Novel Chromogenic Materials Expected for Future FPD

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Abstract

Phtalocyanine derivative thin films were accumlated on ITO glasses by a Langmuir-Blodgett method. The layered structure and chromogenic properties of the films were investigated. We observed color changes which took place probably according to modulations of electronic distributions in the molecule. The novel chromogenic mechanism which can be applied to future FPD's was proposed.

1. Objectives and Background

Many transition metal oxides[1] and also organic materials[2] have been studied about applications to an electrochromic (EC) flat panel display (FPD). The conventional EC phenomena had, however, fatal problems, namely slow responses and/or a short life of color changes according to chemical redox reactions. So the EC FPD's have not been widely studied, while a smart window system using characteristic color changes of WO_3 films has been developed.

We have proposed a new mechanism of reversible color changes, namely a novel chromogenic phenomenon which was induced by applied electric fields not accompanying with redox reactions. In the model the distribution of electrons is expected to be changed intra molecules. A Langumuir-Blodgett (LB) technique has been widely adopted to accumulate ultrathin molecular films with characteristic assembly structures. In this work we have focussed phthalocyanine derivative LB films with highly aligned dye molecular. The layered structure and chromogenic properties of the LB films were investigated.

2. Experimental Procedures

The details of the LB apparatus used were appeared in elsewhere[3]. The phthalocyanine derivative studied was an Aluminium1,4,8,11,15,18,22,25-octabutoxy-29H, 31H-phthalocyanine triethyl siloxide (AlPcTr). An arachidic acid (AA), $CH_3(CH_2)_{18}COOH$ was also used as an amphiphilic molecule in order to stabilize a Langumuir-film on the subphase surface. These molecular structures were schematically shown in Fig. 1. The AlPcTr was a commercial product of Aldrich-Chemical Co., Ltd. , and the AA was one of Kanto-Chemical Co., Ltd.

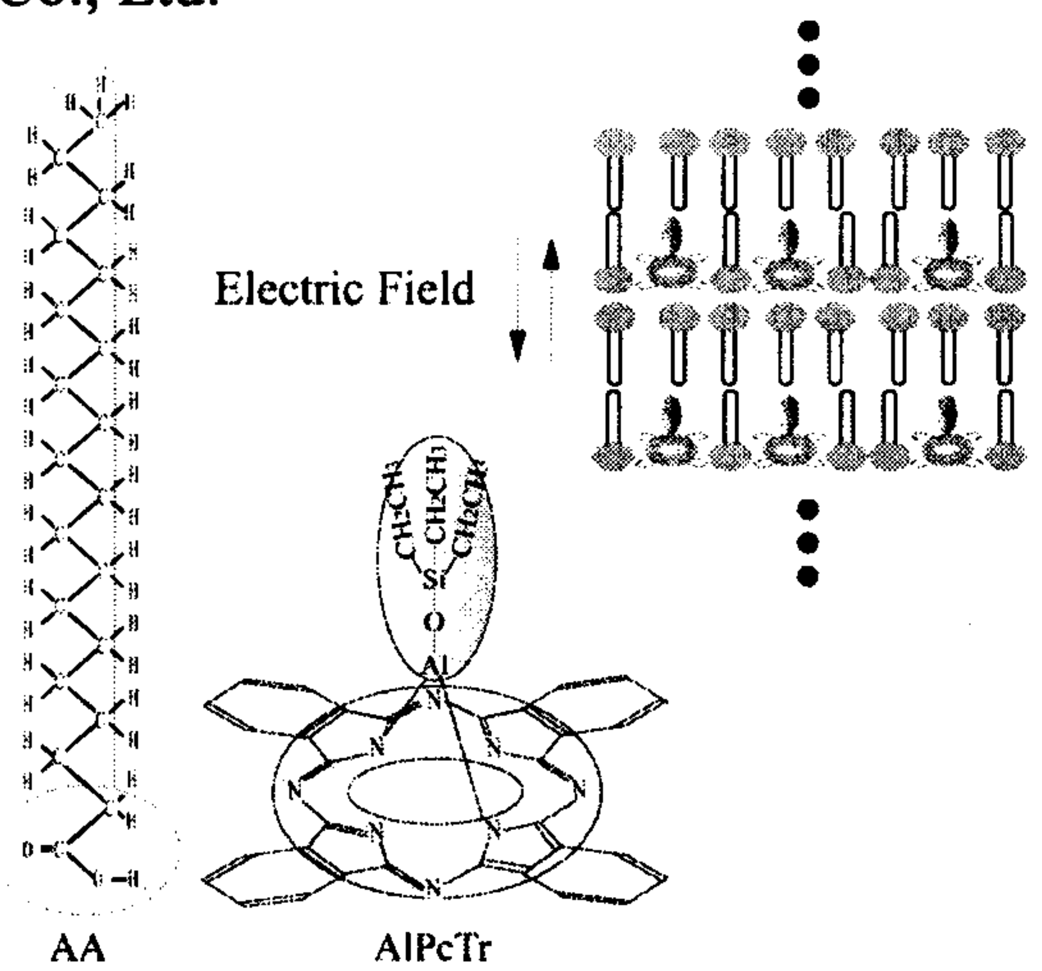

Figure 1: Molecular structures of the arachidic acid (AA) and the phthalocyanine derivative (AlPcTr). Also the schematic hetero-layered structure of the LB film.

