Experimental Study of Electronic Properties of Organic Conductors using Uniaxial Tensile and Compressive Strain

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The soft crystal lattice of organic conductors allows the electronic state to change significantly under pressure. Until now, electronic properties under hydrostatic pressure have been mainly studied using a clamp-type pressure cell. In these experiments, the crystal lattice is isotropically compressed through the pressure medium oil. On the other hand, a method of applying uniaxial strain to a sample embedded in epoxy (instead of oil) has been also developed [1]. Uniaxial strain can change the lattice in only one direction, making it possible to achieve new electronic states not seen in hydrostatic pressure. For example, in α-(BEDT-TTF)$_2$I$_3$, it has been reported that the charge ordered (CO) state is strongly suppressed by uniaxial strain (*Pa* = 1.5 kbar), and a superconducting transition is observed at 7 K [2]. However, this method using clamp-type cells causes a pressure drop at low temperatures (about 2 kbar), making it difficult to study low-pressure regions. In this study, we used a piezoelectric-based apparatus for strain tuning and tried to control the electronic properties of organic conductors. Sample and strain gauge were epoxy-glued to a plastic plate and piezoelectric stacks are used to apply strain to the sample (Fig. 1 (a)). The outstanding features of this device are the ability to apply both compressive and tensile strain, and the precise and continuous control of strain at low temperatures. This device enables research in the low-pressure region, which has been difficult with conventional methods. Figure 1 (b) shows the preliminary results of applying this method to α-(BEDT-TTF)$_2$I$_3$. We observed a clear change in electrical resistance with compressive and tensile strain, and a slight shift in the CO transition temperature. We will investigate the behavior of α-(BEDT-TTF)$_2$I$_3$ under different strain directions, and also apply this method to other organic conductors.

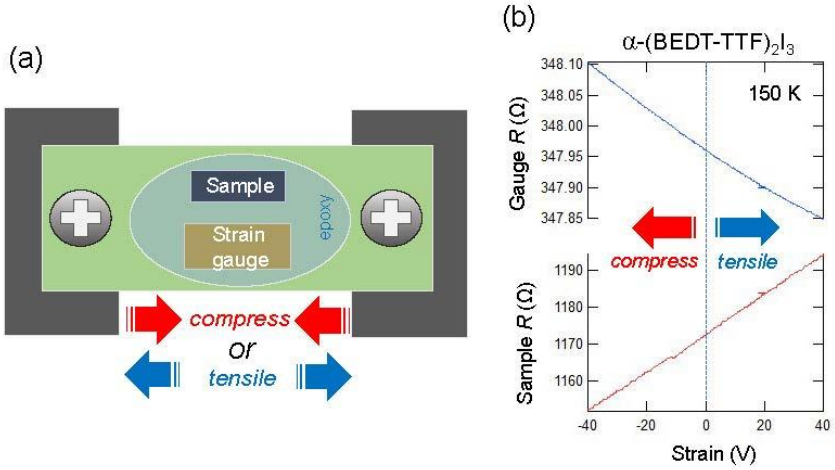

Fig. 1. (a) Sketch of sample stage. (b) Strain dependence of the resistivity of strain gauge and α-(BEDT-TTF)$_2$I$_3$.

References

[1] M. Maesato *et al.*, Rev. Sci. Instrum. **71**, 176 (2000). [2] N. Tajima *et al.*, Phys. Soc. Jpn. **71**, 1832 (2002).