Resonant X-ray Scattering in Phthalocyanine-molecular Conductor Exhibiting Giant Magnetoresistance

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The $Fe(Pc)(CN)_2$ (Pc : phthalocyanine) molecule forms a one-dimensional chain, while there is a local moment in the next HOMOs of the Fe 3*d* orbitals. Since the $Fe(Pc)(CN)_2$ has the molecular orbitals contributing to both the electron conduction and the local moments, one can expect the strong intramolecular interaction between the one-dimensional conduction and the local moments. The molecular conductor $TPP[Fe(Pc)(CN)_2]_2$ (TPP : tetraphenylphosphonium) shows giant negative magnetoresistance below 50K [1]. In order to understand the origin of this gigantic response, it is important to clarify the nature of the insulating ground state. In the low-temperature X-ray diffraction, the diffuse streak is observed at the position of $k = (n+1/2)\ c^*$ (n : integer) below 80K. On lowering the temperature, the diffuse intensity increases, in accord with the enhancement of the resistivity. Taking account of the three-quarter filled HOMO band, the position of the diffuse streak corresponds to the $4k_F$. This result suggests that the insulating state is the charge-ordered state due to the nearest neighbor Coulomb interaction in the HOMO.

The local moments have the antiferromagnetic order at the low temperature, as suggested by the torque measurement and the NMR measurement (M.Takigawa *et al.*,ISSP). The $4k_F$ diffuse streak intensity is also enhanced at the temperature region of the antiferromagnetic state and its resultant weak ferromagnetism. If the local moment is antiparallel to that in the neighboring site, the ferromagnetic intramolecular interaction is anticipated to stabilize the charge-ordered state. Under the high magnetic fields, the magnetization curve has the kink structure, suggesting the flipping of the local moments. Recently, we find that the intensity of the diffuse streak decreases under the high magnetic field. The magnetic field is anticipated to reduce the stability of the charge-ordered state by suppressing the antiferromagnetic fluctuation.

In order to detect directly the difference in the molecular charge arising from the charge order between the sites in the charge-ordered state, we perform the resonant X-ray scattering in Photon Factroy BL3A. Recently, the diffraction signal is observed in the XANES energy region just above the Fe K edge, where the X-ray absorption spectra are sensitive to the molecular charge of the Pc.

[1] N.Hanasaki *et al.*, J. Phys. Soc. Jpn. **75**, 033703 (2006).