Charge transport and devices of soft semiconductor crystals

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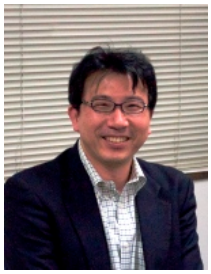
Usually, charge transport is described using extended coherent electronic wavefunctions in a static, periodic lattice in “solid” matters. Therefore, the fundamental challenge arises to characterize and understand charge transport in “soft” lattices with vibrating molecules. In soft molecular organic materials charge transport originates from the overlap of the molecular orbitals between adjacent molecules. The vibration of these molecules, however, considerably modifies charge transport to the point that the coherence of charge transport is severely limited or even collapses. Therefore, one has to seriously fight with the molecular vibration to realize high-speed organic electronics in the presence of coherent charge. This colloquium focuses on the impact in the fields of physics, chemistry, and engineering by emergence of charge coherence in weakly van der Waals bonded molecular systems, which was not yet experimentally established even in the previous century. The discovery of high-mobility organic semiconductors and elucidation of band transport by Hall-effect measurement, which took place early this century, caused the paradigm shift not only in the understanding of physics of charge transport. It also motivated chemistry to synthesize molecules based on a new prescription, and broadened possible future markets due to practical applications enabled with high-speed transistors.



Jun Takeya is a Full Professor in Graduate School of Frontier Sciences at the University of Tokyo from 2013. He got his Ph.D. at the university in 2001 when he was a research scientist in Central Research Institute of Electric Power Industry from 1991. He was an Associate Professor in Graduate School of Science at Osaka University from 2006 and became a Full Professor in Institute of Scientific and Industrial Research at the same university at 2010 before moving to the current position. His research interests lie in the area of material science and device physics of organic electronics.