X-ray Irradiation Effect on Magnetic Properties of Dimer-Mott Insulators: κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Cl and β'-(BEDT-TTF)$_2$ICl$_2$

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An organic molecular conductor κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Cl (κ-Cl) has a Mott insulating ground state in ambient pressure with an antiferromagnetic (AF) long range order below T_N = 27 K [1]. Recently, carrier induction by X-ray irradiation is revealed by means of dc resistivity [2] and optical conductivity [3] measurements. With increasing irradiation dose, the resistivity at room temperature decreases and the temperature dependence shows metallic behavior above ~50 K. The optical conductivity at 4 K shows a marked enhancement of the Drude part, supporting itinerant carrier apart from the insulator picture. These observations suggest that X-ray irradiation arises local destruction of the balance for the charge transfer between donor and anion molecules, causing not only disorder but also carrier doping to a half-filling band. Such a doped Mott insulator picture is receiving considerable attention and it is indispensable to clarify the origin of the carrier induced by irradiation.

We here report the irradiation does dependence of the magnetic susceptibility in dimer Mott insulators: κ-Cl [4] and β'-(BEDT-TTF)$_2$ICl$_2$ (β'-ICl$_2$). The static susceptibility measurements for each single crystal were carried out by using a SQUID magnetometer. Both the susceptibilities indicate the existence of the AF long range order even after high irradiation (over 300 MGy), but the behavior of T_N differ significantly for the two cases; T_N of 27 K in κ-Cl reduces to ~22 K, while that of β'-ICl$_2$ (22 K) does not vary within the experimental error. Thus the influence on T_N is not seen in β'-ICl$_2$. Taking account of ESR data [4] and variation of a molecular vibration amplitude in the optical resistivity in κ-Cl, we conclude that X-ray irradiation destroys an anion site related to the CN groups in κ-Cl, which does not hold in β'-ICl$_2$.

[1] K. Miyagawa *et al.*, Phys. Rev. Lett. 75 (1995) 1174.
[2] T. Sasaki et al., J. Phys. Soc. Jpn. 76 (2008) 123701.
[3] T. Sasaki et al., Phys. Rev. Lett. 101 (2008) 206503.
[4] N. Yoneyama et al., in preparation.