High Pressure Study of the First Organic Conductor TTF-TCNQ by using Diamond Anvil Cell

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Introduction

The first organic conductor TTF-TCNQ (tetrathiafulvalene-tetracyanoquinodimethane becomes an insulator at low temperature due to charge –density –wave (CDW) formation. Anticipating a quantum state or superconducting state after suppressing the CDW transition, high pressure resistivity measurements started 30 years ago[1]. Very recently, using a cubic anvil apparatus, pressure up to 8 GPa shows the CDW transition temperature will decreases with increasing pressure. However, even though metallic behavior appears below 25 K, the CDW state still remains[2]. To investigate electrical properties at higher pressures, we are using a diamond anvil cell(DAC) to perform four-terminal resistivity under high-pressure measured up to 10 GPa.

Experimental

Top surface diameters of 560 μm or 700 μm were used, and Inconel 625 was used as the metal gasket. A mixture of fluorinert (3M) 1:1 of FC-70 and FC-72 was used for the pressure medium. The pressure was determined by the standard ruby fluorescence method at room temperature.

Results and Discussion

The four-contact are made along different crystal axis. When the current direction along *b* axis (molecule stacking axis), and the pressure is higher than 8 GPa, the room temperature resistance starts to abruptly increase with pressure, and the temperature dependent of resistance shows semiconducting behavior. Compared with the cubic anvil measurement[2], the CDW transition temperature changes are not as obvious. We suggest that this is caused by a different pressure medium and pressurizing speed. With the measurement current along *c* axis, the room temperature resistance decreases, and the CDW state activation energy decreases with increasing pressure, but the CDW transition temperature tends to higher temperature. All three different directions measurement, the CDW states are not completely suppressed. Investigations above 10 GPa pressure experiment are still in progress.

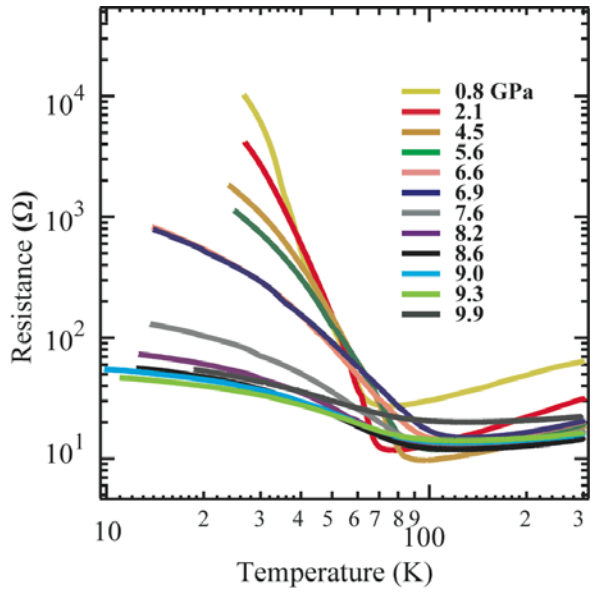

Fig.1. Temperature dependent of resistance for various pressures.

Conclusions

The TTF-TCNQ single crystal four- terminal resistivity under high pressure are measured up to 10 GPa, using DAC. Because the pressure medium solidified under high pressure, the applied sample pressure was not homogeneous. We made four contact along three different crystal axis, and all samples temperature dependent resistivity were measured up to 10GPa. We found under high pressure the TTF-TCNQ turn to irreversible phase, and in this phase the sample was semiconducting.

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References

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