Characteristic Voltage Oscillation and Simulation of Nonlinear Conductivity in Organic Conductors

Takehiko Mori[1], Kozo Tamura[2], Tatsuhiko Ozawa[2], Yoshimasa Bando[1], Tadashi Kawamoto[1]
[1]*Department of Organic and Polymeric Materials, Tokyo Institute of Technology, Japan*
[2]*Department of Chemistry and Materials Science, Tokyo Institute of Technology, Japan*
Email: mori.t.ae@m.titech.ac.jp

Recently, giant nonlinear conductivity has been successively found in several organic conductors [1], and current oscillation called an organic thyristor has been reported [2]. We have reproduced the voltage-current (*V-I*) characteristics by assuming energy balance [3]. When the resistivity follows a simple activation type, the *V-I* characteristics show a smooth peak, but when the resistivity undergoes a sharp metal-insulator transition, the *V-I* characteristics exhibit a sharp negative differential resistance as exemplified by β"-(BEDT-TTF)$_3$(HSO$_4$)$_2$ (Fig. 1), which is satisfactorily reproduced by the simulation (Fig. 2). Since the energy balance equation defines nonlinear dynamics with respect to electron temperature, the model affords not only oscillation but also chaotic outputs. α-(BEDT-TTF)$_2$I$_3$ also shows the steep "transition-type" nonlinearity, and exhibits remarkable voltage oscillation (Fig. 3), whose frequency (several 10 kHz) increases in proportion to the current. In analogy with narrow band noise in sliding one-dimensional density waves, the characteristic oscillation is interpreted by the collective motion of two-dimensional charge order, where a bundle of 10-15 chains is moving collectively.

[1] T. Mori, et al., J. Mater. Chem. 17 (2007) 4343. [2] F. Sawano, et al., Nature 437 (2005) 522. T. Mori, et al., Phys. Rev. Lett. 100 (2008) 037001. [3] T. Mori, et al., Phys. Rev. B 79 (2009) 115108.

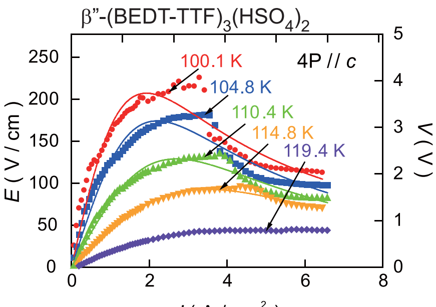

Fig. 1

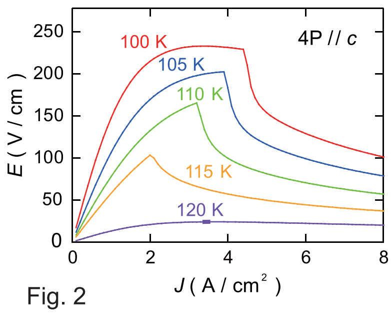

Fig. 2

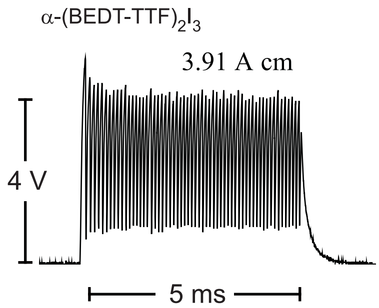

Fig. 3