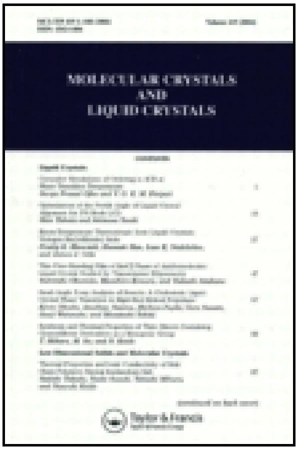


Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl16

Transverse Magnetoresistance of $(TMTSF)_2ClO_4$, in Intermediate Field Region

Keizo Murata [a] , Hiroshi Bando [a] , Koji Kajimura [a] , Takehiko Ishiguro [a] , Hiroyuki Anzai [a] , Seiichi Kagoshima [b] & Gunzi Saito [c]

[a] Electrotechnical Laboratory, Sakuramura, Ibaraki, 305, Japan

[b] Department of Pure and Applied Science, The University of Tokyo, Komaba, Tokyo, 153, Japan

[c] Institute for Molecular Science, Okazaki, Aichi, 444, Japan

Version of record first published: 17 Oct 2011.

Mol. Cryst. Liq. Cryst. 1985, Vol. 119, pp. 131-134
0026-8941/85/1194-0131/$10.00/0

TRANSVERSE MAGNETORESISTANCE OF $(TMTSF)_2ClO_4$ IN INTERMEDIATE FIELD REGION

KEIZO MURATA, HIROSHI BANDO, KOJI KAJIMURA,
TAKEHIKO ISHIGURO and HIROYUKI ANZAI
Electrotechnical Laboratory, Sakuramura, Ibaraki 305, Japan
SEIICHI KAGOSHIMA
Department of Pure and Applied Science, The University of Tokyo, Komaba, Tokyo 153, Japan
GUNZI SAITO
Institute for Molecular Science, Okazaki, Aichi 444, Japan

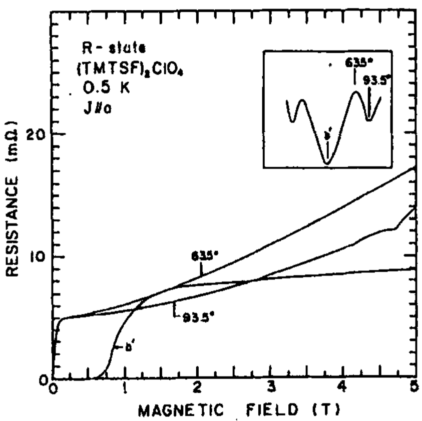
Abstract The transverse magnetoresistance along the a axis exhibits anomalous angular dependence with respect to the direction of a magnetic field. The behavior varies with the temperature and the field intensity.

It is well known that an inspection of the magnetoresistance of the metal, as a fuction of orientation relative to the magnetic and the electric fields, provides a key to elucidate the Fermi surface.[1] This is true particularly for the high field magnetoresistance at low temperatures, in which quantum oscillation provides the size of the Fermi surface and so on.

In the organic synthetic metal $(TMTSF)_2ClO_4$, the magnetoresistance exhibits the Shubnikov-de Haas-like oscillition, but this does not permit us to interpret the results in ordinary way.[2-4] It is found that the electronic state to be inspected is modified by the high magnetic field.[5] In other words, we meet a field induced state in the high field region. To inspect the metallic state, the applied field should be lower than the threshold field although it should be higher than the superconducting critical field, H_{c2}.

As described separately,[6] the electrons on the Fermi surface based on the tight binding band model do not bring about finite transverse magnetoresistance for the resistance along the a direction ρ_{aa}, although ρ_{bb} can be well explained with it. This fact suggests that ρ_{aa} is dominated by some unrecognized mechanism, such as collective modes. In this paper we present the anomalous features observed for ρ_{aa}.

In Fig.1 we show the transverse magnetic field dependences of $\rho_{aa}(H)$ at 0.5 K. The sample was cooled down slowly to realize the relaxed state at low temperatures. The denoted angles in Fig.1 indicate the deflection of the magnetic field from the b' axis. The magnetic field $\underline{H}$ is rotated in the b'-c* plane, which is normal to the a axis. (We do not claim that the standard direction is b' rather than b* in Fig.1, though we adopt b' here.) The angular dependences of ρ_{aa} at constant field are shown in Fig.2. Case I exhibits the angular dependence at 0.5 T under which the superconductivity remains when $\underline{H}$//b'. Cases II and III



