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Giant photoconductivity in organic materials by UV irradiation

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In our group the molecular charge transfer (CT) complexes including photoreactive species such as Ag⁺, [Ru(bpy)₃]²⁺, and methyl viologen have been widely examined to elucidate their possibility as new types of photoconductors. It is anticipated that utilizing the photoreactive species as a trigger of CT, the counter species are doped with carriers under irradiation to exhibit unusually large photoconductivity. The π -electron-donor molecules with extended molecular orbitals are suitable for such counter species, because they are redox-active and aggregate in the solid state to form conduction pathways. NMQ[Ni(dmit)₂] (NMQ=N-methyl quinolinium, dmit=1, 3-dithiol-4, 5-dithiolate anion) functions as a diamagnetic insulator with an activation energy, $E_a(\text{dark})$, of 0.20 eV. However, at 300 K it exhibits ~40 times higher conductivity under UV irradiation (375±5 nm, 15.7 mWcm⁻²) (σ_{UV}) than it does under dark conditions (σ_{dark}). The ratio $\sigma_{\text{UV}}/\sigma_{\text{dark}}$ rapidly increases with decreasing temperature and reaches ~880 at 200 K. From the temperature dependence of σ_{UV} the activation energy under irradiation, $E_a(\text{UV})$, is 0.12 eV. These observations cannot be explained as the result of sample heating during UV irradiation. Rather, X-ray photoelectron spectra of sulfur and nitrogen atoms, the calculated band structure and UV-Vis spectra of the salt all indicate that CT takes place from Ni(dmit)₂ to NMQ upon exposure to UV light. Owing to the redox activity of both molecular species, the CT transition is expected to provide a larger number of carriers than are usually associated with HOMO-LUMO interband transitions, thus accounting for the unusually large photoconductivity of NMQ[Ni(dmit)₂].

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).

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