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Photo and Electrical Properties of Organopolysilanes and Their Applications

Masaaki YOKOYAMA

Polysilanes have been recognized as a new class of functional polymers characterized by high hole mobility due to σ-conjugation in their Si backbone as well as ultra-violet (UV) photodecomposition due to the photochemical nature of Si-Si bonds. Since the first report of their film-forming capability in early 1980s, considerable attention has been paid from the viewpoint of both basic research and technological use.

In this paper, several novel applications will be presented based mainly on our recent investigations on the photo and electrical properties of polysilanes.

(1) Application to Electrophotographic Photoreceptors

The high hole mobility of the order of 10^{-4} cm^2/Vs for amorphous polymers[1] has attracted extensive interests in their potential application as electrophotographic photoreceptor materials, especially as a hole transport material. Several combinations with a-Se[2] or organic pigment[3] as a charge photogeneration material in the layered photoreceptors gave the excellent photosensitivity enough to practical use. Unfortunately, however, there has been no report on their practical use so far. The reason is mainly due to their weak mechanical properties rather than their electrical properties. The continuous efforts to develop new Si-based polymers will be desired.

(2) UV Modification of polysilane-based Photoreceptor

UV irradiation on polysilane films gives rise to various physical or chemical property changes as a result of UV photodecomposition accompanying Si-O-Si and Si-OH bond formations. The UV irradiated polymer turns to the completely insulating polymer with no charge transport ability due to disconnection of σ-conjugation by the insertion of hetero atom. Thus, pre-exposure of UV image on the polysilane-based photoreceptor can modify it into a "memory photoreceptor", i.e.,the multi-duplication with once UV image exposure becomes possible in electrophotographic copying process without every image exposure.[4] The working mechanism is shown in Fig. 1. This provides a demonstration for ingenious combination of the physical and chemical properties of polysilanes.

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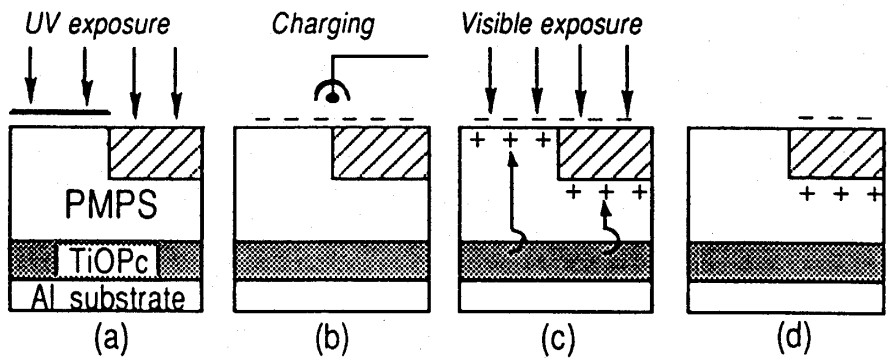

Fig. 1 Electrophotographic process by a "memory photoreceptor" based on UV photodecomposition. Repetition of (b)-(d) gives multi-duplication without every image exposure.

(3) Pattern Coloration of Polysilane Film Imaged by UV Irradiation

The Si-O-Si and SiOH bond formations due to UV photodecomposition in air are considered to induce wettability or swelling effect to water only in the UV irradiated part. The UV irradiated polysilane film was effectively dyed simply by soaking it into aqueous dye solution.[5] Fig. 2 illustrates a typical pattern dyeing. The coloration based on spatially well-patterned UV photo-decomposition would be applicable in manufacturing color filters for TFT liquid crystal display. The UV enhanced swelling effect is also applicable to the patterned electrochemical deposition of pigment micell, and the electrochemical polymerization of thiophene in the polysilane film to form the conducting polymer pattern.

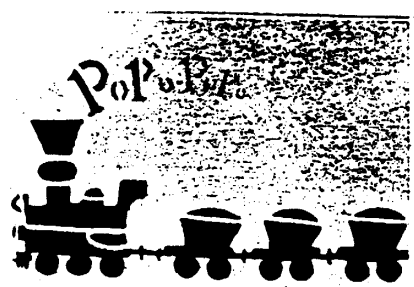

Fig. 2 Typical pattern dyeing of polysilane film.

(4) Thermo-chemical Decoloration of Titanyl Phthalocyanine Pigment with Polysilane

Accidentally, we have found a peculiar decoloration reaction of blue-colored titanyl phthalocyanine (TiOPc) with polysilane in a layered structure of TiOPc and polysilane films by heating higher than 250°C.[6] This decoloration of TiOPc has been revealed to be due to the thermo-chemical reaction triggered by pyrolysis of polysilane, but not due to sublimation of the pigment. Such phenomena occurred only in cases of oxometal phthalocyanines such as TiOPc and VOPc. Interestingly, the decoloration reaction was accelerated by UV pre-exposure on the polysilane film, i.e., decoloration occurred at much lower temperature of about 200°C depending on the dose of UV exposure. This means that the heat-treatment of UV pre-exposed polysilane/TiOPc layered films at an appropriate temperature (~250°C) enable us to develop the decoloration pattern corresponding to the UV image. Furthermore, if TiOPc pigments were taken as a photon-thermal energy transducer, the conversion of the reaction from thermal to photon mode becomes possible. The writing-in with a focussed diode laser beam marked small decoloration pit of 1 μm in diameter. This would provide a novel write-once type optical recording based on thermo-chemical reaction different from pigment abrasion.

References

1) R.G. Kepler, J.M. Zeigler, L.A. Harrah, S.R. Kurtz, Phys. Rev. B, 35, 2818 (1987).
2) M. Stolka H.-J. Yuh, K. McGrane, D.M. Pai, J. Polym. Sci. Polym. Chem. Ed., 25, 823 (1987).
3) K. Yokoyama and M. Yokoyama, Chem. Lett., 1989, 1005.
4) K. Yokoyama and M. Yokoyama, Appl. Phys. Lett., 55, 2141 (1990); J. Imag. Technol., 16, 219 (1991)
5) M. Yokoyama, T. Koura, Y. Hiroshige, S. Notsu, Chem. Lett., 1991, 1563.
6) M. Kakui, K. Yokoyama, M. Yokoyama, Chem. Lett., 1991, 867.