

Macroscopically Strain-Free Fe(Se,Te) Membrane

Len Masuda¹, Kose Moorinaga¹, Ryo Matsumoto², Yoshihiko Takano², Alberto Martinelli³, Kai Walter⁴, Alexandra Jung⁴, Jens Hänisch⁴, *Kazumasa Iida¹ (12-point)

¹ College of Industrial Technology, Nihon University, ² National Institute for Materials Science (NIMS),

³ CNR-SPIN Genova, ⁴ Institute for Technical Physics, Karlsruhe Institute of Technology

*iida.kazumasa@nihon-u.ac.jp

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Thin films differ from bulk single crystals primarily in two aspects: defect density and strain state. Due to the nature of the growth process, superconducting thin films generally contain many more structural defects than single crystals. These include threading dislocations, twin or anti-phase boundaries, and precipitates. While such defects are detrimental in some contexts, in superconducting films they often act as strong pinning centers, significantly enhancing the critical current density.

Another important difference is strain. Epitaxial films are typically strained due to lattice mismatch with the substrate. This in-plane strain can persist through a certain film thickness—and sometimes even beyond—resulting in compensating strain along the out-of-plane direction, often along the c-axis. This strain state can lead to noticeable shifts in the critical temperature T_c , particularly in iron based superconductors.

To decouple the effects of defect density and strain, and to facilitate a more accurate comparison between thin films and bulk single crystals, we have developed multiple techniques to obtain substrate-free Fe(Se,Te) thin films. These include adhesive cleavage at or slightly above the film–substrate interface, as well as the use of a water-soluble sacrificial buffer layer. In this presentation, I will examine the structural and superconducting properties of the films prepared by these two methods and discuss their correspondence to the behavior observed in bulk single crystals.

References:

1) L. Masuda *et al.*, submitted in *Supercond. Sci. Technol.*

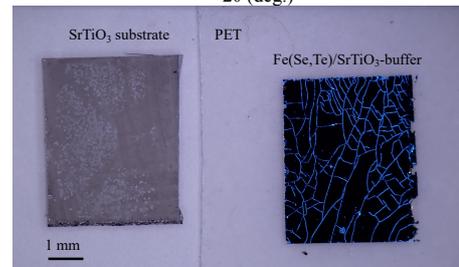
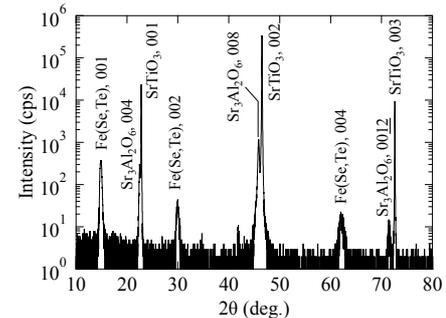


Figure X-ray diffraction pattern of the Fe(Se,Te) film grown on a SrTiO₃/Sr₃Al₂O₆-buffered SrTiO₃ substrate. The bottom panel shows a photograph taken after water etching: left) SrTiO₃ substrate; right) Fe(Se,Te)/SrTiO₃ membrane transferred onto PET.