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Multilayers of merocyanine dyes and their mixture were prepared on a glass substrate by the Langmuir-Blodgett (LB) method. The J-aggregates of dye molecules have been confirmed by the optical absorption and fluorescence spectra. The structures of these films are investigated by a scanning near-field optical/atomic force microscopy (SNOAM). SNOAM images showed that the topographical and optical structures of these films were not only depended on the chemical property but also physical property.

Keywords: SNOAM; topographic image; optical transmission image

INTRODUCTION

The spectroscopy of dyes has been a popular subject of study for many years, both theoretically and experimentally[1,2]. Merocyanine dyes, originally developed as photosensitizers for silver halide photography, have renewed interest as a class of organic photoconductor, which may be useful for high efficiency photovoltalic device. On the studies of photoconductivity,

the formation of J-aggregates is one of the important subjects for molecular arrangement of dye because the existence of J-aggregation can improve the optical applications, and variously reported[3-5]. Even though, various reports were faced on the optical properties of merocyanines, there were no reports on the optical structures of these dyes.

On the other hand, the SNOAM[6,7], which was introduced as one application of the atomic force microscope (AFM), is a new tool for the study of photographical structure and optical property of a sample surface. In this paper, we will illustrate the topographical structure and optical structure of the merocyanine dye LB films obtained by the SNOAM.

EXPERIMENTAL

The sample for the optical and topographical measurement was prepared by the standard procedure LB deposition technique with 10 layers using glass substrates. SNOAM measurements were performed applying approximately 3 mW of 488 nm line of Ar ion laser in coupled with the untapped end of the fiber probe with dynamic (non-contact mode) and transmission mode operation. The optical-fiber cantilever is mounted on a bimorph and vibrated vertically (typically 15~40kHz). The distance between the tip of the probe and sample surface is controlled by a laser-beam-deflecting AFM technique in which the cantilever vibrates vertically at the resonant frequency. (Model SPI 3700, Seiko Instruments Inc.).

RESULTS AND DISCUSSION

In merocyanine LB films, their anisotropy and the J-aggregates of dye molecules have been confirmed by optical spectrum[5]. Figure 1 shows the dynamic mode AFM image (a) and near-field optical transmission image (b) of merocyanine dye LB film [DO] by SNOAM. The distance between cantilever and sample maintained about 50 nm during the experiment, and scan rate held 0.127 Hz with 256 scan lines.

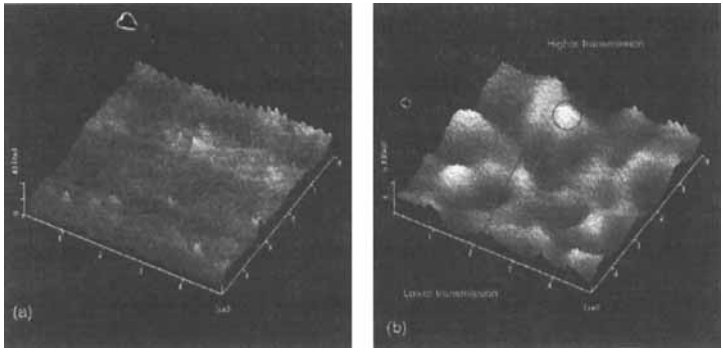

FIGURE 1 Surface topography (a) and optical transmission image (b) of merocyanine dye LB film (DO) in the area of 5×5 μm^2

See color plate XIII at the back of this issue.

In the topographic image, the LB film shows more rough surface structure than that of our expectation, and is grained with average size about 50 nm. The grain size is influenced by the chemical and deposition condition of film. In the same image, elevated parts correspond to dyes (DO) and the lower parts to the glass surface. In the optical transmission

image, the dark orange color parts correspond to the dye surface of weak optical responses and the yellow and white color parts to the dyes depend on strong optical responses because the all parts are transparent. In the same image, the elevated area means higher transmission than lower parts. The higher and lower parts are understandable as the gathered region of activated and inactivated photo-carrier, respectively. The far-field spectrum study for these merocyanine LB films, their anisotropy and the J-aggregates, previously reported[5]. In the continuous measurement on these dyes, the appearance of near-field optical transmission images showed a certain dependence on the kinds of dyes and the mutual mixing ratios of dyes. These experimental results suggest that there is a certain kind of interaction between these two dyes. In conclusion, the dual information, their optical structure and surface morphology, afforded by SNOAM system is valuable for LB film research, their optical response and surface morphology.

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