a_R=5.446 °A, a_H=9.078 °A for $SrMnO_3$. When the amount of Sr addition was less than 50 at.%, a two phase region consisting of $YMnO_3$ and cubic perovskite was observed. After the Sr addition increased to 50～70%, a single phase perovskite structure was observed. Further addition of Sr resulted in the formation of deformed tetragonal perovskite. Fig. 2 shows the logarithm of the product of electrical conductivity and absolute temperature plotted as a function of the reciprocal temperature in the range from 300 to 900K. From this figure, it was observed that $Y_{0.3}Sr_{0.7}MnO_{3-\delta}$ in the system $Y_{1-x}Sr_xMnO_3$ has the highest conductivity of 91.87 S/cm at 900K. Thus, the electrical conductivity of $YMnO_3$ was significantly improved by the addition of Sr. Such an enhancement in conductivity may be expressed by the following defect reaction:

$$SrO+MnO+1/2O_2 \xrightarrow{YMnO_3} Sr_Y' + Mn_{Mn}^x + 3O_o^x + h^{\bullet}$$

The linear dependence of log(σT) vs 1/T for the composition studied can be attributed to the small polaron hopping by thermal activation.

Acknowledgement

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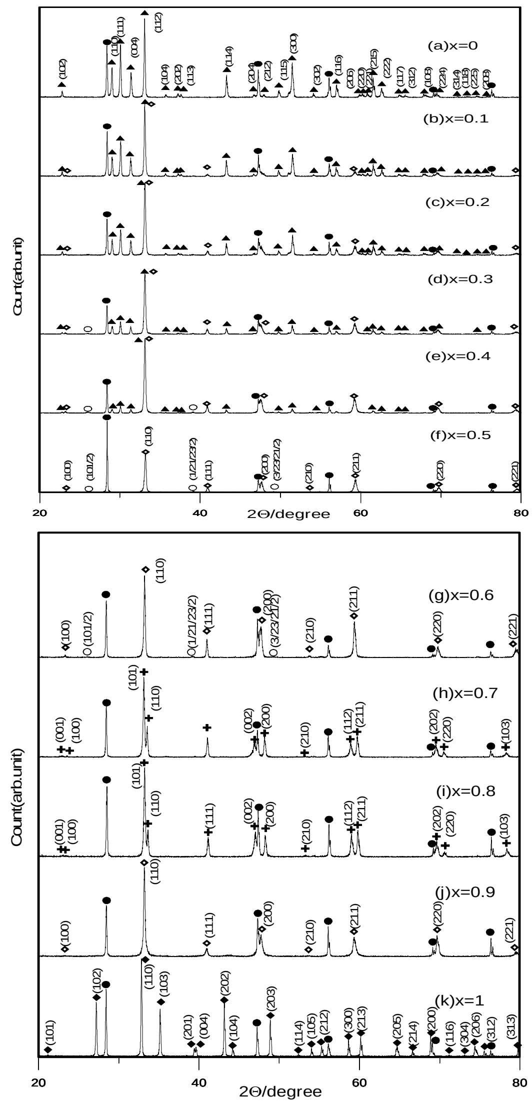

Fig. 1 XRD traces of $Y_{1-x}Sr_xMnO_3$ after sintered at 1400℃ for 6 hr where x was 10% increment in step.(Si powder ●, $YMnO_3$ ▲, cubic perovskite ◇, tetragonal perovskite ✚, $SrMnO_3$ ◆, superlattice ○).

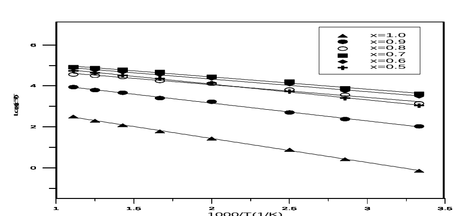

Fig. 2 Arrhenius plot of conductivity of Sr-doped $YMnO_3$ doped with the amount of Sr ranging from 50 to 100 at.%.