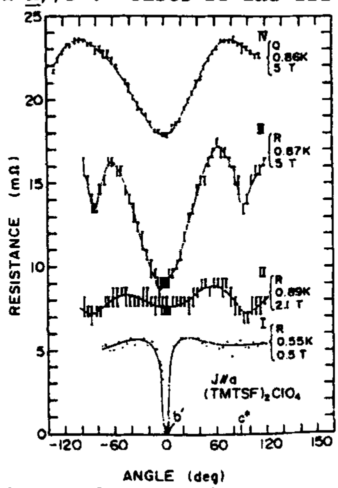
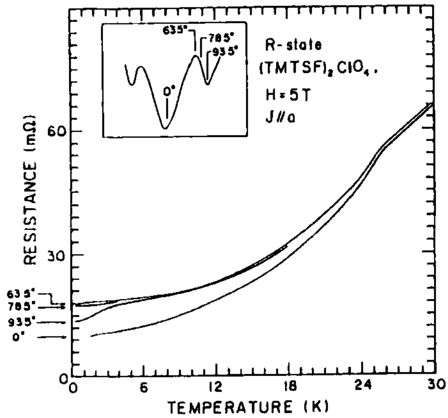


FIGURE 1 (Left) Temperature dependence of ρ_{aa} at 0.5 K for three field directions.

FIGURE 2 (Right) Angular dependence of $\rho_{aa}(H)$. Cases I, II and III are for the relaxed state, whereas case IV is for a rapidly cooled sample.

are given under 2.1 T at 0.89 K and under 5.0 T at 0.87 K, respectively. Note that $\rho_{aa}(H)$ forms a local minimum near H//c*. The case III is copied as inset figures in Fig.1 and Fig.3, to illustrate the relation to the denoted angles. The case IV in Fig.2 shows that the local minimum disappears when the sample is cooled down rapidly and the relaxed state is not well established. (The sample was not cooled down rapidly enough to realize a completely quenched state.)

In order to characterize the local minimum, the temperature dependences of $\rho_{aa}(H)$ at H = 5 T for various directions are shown in Fig.3, which illustrates clearly that the local minimum appears below 4 K. The onset temperature of the local minimum is decreased with decreasing the field intensity, as shown in Fig.4. The temperature and field dependence reminds us the field-induced SDW state. However the onset field is lower than that observed in the Shubnikov-de Haas like oscillation or the Hall effect, and the decrease in the resistivity seems to contradict the



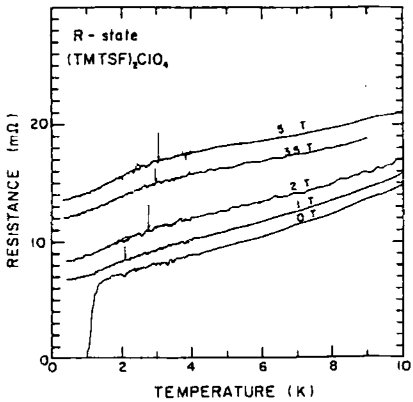


FIGURE 3 (Left) Temperature dependences of ρ_{aa} at 5 T for four field directions.

FIGURE 4 (Right) Temperature dependences of $\rho_{aa}(H)$ at 93.5° for different field intensities.

contribution of the insulating SDW.

We have confirmed that the anomalous angular dependence is reproduced in different samples and have no relation to the crystal twinning or domain. We should notice also that the similar angular dependences have been reported by Brusetti et al.[7] and Kwak et al.[8] for $(TMTSF)_2ClO_4$ and $(TMTSF)_2PF_6$, respectively.

Another anomalous feature is found in Fig.1, for the case $\underline{H}//b'$. In this case, $\rho_{aa}(H)$ is rather independent of $\underline{H}$, but the value, which is reached at H_{c2}, is almost 1.5 times for the cases with $\underline{H}\not\parallel b'$. These features cannot be understood based on models proposed to describe the matallic ground state of $(TMTSF)_2ClO_4$[6] and are open to questions.

Finally we should mention about the resistance jumps, which appear more or less during cooling[9] and dominate the resistance at low temperatures. The intrinsic nature of the effect has not been fully understood and we cannot rule out the contribution of the effect to the anomalous feature presented here.

REFERENCES

1. J. M. Ziman, Principles of the Theory of Solids (Cambridge University Press, London, 1964), p. 250.
2. K. Kajimura, H. Tokumoto, M. Tokumoto, K. Murata, T. Ukachi, H. Anzai, T. Ishiguro and G. Saito, J. Phys. (Paris) C3-1983 1059 (1983).
3. M-Y. Choi, P. M. Chaikin and R. L. Greens, J. Phys. (Paris) C3-1983 1067 (1987).
4. H. Bando, K. Oshima, M. Suzuki, H. Kobayashi and G. Saito, J. Phys. Soc. Jpn. 51 2711 (1982).
5. See for example K. Yamaji, in these proceedings.
6. T. Ishiguro, K. Kajimura, H. Bando, K. Murata and H. Anzai in these proceedings.
7. K. Brusetti, K. Bechgaard, G. G. Lonzarich and R. H. Friend, J. Phys. (Paris) C3-1983 1055 (1983).
8. J. F. Kwak, J. E. Schirber, R. I. Greene and E. M. Engler, Mol. Cryst. Liq. Cryst. 79 467 (1982).
9. T. Ishiguro, K. Murata, K. Kajimura, N. Kinoshita, H. Tokumoto, M. Tokumoto, H. Anzai and G. Saito, J. Phys. (Paris) C3-1983 831 (1983).