Nonequilibrium Charge Ordering in θ-(BEDT-TTF)$_2$MM'(SCN)$_4$ (M=Rb, Cs; M'=Co, Zn)

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The organic salt θ-(BEDT-TTF)$_2$RbZn(SCN)$_4$ (the Rb salt) exhibits a charge ordering (CO) transition at 190 K, and has been extensively investigated as a two-dimensional charge ordered conductor for the last decade. In contrast, the related salt θ-(BEDT-TTF)$_2$CsZn(SCN)$_4$ (the Cs salt) shows fluctuation of CO below about 100 K, but does not show thermodynamic phase transition down to 2 K [1]. Inagaki et al. [2] and Sawano et al. [3] found large nonlinear conduction in the Cs salt at 4 K, which was ascribed to the suppression of CO specified with a wave vector of $\mathbf{q}_2$=(0, *k*, 1/2). By means of x-ray diffraction in external currents, Watanabe et al. [4] and Ito et al. [5] found that the peak intensity at $\mathbf{q}_2$ roughly linearly decreases with current density. Similar suppression of the $\mathbf{q}_2$ peak is observed in a rapidly-cooled Rb salt [6], which is non-thermal evidence of this phenomenon. Sawano et al. [7] and Inada et al. [8] showed that the activation gap evaluated from the resistivity linearly decreases with current density.

Here we show how the CO gap of these salts changes with temperature and current, and quantitatively discuss how and why the external current density drives this phenomenon by comparing the experimental data with theories of nonequilibrium CO phase transition proposed by Mori et al. [9] and Ajisaka et al. [10]. Since the two theories correspond, respectively, to the T*- and μ*-models in nonequilibrium superconductivity, we will further discuss the relationship between the two nonequilibrium phenomena.

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