

Time-resolved Optical Study on BETS Superconductors and Related Salts

Toshio Naito¹, Marie Fukusaku¹, Saori Matsuo¹, Tamotsu Inabe¹, and Yasunori Toda²

¹Graduate School of Science, Hokkaido University, Japan

²Graduate School of Engineering, Hokkaido University, Japan

Email: tnaito@sci.hokudai.ac.jp

The λ -type BETS salts, λ -(BETS)₂MCl₄ (M = Ga, Fe), are interesting superconductors. While they exhibit nearly identical temperature-dependence of electrical resistivity from 300 K to ~8 K, they have contrasting ground states at ambient conditions [1]. The Ga and Fe salts exhibit superconducting and metal-insulator transitions at the same temperature (~ 8 K). In addition to pressure-induced superconductivity, the Fe salt exhibits magnetic-field-induced superconductivity [2]. The κ -type BETS salts, κ -(BETS)₂MCl₄ (M = Ga, Fe), are also interesting (super)conductors. Both again exhibit nearly identical temperature-dependence of electrical resistivity from 300 K down to 2 K [1]. Only the Fe salt is observed to exhibit a superconducting transition at 0.1 K [3].

Many experimental facts indicate that π -d interaction should play an important role in the physical properties of these Fe salts. Meanwhile, as for the mechanism of superconductivity, important questions remain to be answered such as the relation between superconductivity and π -d interaction. Thus we measured time-resolved polarized reflectance spectra of the abovementioned salts in order to observe and compare their carrier dynamics. This method can detect any interaction related to carrier dynamics and thus effecting on electrical behavior.

Main results are as follows; for both of the λ -type salts, (i) nearly T -independent relaxation time of 0.5-0.8 ps ($T \leq 100$ K), (ii) no energy gap ($T \leq 100$ K), and (iii) coherent phonon with a low frequency of 0.7 THz ($T \leq 40$ -50 K) were observed. The features (i) and (ii) remind us of pseudogap behavior in high- T_C cuprates, and are shared by the κ -type BETS salts. On the other hand, no phonon oscillations were observed in κ -(BETS)₂FeCl₄ and κ -type ET salts. Thus no clear difference was found in carrier dynamics between the corresponding Fe and Ga salts, which is consistent with their electrical behavior. Instead, κ - and λ -type (super)conductors are distinguished from each other by whether coherent phonon is active or not. We will discuss more detailed results of κ -, λ -(BETS)₂MCl₄ referring to the carrier dynamics of κ -type ET and high- T_C cuprate superconductors.

[1] A. Kobayashi *et al.*, Chem. Lett. 22 (1993) 2179.

[2] S. Uji *et al.*, Nature 410 (2001) 908.

[3] T. Otsuka *et al.*, Chem. Lett. 29 (2000) 732.