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Séminaire Invité

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High-pressure phase diagram of high-quality single-crystalline FeSe

Among the iron-based superconductors, structurally-simplest FeSe exhibits tetragonal-to-orthorhombic structural transition at $T_s \sim 90$ K and superconducting transition at $T_c \sim 9$ K. FeSe is unique in that it does not exhibit antiferromagnetic transition accompanying the structural transition[1,2]. In addition to this, the previous study on powder crystals has revealed four-fold increase of T_c with applying pressure [3]. Therefore, FeSe is considered to be a key material to understand the mechanism of iron-based high-temperature superconductor.

Recently high-quality single crystals have been synthesized[4] which show large residual resistivity ratio[5], and quantum oscillations[6,7]. The study on these crystals under hydrostatic pressure has revealed a complex temperature-pressure (T-P) phase diagram, where the pressure dependence of T_c has three plateaus, and the T_s is monotonically suppressed with the sudden development of magnetic phase [8].

To reveal the T-P phase diagram under higher pressure, we perform the high-pressure resistivity measurements up to 15 GPa[9], and synchrotron X-ray scattering measurements up to 4 GPa using several pressure techniques. From resistivity measurements, we observe increase of magnetic transition temperature (T_m) with increasing pressure up to 5 GPa. Above 6 GPa, however, the drop of T_m is observed, which is accompanied by the sudden enhancement of T_c up to 38 K, indicating the competing nature of the two orders with similar energy scales. From X-ray scattering measurements, we find tetragonal-to-orthorhombic structural transitions at all pressure points. At 1 GPa, the orthorhombic distortion exhibits second-order-like temperature dependence which is similar to the one at ambient pressure. Above 2 GPa, however, it displays sudden splitting just below the T_m, indicating first-order nature of the transitions in this pressure range. Here, we report on the T-P phase diagram obtained from both measurements, and the details of the temperature dependence of resistivity and orthorhombicity at each pressure.

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