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Itinerant Ferromagnetism in Cr Doped Perovskite Ruthenates¹

V. DURAIRAJ, E. ELHAMI, S. CHIKARA, X.N. LIN, A. DOUGLASS, G. CAO, University of Kentucky, P. SCHLOTTMANN, E.S. CHOI, National High Magnetic Field Lab, R.P. GUERTIN, Tufts University — We report results of structural, magnetic and transport properties of single crystal $\text{CaRu}_{1-x}\text{Cr}_x\text{O}_3$ ($0 \leq x \leq 0.36$) and $\text{SrRu}_{1-x}\text{Cr}_x\text{O}_3$ ($0 \leq x \leq 0.20$). Cr substitution as low as $x=0.08$ drives $\text{CaRu}_{1-x}\text{Cr}_x\text{O}_3$ from paramagnetic state to an itinerant ferromagnetic state with an abrupt jump in isothermal magnetization leading to a sizeable saturation moment ($\sim 0.4\mu_B/\text{f.u.}$ within the ab plane). Ferromagnetism occurs abruptly and reaches as high as $T_C=123$ K for $x=0.22$. The Cr-driven ferromagnetism is highly anisotropic, suggesting an important role for spin-orbit coupling. Lattice constant and magnetic measurements strongly support the valence of the Cr to be tetravalent (Cr^{4+} , $3d^2$ configuration). The Cr substitution for Ru in SrRuO_3 ($T_C=165$ K) enhances the itinerant ferromagnetism, consistent with Cr-induced ferromagnetism in paramagnetic CaRuO_3 , but without significant magnetic anisotropy. Preliminary pressure-dependent magnetization of $\text{CaRu}_{0.85}\text{Cr}_{0.15}\text{O}_3$ shows strong enhancement of the saturation magnetization (25% for $P \sim 0.7$ GPa). All results indicate a coupling of Ru 4d and Cr 3d electrons that is unexpectedly favorable for itinerant ferromagnetism which often exists delicately in the ruthenates.

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