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Coulomb brocade transport emerged in two dimensional organic polymer layers

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Abstract

Interface between organic semiconductor and dielectric is an important key requirement to survey the mechanism of carrier transport, because only few molecular layers at the interface govern the intrinsic feature in organic field effect transistors. Nevertheless, fundamental questions in terms of charge transport mechanisms in such low-dimensional organic layer are still controversial. A nonlinear conduction, which depends on both temperature and lateral voltage, is an intriguing and fundamental physical property of them. Recently, power law behaviors of current-voltage characteristics have been reported in low dimensional systems. In some cases, the apparent of power law has been related by dissipative tunneling processes, such as Coulomb blockade. The Coulomb blockade effect was rarely suggested for origin of the nonlinear conduction in condensed organic conductors.

We investigated a charge transport through two-dimensional conjugated polymer monolayer. The observed features, lateral voltage threshold decrease as temperature increase and the subsequent current increase according a power law, coincide in an expression for electrical conductivity in two-dimensional Coulomb blockade array system. We propose a carrier transport model composed of isotropic extend state of charged carrier in the monolayer, which has been calculated by a density functional theory calculation. Quantitatively evaluated capacitances of the charged states are adequate to explain the experimental results, though they are quite small as compared with that of metal particles. We suggest that Coulomb blockade effect should be taken into account as one factor in origin of nonlinear charge transport, which is frequently observed in organic materials.

Biography

Megumi Akai-Kasaya obtained her Ph.D. in physical chemistry from Osaka University in 1997 on the topic of STM imaging mechanisms of organic molecules combined with computational simulations. She is currently an Assistant Professor of Division of Precision Science & Technology at Graduate School of Engineering Osaka University. From 2005–09 she joined the PRESTO program of “Structure Control and Function” at Japan Science and Technology agency. Her scientific interests include self-assembly in non-equilibrium/dynamic systems, carrier transport in nanostructured soft materials and development of new functional device utilizing their nanoscale physical properties.