Metal-Insulator Transition Induced by Disorders in Organic Superconductor
κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br

Takahiko Sasaki$^{1,2}$, Naoki Yoneyma$^{1,2}$, Koichiro Sano$^1$ and Norio Kobayashi$^1$
$^1$Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan
$^2$Japan Science and Technology Agency, CREST, Tokyo 102-0075, Japan.
Email: takahiko@imr.tohoku.ac.jp

Organic charge-transfer salts based on a donor molecule bis(ethylenedithio)-tetrathiafulvalene (abbreviated BEDT-TTF) have been recognized as one of highly correlated electron systems. Among them, κ-(BEDT-TTF)$_2$X with X = Cu(NCS)$_2$, Cu[N(CN)$_2$]Y (Y = Br and Cl), etc. has attracted considerable attention as a bandwidth-controlled Mott transition system because of its strong dimer structure consisting of two donor molecules, which effectively makes the conduction band a half-filling band. Recently, a study was conducted on the effect of X-ray irradiation-induced carrier doping on the dc conductivity and optical conductivity of an organic dimer-Mott insulator κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Cl. We observed a large reduction of the dc resistivity [1] and a large enhancement of the Drude part in a low-energy region of the optical conductivity [2]. These results indicate a carrier doping into the Mott insulator. The carrier doping introduced by the X-ray irradiation also causes a disorder effect which will induce a carrier localization by random potentials as Anderson transitions. It is interesting to investigate the random potential effect in the strongly correlated electron systems [3]. We measured the temperature dependence of the resistivity in the X-ray irradiated organic superconductor κ-(BEDT-TTF)$_2$Cu[N(CN)$_2$]Br which is located nearby the Mott transition. With increasing the irradiation dose by the X-ray irradiation using the tungsten tube with 40kV, 20mA, the superconducting transition temperature decreases accompanying the increase of the residual resistivity as has been observed in κ-(BEDT-TTF)$_2$Cu(NCS)$_2$ [4]. An insulating behavior, however, appears at low temperatures in the resistivity of the samples with longer irradiation times. The observed correlated metal (superconductor) – insulator transition is induced by the random potential effect, which may be qualitatively different from the Mott transition. We will discuss the random potential effect near the Mott transition in the organic dimer-Mott system on the basis of the experimental results of the dc conductivity and the optical conductivity spectra.