

# Dopant-dependence on charge/orbital ordering in layered manganite $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$

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Manganites are intensively studied because of their unique features such as colossal magnetoresistance and multiferroics. When impurity ions are substituted for the manganese ion in the compound, a new local electronic state often emerges. In this study we have investigated the impurity effect on a typical charge/orbital ordered system, a layered manganite, using resonant x-ray scattering (RXS) technique to reveal experimentally the new state emerged by substitution of impurity ions.

A layered manganite  $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$  shows orbital ordering below 220 K. We have studied how the ordering state is changed by the substitution of Cr, Fe and Ga ions for Mn ions using a RXS technique at absorption edge energy of Mn K-edge. Figure 1 shows temperature dependences of RXS intensities of  $(3/2\ 3/2\ 0)$  reflection, which reflect charge order, in  $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$  and  $\text{La}_{0.5}\text{Sr}_{1.5}\text{Mn}_{0.97}\text{T}_{0.03}\text{O}_4$  ( $\text{T}=\text{Cr, Fe, Ga}$ ) near Mn K-absorption edge energy. These intensities in the figure are normalized by the intensity of the fundamental Bragg reflection  $(110)$ . The RXS intensities of all doped compounds are smaller than that of pure compound, but degrees of decrease are different according to the dopants. Additionally, RXS intensities of Cr and Fe doped compounds drastically decrease in lower temperature than 90K and 70K, respectively. Figure 2 shows temperature dependence of RXS intensities of  $(5/4\ 5/4\ 0)$  reflection, which reflect orbital order, in all compounds near Mn K-absorption edge energy. These intensities in the figure are normalized by the maximum intensity of  $(5/4\ 5/4\ 0)$  reflection in each compound. In all compounds, the RXS intensities of  $(5/4\ 5/4\ 0)$  reflection have the same temperature dependence as that of  $(3/2\ 3/2\ 0)$  reflection. These results indicate that the charge/orbital ordering states are suppressed by the substitution of impurity ions, but the degrees of suppression of the orderings vary with impurity ions.

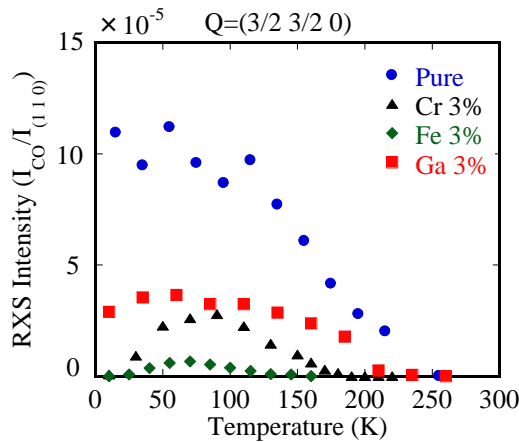


Figure 1. Temperature dependence of RXS intensities of  $(3/2\ 3/2\ 0)$  reflection in  $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$  and  $\text{La}_{0.5}\text{Sr}_{1.5}\text{Mn}_{0.97}\text{T}_{0.03}\text{O}_4$  ( $\text{T} = \text{Cr, Fe, Ga}$ ).

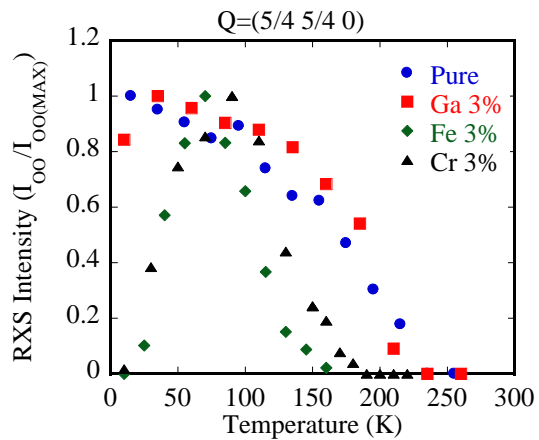


Figure 2. Temperature dependence of RXS intensities of  $(5/4\ 5/4\ 0)$  reflection in  $\text{La}_{0.5}\text{Sr}_{1.5}\text{MnO}_4$  and  $\text{La}_{0.5}\text{Sr}_{1.5}\text{Mn}_{0.97}\text{T}_{0.03}\text{O}_4$  ( $\text{T} = \text{Cr, Fe, Ga}$ ).