Contribution ID : **63** Type : **Oral Presentation**

The role of lattice dynamics in the superconductivity enhancement at FeSe/SrTiO3 interface

Wednesday, 15 August 2018 14:15 (15)

The superconducting transition temperature (TC) of monolayer FeSe on SrTiO3 is significantly enhanced to 60-70 K in comparison with the bulk TC of 8 K. To understand the mechanism of the extraordinary interfacial phenomenon, extensive investigations have been carried out with complementary surface analyses techniques. We use the high-resolution electron energy loss spectroscopy (HREELS) to study the system from the perspective of lattice dynamics. Recently we have developed a new strategy for HREELS, which can simultaneously measure the energy and momentum of surface elemental excitations with high energy and angular resolution, as well as detecting efficiency and sampling density. By growing epitaxial FeSe films on SrTiO3, we study the phonon behaviors of FeSe. Although the superconductivity shows dramatic dependence on FeSe film thickness, no change of phonon energy or line width is detected. On the other hand, we detect the Fuchs-Kliewer (F-K) phonon modes of SrTiO3 substrate on FeSe surface. It is revealed that the electric field generated by the F-K phonon can penetrate into FeSe and strongly interact with electrons. With the increase of FeSe thickness, the penetrating field intensity decays exponentially, associated with the superconductivity enhancement weakened. We conclude that the SrTiO3 F-K phonon penetrating into FeSe is essential in the interfacial superconductivity enhancement.

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Session Classification : Speaker Sessions and Seminars

Track Classification : Surface Science