Doping variation of oxygen hole symmetry in layered perovskite nickelates

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High-T_c superconductivity appears close to the Mott transition induced by doping holes into antiferromagnetic parent insulators. Such filling-control insulator-metal transitions are widely observed for transition-metal oxides with strongly correlated electrons, yet the emergence of high-T_c superconductivity remains unique for the layered cuprates. Layered nickelate $R_{2-x}Sr_xNiO_4$ (R being rare earth element) with K_2NiF_4 type structure is a rare example of a two-dimensional antiferromagnetic insulator-metal transition system, providing a contrastive counterpart to superconducting $R_{2-x}Sr_xCuO_4$ with the same crystal structure. RSNO shows diagonal-stripe and checkerboard charge ordering at x~1/3 and 1/2, respectively, and then undergoes an insulator-metal transition at x~1.

We have succeeded in growing single crystals of $Nd_{2-x}Sr_xNiO_4$ up to the metallic region by using a high-pressure floating zone method and investigated the orbital characters of doped holes by systematically measuring polarization-dependent O K- and Ni L-edge absorption spectra. Figure shows the doping dependence of the O K-edge absorption spectra for E || c. Two peaks appear above x=0.6 and 1.0, respectively, suggesting that the checkerboard type charge ordering persists above x=1/2 with introducing the excess holes to $3z^2$-r^2 orbital states and that the insulator-metal transition occurs with its melting at x~1.

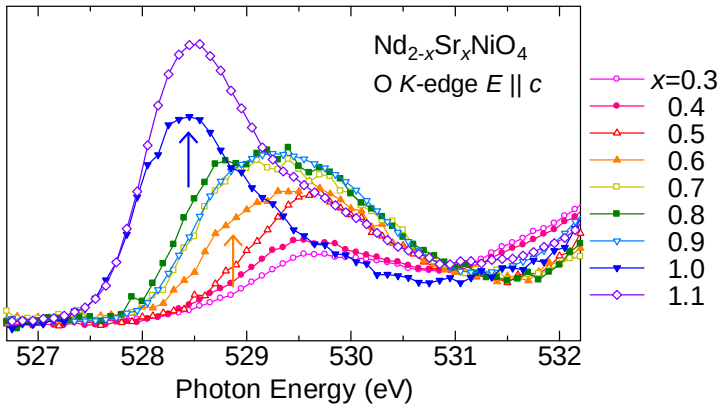

FIG. Doping variation of O K-edge absorption spectra for E || c in $Nd_{2-x}Sr_xNiO_4$.