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Doping-dependent electronic structure of $Nd_{1-x}Eu_xNiO_2$

Sangjae Lee[1], Dung Vu[1], Wenzheng Wei[1], Frederick J. Walker[1], Charles H. Ahn[1,2]

[1]Department of Applied Physics, Yale University, New Haven, CT 06520, USA
[2]Department of Physics, Yale University, New Haven, CT 06520, USA

The discovery of superconductivity in infinite-layer nickelates has opened a new frontier for exploring unconventional superconducting mechanisms in transition metal oxides [1]. Depending on the choice of primary rare-earth ions and its substituents for doping, the system exhibits distinct electronic ground states and superconducting mechanisms [2, 3]. In this study, we investigate the superconducting and electronic phase behavior of Eu-doped $Nd_{1-x}Eu_xNiO_2$ (NENO) thin films [4], which display markedly different properties from Sr-doped counterparts. The multivalent Eu valence states (coexisting Eu^{2+} and Eu^{3+} oxidation states) and large magnetic moment of Eu due to partially filled 4*f* orbitals are believed to play a crucial role in the unconventional superconductivity in NENO systems. To better understand the phase diagram of NENO which exhibits a superconducting dome between $x = 0.2$ and $x = 0.35$, we systematically study the electronic structure as a function of Eu concentration using x-ray absorption spectroscopy (XAS) and resonant inelastic x-ray scattering (RIXS). These measurements reveal a detailed evolution of Ni and Eu valence states, with varying orbital and spin configurations as well as interactions between Ni and rare-earth sites. Our findings provide new insights into the role of magnetic rare-earth dopants in tuning superconductivity and highlight the importance of their interactions with Ni sites on the electronic structure of infinite-layer nickelates. This work advances the broader effort to uncover the microscopic mechanisms behind high-temperature superconductivity in layered transition metal oxides.

References:

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