Materials Research Meeting 2019
December 10-14, 2019, Yokohama, Japan

Thermoelectric properties of (Pr, Nd, Sm)$_{1-x}$Sr$_x$FeO$_3$ (0.1≤ x ≤0.5) oxides

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Keywords: Fe-oxides, electric resistivity, Seebeck coefficient, thermal conductivity, figure of merit

Recently, oxide material has attracted much attention as a candidate for thermoelectric (TE) conversion material. Among oxides having a perovskite structure, in particular, Nb-doped $SrTiO_3$ [1], $Ca_{1-x}A_xMnO_3$ (A=Yb,Tb,Nd,Ho) [2], $La_{1-x}Sr_xFeO_3$ [3], $La_{1-x}Sr_xCoO_3$ [4] and so on are reported as oxides which show relatively large Seebeck coefficient *S*. These large *S* is the result of strong interaction of the spin state, orbital, charge, and crystal structure of the *3d* transition metal element. It is expected that the TE properties of *3d* transition metal oxide can be controlled by considering the spin state of *3d* electrons in the transition metal ions. We focused on the Fe-oxide with perovskite structure showing P-type and N-type TE characteristics. In this study, the polycrystalline sample of (Pr, Nd, Sm)$_{1-x}$Sr$_x$FeO$_3$ (0.1≤ x ≤0.5) was fabricated, and the correlation between the crystal structure, the magnetic properties and the TE characteristics was clarified by considering the spin state of Fe ions in the Fe-oxides. As shown in Fig.1, we exhibited the P-type TE properties and found that $Pr_{0.9}Sr_{0.1}FeO_3$ shows *ZT*=0.024 at *T*=850K which is the best of the P-type TE characteristics of $Pr_{1-x}Sr_xFeO_3$ (0.1≤ x ≤0.5) [5]. If we can realize the low spin or the intermediate spin states of Fe^{3+} by partially replacing Sr^{2+} having a smaller ionic radius than Pr^{3+} and releasing the chemical pressure applied to Fe ions by precisely controlling the Fe-O distance and the Fe-O-Fe angle, it is possible to realize both the P-type and the N-type TE characteristics. As shown in Fig.2, we exhibited both the P-type and the N-type TE properties and found that $Nd_{0.9}Sr_{0.1}FeO_3$ and $Nd_{0.5}Sr_{0.5}FeO_3$ show *ZT*=0.008 at *T*=850K and *ZT*=0.002 at *T*=850K which are the best P-type and the N-type TE characteristics of $Nd_{1-x}Sr_xFeO_3$ (0.1≤ x ≤0.5), respectively. Thus, it suggests that a PN element for high temperature TE materials can be possible to construct using only Fe-oxides having the perovskite structure.

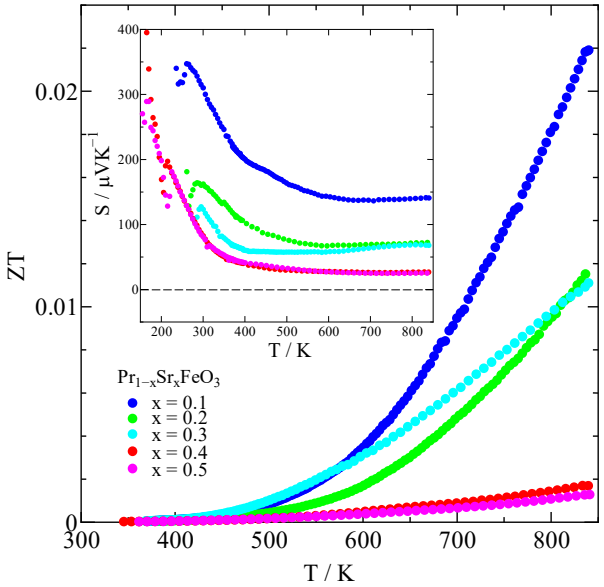

Fig. 1. Temperature dependence of *ZT* for $Pr_{1-x}Sr_xFeO_3$ (0.1≤ x ≤0.5), where the inset shows temperature dependence of *S*.

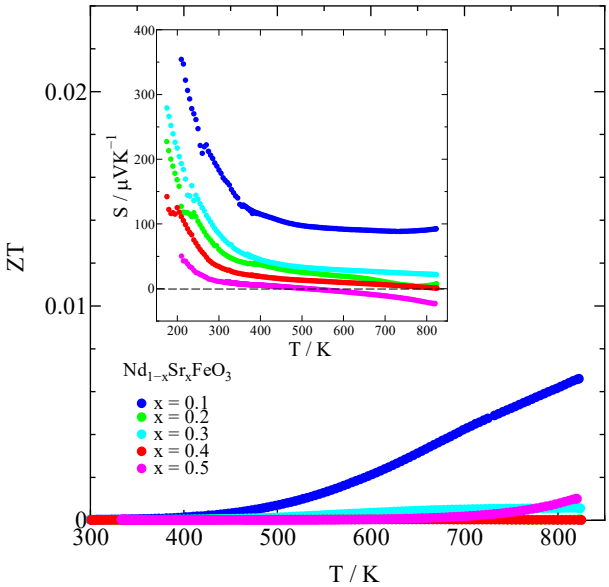

Fig. 2. Temperature dependence of *ZT* for $Nd_{1-x}Sr_xFeO_3$ (0.1≤ x ≤0.5), where the inset shows temperature dependence of *S*.

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