We prepared chloroform mixtured solution of AlPcTr with the concentration of 0.64mmol/l and AA with the concentration of 3.2mmol/l. After spreading the solution a Langumuir-film of AlPcTr/AA was kept on a water subphase of pH 10.3 containing 2mmol/l $CaCl_2$ and 0.1mmol/l NaOH. The subphase was maintained at 290K in a clean room. The film was transferred onto the ITO substrates at a constant surface pressure (30mN/m) through vertical dipping/lifting strokes with the speed of 12mm/min.

The accumulation of the LB films was done by the two kinds of processes; strokes for only AlPcTr/AA, and alternated dipping/lifting strokes for AlPcTr/AA and AA. The latter case was named as the hetero-layered LB film.

The layered structure of the obtained films was investigated by a reflected X-ray diffraction (XRD). The chromogenic properties were measured in the cell where the LB film was sandwiched by electrodes of Au films and ITO.

3. Results

The lattice spacing of the AlPcTr/AA film evaluated from the XRD peaks was about 5.3 nm, of which the value was approximately two times as long as a molecular length of AA. These results revealed that a symmetrically accumulated structure was formed in the LB films. From the result we expected that the molecular planes of the phthalocyanine were aligned parallel to the film planes. Furthermore AlPcTr molecules in the hetero-layered films were aligned nonsymmetrically as shown in the inset of Fig. 1.

The voltages of less than 5V were applied to the cell. Then the leak current flowed in the cell because of poor insulation of the film. Figure 2 shows the typical color changes observed in the hetero-layered LB film with 160 layers. The absorption peak was changed by applying voltages of 3V. The chromogenic field effect was confirmed for the first time though the magnitude of the color change was not so large.

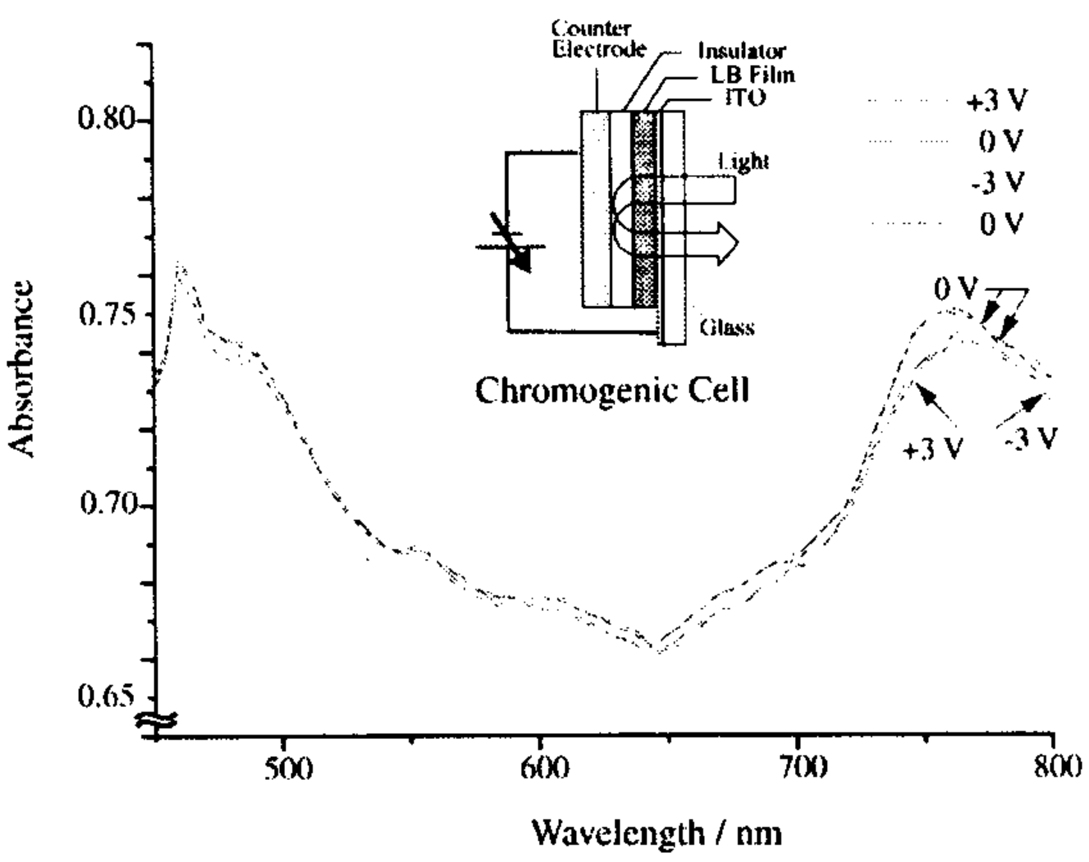

Figure 2: Color changes observed by applying voltages of the hetero-layered AlPcTr /AA LB film. The inset is the schemtic cell structure for the measurement of chromogenic properties.

4. Impact

Phtalocyanine derivatives were accumlated in the LB films on ITO glasses. By applying voltages to the chromogenic cell reversible color changes were observed. It was thought that the modulations of electronic distributions in the molecules resulted in the color changes of the film. The newly obtained result shows the possibility of future FPD's with high speed responses and low electric power consumptions.

5. References

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