The effect of Pb Substitution on the BiS_2-based superconductors La(O, F)BiS_2

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The BiS_2-based superconductors have layered structure consisting of block and conduction layers. The crystal structure is similar to those of high-T_c superconductors, such as iron-based superconductors. These superconductors show an anomalous isotope effect on T_c [1], suggesting that the mechanism of superconductivity in this system may be unconventional type. A key feature of BiS_2-based superconductors is that T_c increases by a factor of 2 to 5 when pressure or chemical pressure is applied [2, 3]. Recently, the substitution of Pb or Sn on Bi sites has been reported to show anomalous resistivity and increase in T_c that cannot be explained by chemical pressure effects [4, 5].

In this study, we synthesized single crystals of $LaO_{0.5}F_{0.5}Bi_{1-x}Pb_xS_2$ (x=0~0.2) and measured resistivity, thermal expansion, specific heat and Seebeck coefficient to understand the change of T_c and anomalous resistivity. Figure 1 shows the Pb concentration dependence of T_c and the characteristic temperature T*, at which anomalous transport properties are observed. T* appears at around x=0.08 and increases linearly with x. The large thermal expansion anomalies, specific heat anomalies, and the results of the crystal structure analysis indicate that a first-order structural phase transition from tetragonal ($P4/nmm$) to monoclinic ($P2_1/m$) occurs at T*. The resistivity anomalies are attributed to the structural phase transition to monoclinic structure. Furthermore, the Seebeck coefficient indicates that the anomalies at T* are associated not only to the lattice system but also to the electronic system. Superconductivity is not observed above 2 K at x=0.08, near the phase boundary where T* appears. At $x \geq 0.09$, the samples exhibit a sharper superconducting transition than those at $x < 0.08$. This result supports that the monoclinic structure has a positive effect on the superconductivity in the BiS_2 system.

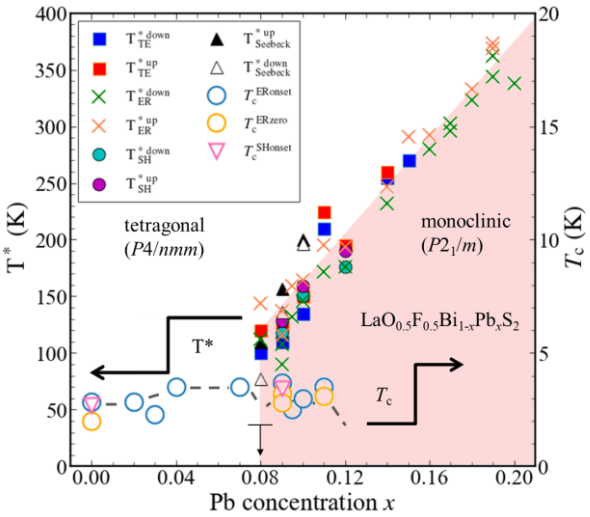

Figure 1. Pb concentration x dependence of T* and T_c

References

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