Metal-insulator transition in Hollandite-type $K_2V_8O_{16}$ and $K_2Cr_8O_{16}$

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The synthesis, structure and electromagnetic properties of Hollandite-type $K_2Cr_8O_{16}$ and $K_2Cr_8O_{16}$ are reported. In the crystal structures, the double chains of edge sharing MO_6(M=V,Cr) octahedra share corners with neighboring chains to form a M_8O_{16} stoichiometry framework that encloses large four-sided tunnels. The K^+ cation is located in the tunnels. These are mixed-valence compounds. Since the crystallographic site of vanadium and chromium atom is unique, the formal oxidation is $M^{3.75+}$(M=V,Cr). We successfully obtained $K_2V_8O_{16}$ and $K_2Cr_8O_{16}$ by a high pressure synthesis. Combining electrical resistivity, magnetic susceptibility, and x-ray diffraction, we found that $K_2V_8O_{16}$ exhibits a first order metal-insulator transition at 170 K, accompanied by charge order of V^{4+} and V^{3+} and the formation of V^{4+}-V^{4+} singlet pairs and V^{4+}-V^{4+} pairs in the low temperature insulator phase.[1] On the other hand, $K_2Cr_8O_{16}$ is a ferromagnetic metal with T_c = 180 K and shows a transition to an insulator at 95 K without an apparent structural change but retaining ferromagnetism.[2]

[1]M. Isobe, S. Koishi, N. Kouno, J. Yamaura, T. Yamauchi, H. Ueda, H. Gotou, T. Yagi, and Y. Ueda, J. Phys. Soc. Jpn. **75**, 07381 (2006).

[2]K. Hasegawa, M. Isobe, T. Yamauchi, H. Ueda, J. Yamaura,H. Gotou, T. Yagi, H. Sato and Y. Ueda, Phys. Rev. Let. **103**, 146403 (2009).