High Pressure Synthesis, Crystal Structure, Magnetic & Transport properties of Cr-doped strontium ruthenates, $SrCr_xRu_{1-x}O_3$

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In recent years, there has been considerable research interest in the ruthenate perovskites, due to the observation of a variety of interesting physical properties, including superconductivity in Sr_2RuO_4. The simple strontium ruthenate perovskite, $SrRuO_3$, which has an orthorhombic *Pbnm* perovskite structure has been of particular interest as it represents a rare example of a ferromagnetic *4d*-transition metal oxide, and exhibits a conducting behaviour best described as a "bad metal" [1].

We have prepared a series of strontium ruthenates in which the *4d* ruthenium is successively replaced by *3d* chromium. $SrCrO_3$ itself is a Pauli paramagnetic metallic conductor [2], and can only be prepared under high pressure conditions (60-65 kbar). We have used a range of high pressure synthetic techniques to obtain increased substitution of Cr^{4+} for Ru^{4+} in these $SrCr_xRu_{1-x}O_3$ materials, and have studied the crystal structure, magnetic and transport properties. Samples at $x \leq 0.2$ were synthesised in Edinburgh at 1100°C under ambient pressure conditions; samples with $0.2 < x \leq 0.6$ were synthesised in Madrid at 1000°C under 35kbar pressures; samples with $x > 0.6$ were synthesised in Munich at 1100°C and a pressure of 105kbar.

Two distinct structural phase transitions are observed with increased Cr-doping – from orthorhombic *Pbnm* to rhombohedral *R-3c*, accompanied by a phase coexistence, at $x = 0.15$, and from rhombohedral to cubic *Pm-3m* above $x = 0.5$. Susceptibility measurements show the presence of an additional magnetic transition, above the Curie transition of $SrRuO_3$, at small levels of Cr-doping. At higher doping levels ($x \geq 0.5$), a single transition is again observed, but with a higher transition temperature than in $SrRuO_3$. Resistivity measurements show "bad metal" behaviour, with transitions to insulating states at low temperatures and medium *x* values.

[1] L. Klein, J. S. Dodge, C. H. Ahn, G. J. Snyder, T. H. Geballe, M. R. Beasley and A. Kapitulnik, *Phys. Rev. Lett.* **1996**, 77, 2774.

[2] B. L. Chamberland, *Solid State Commun.* **1967**, 5, 663.