Superconductivity of β-Type Salts under Uniaxial Compression

Hiroshi Ito[1], Tetsuo Ishihara[1], Masafumi Niwa[1], Takeo Suzuki[1], Seiichiro Onari[1], Yukio Tanaka[1], Jun-ichi Yamada[2], Hideki Yamochi[3], and Gunzi Saito[4]
[1]*Department of Applied Physics, Nagoya University, Japan*
[2] *Department of Material Science, University of Hyogo, Japan*
[3] *Research Center for Low Temperature and Materials Sciences, Kyoto University, Japan*
[4] *Research Institute, Meijo University, Japan*
Email: ito@nuap.nagoya-u.ac.jp

Among organic superconductors, β-type salts attract attention for their high transition temperature (T_C). Due to weak dimerization of molecules compared to the κ-type salt, study on the β-type salts is intriguing in order to clarify whether the dimerization is a prerequisite for the high-T_C in organic superconductors. Uniaxial compression is a powerful technique to get insight into the mechanism of superconductivity since it controls the transfer integrals directly. Using epoxy encapsulation method, we have measured the T_C for β-(BDA-TTP)$_2$X [X=SbF_6, AsF_6] under in-plane uniaxial compression parallel and perpendicular to the molecular stack [1]. For X=SbF_6, T_C increases and takes a maximum at 3 kbar under the parallel compression. On the other hand, T_C decreases monotonically under the perpendicular compression. This behavior is understood as a competition between spin fluctuation and spin frustration effects on the dimerized triangular-lattice Hubbard model like κ-type salts. However, for the X=AsF_6, a T_C minimum is observed as a function of uniaxial pressure, which contradicts to the dimerized model [1].

In this presentation, we report the uniaxial compression effect on β-(BEDT-TTF)$_2I_3$. By embedding the crystal into epoxy resin, 8 K superconducting state is stabilized. By applying uniaxial compression, further T_C increase taking a maximum at 3-4 kbar is observed for both directions parallel and perpendicular to the molecular stack. In order to understand the different behavior against uniaxial compression, we calculate the T_C within the fluctuation-exchange approximation on dimerized single-band or non-dimerized two-band Hubbard models, by assuming displacements of molecules under uniaxial compression for each salt. For β-(BDA-TTP)$_2SbF_6$, both models are consistent with the experiment, but for β-(BDA-TTP)$_2AsF_6$, the non-dimerized model explains the T_C minimum. On the other hand, β-(BEDT-TTF)$_2I_3$ is rather understood by the dimerized model. These results are understood in terms of the difference in the strength of the dimerization among the three salts, that is, β-(BDA-TTP)$_2AsF_6$ < β-(BDA-TTP)$_2SbF_6$ < β-(BEDT-TTF)$_2I_3$.

[1] H. Ito *et al.*, Phys. Rev. B 78 (2008) 172506.