

Photoconductive Properties of Thin Films of Molecular Materials, C₆₀ Fullurene and Oxotitanium(IV) Phthalocyanine

Chyongjin PAC

Kawamura Institute of Chemical Research, 631 Sakado, Sakura, Chiba 285, Japan

Fully π -conjugated molecules are inherently potential candidates for molecular semiconductors, conductors, and superconductors [1]. Molecules have their own unique structures that are essential in determining conductive properties of molecular materials. Phthalocyanines (Pc's) are typical and "classical" molecular materials with a fully π -conjugated planer structure, which have been widely used as thermally stable molecular semiconductors with versatile functions. Among Pc's, oxotitanium(IV) phthalocyanine (OTiPc) has been in commercial use as one of the most sensitive photoconductors for electrophotographic (Xerographic) printing [2]. On the other hand, C₆₀ fullerene is a "newcomer" in the field of material sciences that has been attracting "hot" scientific interests because of the unique, fully π -conjugated soccer-ball-like structure as well as from expectation of new functions. It was however reported that the photoconductivity of C₆₀ solid films is very low without attempted doping [3]. Therefore, a very few works have been carried out on the photoconductive behavior of C₆₀, in sharp contrast to an "explosive" increase of works on the superconductivity of C₆₀ films doped with alkali metals. The comparative investigation on conductive properties of the "classical" planer molecule (OTiPc) and the "new" spherical molecule (C₆₀) would be of crucial significance associated with the understanding of conduction mechanisms in devices based on molecular materials as well as with the development of new devices using functionalized molecules.

In general, planer Pc molecules can take different stacking modes to give various crystal forms, which play essential roles in the photoconductivity [4]. While such stacked molecular assemblies can be predicted to show anisotropic conductive behavior, it is extremely difficult to fabricate various solid films of unsub-

stituted Pc's, in which Pc molecules are orderly oriented and aligned with respect to the substrate (electrode) plane [5,6]. Therefore, little is explicitly known on relationships between molecular stacking habits and photoconductive properties of unsubstituted Pc's. On the other hand, totally symmetric C₆₀ has no anisotropy in molecular stacking and was reported to undergo rapid rotation in the solid state at room temperature. Nevertheless, devices composed of C₆₀ vacuum-deposited films and metal electrodes reveal divergent photoconductive behavior depending on fabrication conditions and the electrode materials [3,7], thus suggesting that other important factors should participate in controlling the conductive properties.

The present lecture deals with (1) fabrication of highly ordered thin films of OTiPc by means of a Langmuir-Blodgett method and vacuum-deposition techniques, (2) conductive properties of the OTiPc films in the dark and under illumination, (3) unusually high photoconductivity of Al/C₆₀/metal sandwich cells, and (4) photovoltaic effects of solar cells based on a molecular OTiPc/C₆₀ p-n junction.

Details will be presented in the lecture.

References

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