# Charge Disproportionation and Weak Localization in $\theta$-(BEDT-TTF)$_2$MZn(SCN)$_4$ [M=Cs,Rb]

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**Abstract**

We studied low-temperature electronic state of the title materials by applying uniaxial strain as it suppresses the M-I transition that is associated with charge ordering. We extended the metallic region below $\sim 5$ K and found no superconductivity but phenomena due to the weak localization of charge carriers. We propose that the fluctuation of the charge ordering is responsible for the localization.

*Key words:* $\theta$-type; charge disproportionation; weak localization

H. Mori [1] has proposed that the $\theta$-type BEDT-TTF salts could be systematically aligned in a single diagram by the dihedral angle ($\theta$) between the donor-molecules in the crystals. In other words, larger the dihedral angle, more insulating the electronic states, i.e. the higher the metal- insulator transition temperature. When the dihedral angle is narrow enough, metallic state is stabilized, and even the superconductivity (SC) is observed. The Fermi surface in $\theta$ -type is calculated to be of 2-dimension, quarter-filled and closed in the 1st Brillouin zone.

Recently, in $\theta$-(BEDT-TTF)$_2$RbZn(SCN)$_4$ (abbreviated as $\theta$-RbZn), the evidence of charge ordering driven by the intersite Coulomb interaction (V) was found below the M-I transition temperature (190 K) and a fluctuation of charge order pattern above $T_{MI}$ were reported [2]. Also, in the $\theta$-(BEDT-TTF)$_2$CsZn(SCN)$_4$ (abbreviated as $\theta$-CsZn) which is located closer to the metallic phase than $\theta$-RbZn, the charge fluctuation among the BEDT-TTF molecules along the c-axis just above the M-I transition temperature (20 K) has been pointed out [3]. In this work, we shed light on this M-I transition and/or charge fluctuation associated with charge disproportionation by means of transport measurement.

Our idea is that the charge fluctuation associated with charge ordering or disproportionation might appear in the similar way as electron weak localization phenomenon in magnetoresistance [4]. However, the effect of the localization is usually more appreciable at low temperature and in the metallic state. In order to combine the metallic state with low temperature, the uniaxial compression along the a-axis (strain method), which suppresses the dihedral angle, was indispensable to suppress the M-I transition, because hydrostatic pressure only gives rise the M-I temperature.

From the temperature dependence of the resistivity under uniaxial strain $\|$a, the M-I transition is controlled to be suppressed *as expected.* However, even at 12 kbar, the SC is not observed down to 1.2 K and the resistivity increases as $\log T$ with decreasing $T$ below

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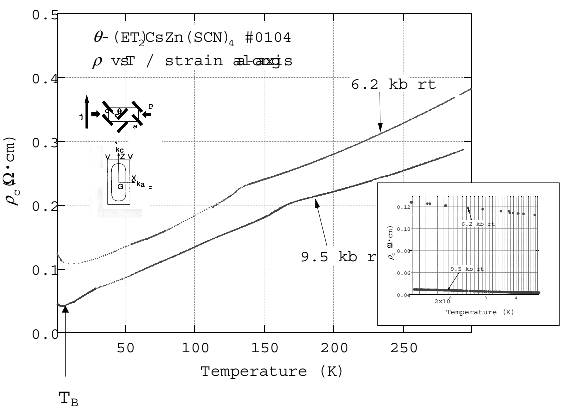


Fig. 1. Temperature dependence of the resistance along the $c$-axis of $\theta$-(BEDT-TTF)$_2$CsZn(SCN)$_4$ under uniaxial strain corresponding to 6.5 and 9.5kb. Inset shows the low teperature part that indicates the $\log T$ dependence.

about 5 K as shown in Fig. 1.

In the temperature region where the resistivity increases as $\log T$ with decreasing $T$, the negative magnetoresistance (N-MR) was observedas shown in Fig. 2. Further, N-MR is strongly angular dependent. The magnetoresistance which is in a weakly localized state can be expressed as a sum of positive MR, due to Lorentz force, and negative MR, due to the break of the time reversal symmetry of electron interference by magnetic field. The angular dependence of MR (not shown) can be fit to the experimental data using the $\rho_0$ value of $2.28 \times 10^{-6}$ ohm cm, for the uniaxially strained (0.9 GPa $\|$a for example) sample of $\theta$-CsZn.

We speculate our result in the following way. At least we could stabilize the metallic state by the uniaxial strain $\|$a. Since the N-MR is observed in both $\theta$-CsZn and $\theta$-RbZn, we assume that the origin of N-MR is common to both. From previous reports, structural disorder is likely in $\theta$-RbZn, but not in $\theta$-CsZn. Therefore we discard this possibility. It is reminded that in both materials, fluctuation in charge order is observed above $T_{MI}$ by X-ray or NMR. The fluctuation might be induced by frustration of two kinds charge order pattern due to balance of the nearest neighbor Coulomb interaction. This time scale of the fluctuation of charge order is slow and is viewed by conduction electron as random Coulomb potentials.

## Acknowledgements

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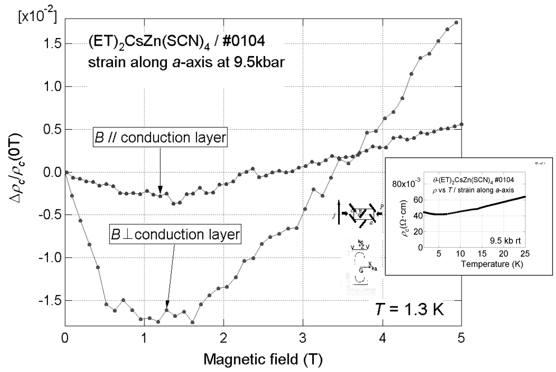


Fig. 2. Magnetoresistance of with current $\|$c in $\theta$-(BEDT-TTF)$_2$CsZn(SCN)$_4$, with magnetic field parallel and perpendicular to the conduction layer. Inset shows that low temperatute part. These negative magnetoresistance is only present below the resistivity upturn temperature.

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