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Reversible and simultaneous control of conduction and magnetism in organic materials by UV irradiation

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Abstract

We have developed molecular non-magnetic insulators which reversibly exhibits metallic properties with localized spins under light irradiation. Such materials can be applied to electromagnetic switches and sensors controlled by light. Such devices are advantageous over existing ones in terms of low energy consumptions and having both function of memory (magnetism) and calculation (conduction). Our strategy is exciting many CT transitions at a time by white light, causing a large amount of electron transfer between photochemical redox pairs. Since the radical anions of $Ni(dmit)_2$ complex molecule, to which we pay particular attention, often produce Mott insulators, this strategy may correspond to "optical doping" to Mott insulators. Doping to Mott insulators is known for often leading to high-T_C superconductors and other unusual physical properties demonstrated by cuprates and fullerides. For example, the methyl viologen (MV) salt, $MV[Ni(dmit)_2]_2$, exhibits higher conductivity under UV irradiation than that under dark by three orders of magnitude, and also exhibits metallic behavior under UV irradiation down to low temperature. The irradiation of vis-NIR light, which is intensely absorbed by the $Ni(dmit)_2$ radical monoanions, does not lead to such high (photo)conductivity. This may be because the photoconductivity of standard mechanism produces carriers in the $Ni(dmit)_2$ bands at the cost of charge disproportionation, while our CT-based photoconductivity can produce more carriers without such charge disproportionation. By clarifying the mechanism as well as synthesizing related compounds, we can make further steps towards new compounds with better performance, which will be applied to practical use in the future advanced information technology.

Biography

Toshio Naito has completed his Master Degree of Science from The University of Tokyo and became an assistant professor at Toho University at the age of 25 years. He obtained PhD at the age of 30 years from The University of Tokyo. He is a full professor, the Director of the Department of Chemistry, and the Dean of Molecular Science Course in Department of Chemistry and Biology, Graduate School of Science and Engineering, Ehime University. He has published more than 170 papers in reputed journals and serving as an editorial board member of Chemistry Letters (The Chemical Society of Japan).