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Composition dependence of penetration depth in $FeSe_{1-x}Te_x$ films measured by superconducting resonators

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The relation between the structural (nematic) transition and superconductivity have attracted much interest in FeSe. Te-substituted $FeSe_{1-x}Te_x$ exhibits the rapid increase of the superconducting transition temperature, T_c, upon disappearance of the structural transition caused by the increase of x[1,2]. The rapid change of T_c may suggest a possible change in the superconducting properties. However, only thin-film growth techniques make it possible to obtain single crystalline samples of $FeSe_{1-x}Te_x$ in the composition region [1,2]. In this study, we measured temperature dependence and its magnitude of the penetration depth in $FeSe_{1-x}Te_x$ films to investigate the relation between superconducting gap structure and the structural transition, by the microwave transmission line resonator technique. [3]. We fabricated coplanar resonators of $FeSe_{1-x}Te_x$ films by using a sandblasting method and obtained the penetration depth from the resonant frequency. The merit of this technique is that the absolute magnitude of the penetration depth is obtained without the aid of any other measurement.

The measured penetration depth as a function of temperature was well represented by the power-law, $\lambda(T) = \lambda(0) + AT^n$ for $0.1 < T/T_c < 0.2$ which agrees with the so far established behavior[4]. Figure.1 shows the low-temperature-limiting $\lambda(0)$ and the power, n, as a function of Te content, x, together with T_c. It is remarkable that $\lambda(0)$ does not change largely when we crossed the orthorhombic-tetragonal boundary, which is in contrast to the T_c behavior. As for the power, n, the end material FeSe, exhibiting the structural transition, shows $n = 1.55$, whereas, other samples without structural transition shows $n > 2$. We will discuss the implications of these results, in terms of the change in the structure of the superconducting gap function as a function of Te substitution.

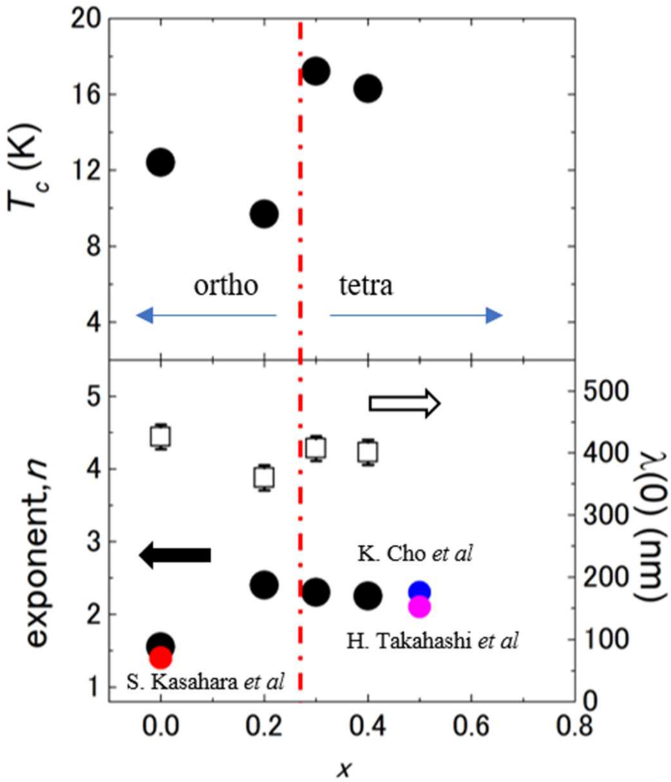

Fig1. x dependence of T_c, $\lambda(0)$ and exponent, n

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