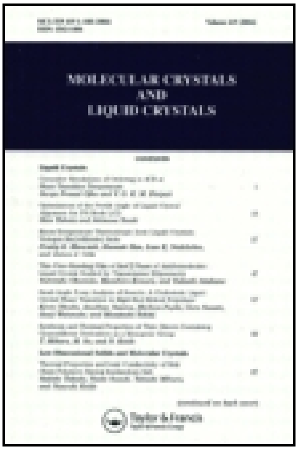

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Electrical Properties and Surface Structure of Polyurethane Monolayers

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Electrical Properties and Surface Structure of Polyurethane Monolayers

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We attempted to fabricate polyurethane derivatives (PU-CN, PU-DCM) LB films by using LB method. We investigated the monolayer behavior at the air-water interface and the surface morphologies of LB films was investigated by surface pressure-area (π-A) isotherms and atomic force microscopy (AFM), respectively. Also, the electrical properties of PU derivatives LB films were investigated by using the conductivity, Schottky barrier height and the dielectric constant.

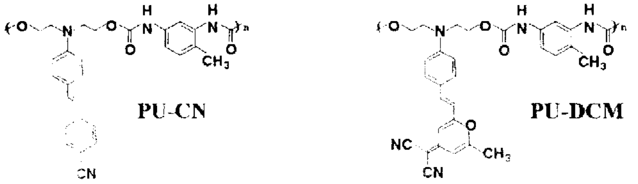
Keywords: polyurethane derivatives, conductivity, dielectric constant

INTRODUCTION

In the last decade, the studies of electroluminescence in organic materials have concentrated on the thin film type devices made of vacuum-deposited films, or polymer films [1]. The single layer EL devices using 4-(Dicyanomethylene)-2-methyl-6-(4-dimethylamino-styryl)-4H-pyran (DCM)-dispersed polyurethane derivative (PU) layer were carried out in previous paper [2]. The increasing interest into technical applications of Langmuir-Blodgett (LB) films emphasizes the need to pay special attention to the mechanical stability of the film structures [3]. Polymerizable surface active substances offer an interesting alternative to produce extremely stable thin and homogeneous organic films. In this paper, we attempted to fabricate polyurethane derivatives (PU-CN, PU-DCM) LB films by using LB method. Also, we investigated the monolayer behavior at the air-water interface by surface pressure-area (π-A) isotherms. And, the surface morphologies and the physicochemical properties of LB films were investigated by atomic force microscopy (AFM) and UV-vis spectroscopy, respectively. Also, the electrical properties of polyurethane derivatives LB films were investigated by using the conductivity and the dielectric constant.

EXPERIMENTAL

PU-CN and PU-DCM denote the PU derivative possessing stilbene pendant and DCM dye as a pendant, respectively (Fig.1). The synthesis of the PU derivatives was described in previous paper [4].



(a) PU-CN (b) PU-DCM

FIGURE 1. Molecular structures of polyurethane(PU) derivatives.

The surface pressure-area (π-A) isotherms were investigated by NL-LB200-MWC (Nippon Laser and Electronics Lab, Japan) Moving Wall Method; trough size: 80 mm ×585 mm). The LB transfer was carried out on a freshly cleaned silicon wafer and glass slide. We carried out AFM imaging in the contact mode with a commercial instrument Autoprobe CP (PSIA, Korea). For the electrical properties of the LB films, a DC power supply and a Keithley 6517 electrometer were used to measure the current-voltage (I-V) characteristics. The capacitance of the MIM structure was measured by a HP 4192A impedance analyzer from 5 Hz to 13 MHz [5].

RESULTS AND DISCUSSION

Figure 2(a) shows surface pressure-area (π-A) isotherms of PU-CN and PU-DCM on the pure water. PU-CN formed monolayer with the limiting areas of 37 Å^2/molecule without any transition. In contrast to this, for PU-DCM, the surface pressure developed at large molecular area of 70 Å^2/molecule and on the compression of the monolayer became the condensed state with the limiting areas of 66 Å^2/molecule through the transition region. The larger molecular area of PU-DCM seems to be ascribed to the increased hydrophilicity. Figure 2(b) shows the ultraviolet-visible (UV-VIS) absorption spectra for LB films of PU derivatives. The effective absorption wavelengths of PU-CN and PU-DCM LB films are at about 550 and 650 nm, respectively.

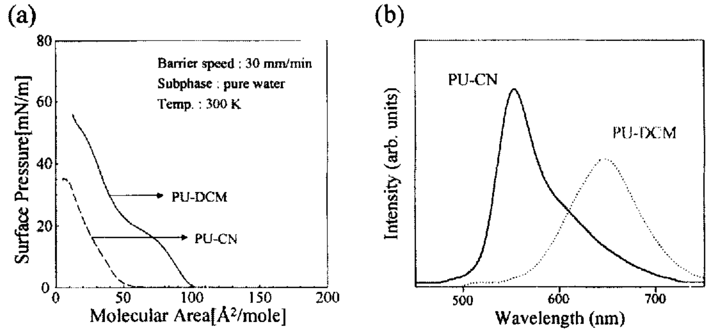
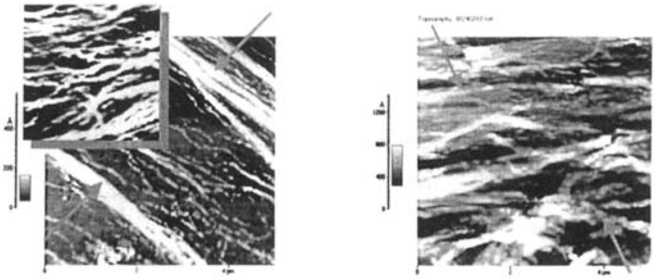


FIGURE 2. (a) surface pressure-area (π-A) isotherms of polyurethane(PU) derivatives (b) UV-vis absorption spectra of polyurethane(PU) derivatives.

Figure 3 shows the AFM images for LB films of PU derivatives deposited on a silicon substrate. The AFM images show the differences in the surface morphology between PU-CN and PU-DCM LB films, such as molecular packing density, homologous series of monolayers, film thickness.



(a) PU-DCM (b) PU-DCM

FIGURE 3. AFM images of LB films of polyurethane(PU) derivatives.

We conclude that surface morphology of PU-DCN LB films is smooth and homogeneous and has optimal hydrophobicity and good stability, whereas PU-CN LB films give rougher surfaces with more excess material.

In the current-voltage (I-V) characteristics, the conductivity of PU-CN and PU-DCM LB films were about 8× 10^{-15} and 2× 10^{-13} S/cm, respectively, which corresponds to these of the insulating properties. Also, the Schottky barrier height of PU-CN and PU-DCM LB films obtained in the current-voltage (I-V) characteristics was about 1.36 and 1.31 eV, respectively. Dielectric constant of PU-CN and PU-DCM LB films obtained from the capacitance characteristics were about 2.64 and 4.66, respectively. This phenomena could be described by the difference of lumophore pendent which was adhered at PU main chain. It was considered that lumophore pendent is affected the I-V characteristics. But, we could not obtain the accurate response mechanism yet. Table 1 lists the values of the conductivity and relative dielectric constant for electrical properties of PU derivatives LB films.

TABLE 1. Conductivity, dielectric constant and activation energy of PU derivatives LB films.

Materials	Conductivity	Dielectric constant	Schottky barrier height
PU-CN	8×10^{-15} S/cm	2.64	1.36 eV
PU-DCM	2×10^{-13} S/cm	4.66	1.31 eV

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