Transport Properties of the Novel Quasi-1D Cobalt Oxide (Ca,Na)Co_2O_4

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Cobalt oxides have attracted much attention from many scientists because of the unusual large thermoelectric power and unconventional superconductivity. Most of their interests are directed toward "2D" CoO_2 lattices in layered oxides such as Na_xCoO_2 or $Na_xCoO_2{\cdot}yH_2O$, because the 2D lattice is a main stage of the electronic conduction showing the unusual properties. However, to our knowledge there has been no report on "1D" effect on transport properties in cobalt oxides, because there has been no metallic 1D cobalt oxide so far. In this presentation, we report on transport properties of the novel quasi-1D metallic cobalt oxide (Ca,Na)Co_2O_4.
(Ca,Na)Co_2O_4 crystallizes in the calcium-ferrite-type structure, which consists of an edge- and corner-shared CoO_6 octahedral network including quasi-1D CoO_2 double chains along the b-axis. Since the Co t_{2g} orbital directly overlaps with the nearest neighbor Co t_{2g} orbitals, the charge transport is controllable by the carrier doping. The metallic conduction ($d\rho/dT>0$) appears for the highly Na doped phases. The non-zero Sommerfeld constant ($\gamma\sim$20 mJ/Co-mol K^2) indicates finite density of states at Fermi level. Ab-initio band calculation study revealed that this phase possesses multiple 1D bands located between Γ and Y points in the momentum space, with the flat top and steep dispersion near Fermi level. The band structure is very similar to those in Na_xCoO_2, except for the dimensionality.