Synthesis and physical properties of $FeSe_{1-x}Ae_x$ (A=Te, S) epitaxial films

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Fe chalcogenides, $FeSe_{1-x}A_x$ (A=Se and S) have focused attention, because of (1) large increase of T_c by the application of pressure, intercalation, *etc*, (2) high T_c superconductivity (SC) in ultrathin films on some oxide substrate, (3) possible BCS-BEC crossover, and (4) absence of magnetic order at low temperatures. Previously, we succeeded in preparing a series of $FeSe_{1-x}A_x$ thin film samples (A=Te, S) with different *x* values for wide range of Te concentration, *x* (typically 0<*x*<1.0)[1,2] (bulk Te substituted material cannot be synthesized because of the phase separation), and found that T_c behavior at the orthorhombic–tetragonal (O-T) phase boudary is contrastive (Fig. 1)[2]. This casts a serious question on the role of the nematic fluctuation on SC. We have investigated various physical properties both in the normal state and in the SC state, such as resistive transition under finite magnetic fields[3], ARPES, optical, THz and microwave conductivity, Nernst effect, *etc*. Detailes will be discussed in the wrokshop. In S substituted film samples in the tetragonal phase, another anomaly at *T*" takes place[3], which we consider is due to the antiferromagnetic transition. What is surprising is that the T_c vs *x* behavior is almost similar between bulk crystals and epitaxial films for S-substituted case. This might also suggests that the antiferromagnetic fluctuation does not affect SC. Thus, the key factor to determine T_c of Fe chalcogenides is becoming of central interest. To answer this question, we investigated the magneto-resistivity and Hall effect[4]. The results show that the carrier concentration is a key factor dominating T_c in all cases. This is in accordance with our previous results on film samples with different degree of lattice strain[5]. These results also provide an important clue to another key question on SC of Fe chalcogenides; What are different among three different classes of SC in these materials?; (1) 25-30 K class in our films and pressurized bulk crystals, (2) 50 K class in the EDLT structure[6] and also c-axis elongated materials, and (3) 65 K (or more) class reported in ultrathin film samples.

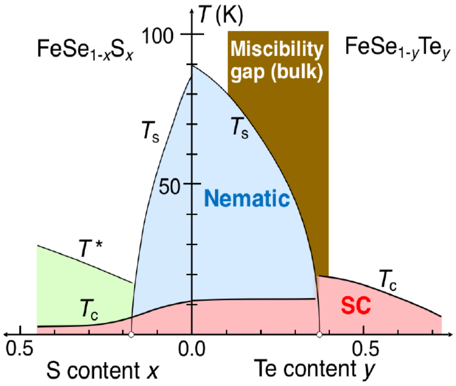

Fig. 1 Experimentally obtained phase diagram of Fe chalcogenide film

We also investigate SC fluctuation. Our microwave conductivity result[7] and a recent torque magndetometry result[8] show that SC is just large in the conventional GL sense, and not so anomalous in FeSe and Fe(Se,Te).

References

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