

Transport Properties and Phase Diagram in $K_xFe_{2-y}Se_2$ Superconductors

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We successfully grew the high quality single crystals of $A_xFe_{2-y}Se_2$ ($A = K, Rb, Cs, Tl/K$ and Tl/Rb) with nearly 100% shielding fraction. We measure the resistivity and magnetic susceptibility in the temperature range from 5 K to 600 K. An antiferromagnetic transition is observed in susceptibility at Neel temperature (T_N) as high as 500 K to 540 K depending on A . This indicates the coexistence of superconductivity and antiferromagnetism in this intercalated iron selenides. A sharp increase in resistivity arises from the structural transition due to Fe vacancy ordering at temperature slightly higher than T_N .

We also report electronic and magnetic phase diagram of $K_xFe_{2-y}Se_2$ system as a function of Fe valence. We find two AFM insulating phases and reveal that the superconducting phase is sandwiched between them, and give direct evidence that the superconductivity in $K_xFe_{2-y}Se_2$ originates from the AFM insulating parent compounds.