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The Study on Optical Characteristics and Surface Morphologies for J-aggregates Formation of Merocyanine Dye LB Films

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The Study on Optical Characteristics and Surface Morphologies for J-aggregates Formation of Merocyanine Dye LB Films

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In this study, we investigated the optical characteristics of merocyanine dye Langmuir-Blodgett (LB) film and had analysis combined with surface morphology using AFM. And preparation condition for merocyanine dye LB film was determined. As a result, domains could be observed in the J-aggregate LB film and domain size was dependent on the mixing ratio. And the domain had very homogeneous two-dimensional structure. After UV irradiation, the domain size was decreased or disappeared correspond to the decrease of absorbance peak, which mean the dissociation of J-aggregate. These results can suggest the modulation of structure by light

Keywords : merocyanine dye, LB method, J-aggregate, AFM

INTRODUCTION

J-aggregate formation of dye molecules has been investigated extensively in the Langmuir-Blodgett film due to its possible application to high efficiency photo-electric devices such as solar cell, photovoltaic cell, photochemical swiching device[1-3]. Also the isomerization in the film is dependent on the geometrical packing of the photoactive molecules[4]. In this study, we report on the morphology of the J-aggregated LB film of merocyanine dye and its structural change using AFM after UV irradiation, which mean the dissociation of J-aggregate state.

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EXPERIMENTALS

The merocyanine dye (NK2746, Hayashibara Biochemical Lab.) was used for the fabrication of optical system without further preparation. The cadmium-containing buffer solution can contribute to form J-aggregate at air/water interface. For the LB film deposition, moving wall barrier type trough was used. Generally, the fatty acid has been used to improve the structural stability of dye LB film. In this study, the dye was mixed with arachidic acid and their moral ratio of [dye]:[C_{20}] were 1:1 and 1:2. The optical systems were fabricated and kept in the dark state to avoid any optical reaction.

RESULTS AND DISCUSSION

Figure 1 (a) represents the π-A isotherm as to the mixing ratio(solid - 1:2, dashed-1:1). The monolayer mixed with arachidic acid can form more stable state on the air/water interface, which suggest that the mixing with arachidic acid can contribute to improve the stability of monolayer.

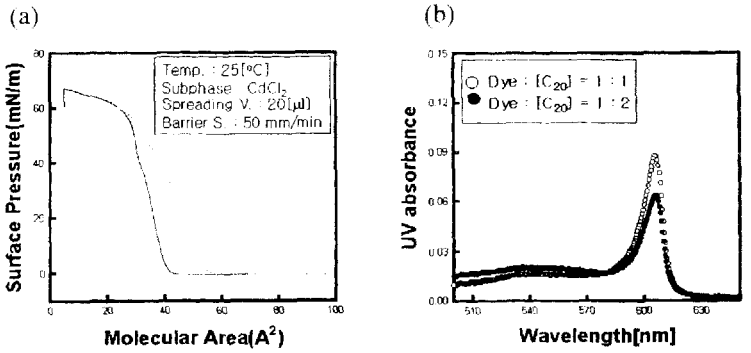

Figure 1. The π-A isortherm (a) and UV absorbance (b) of monolayer LB film of merocyanine dye

Figure 1 (b) shows the UV absorbance fabricated by the different mixing ratio. The narrow absorbance peak was occurred at around 600nm, which has been characterized as J-aggregates. The absorbance peak was decreased with the amount of arachidic acid mixed. These kinds of absorbance peak couldn't be observed in the case of pure water subphase, so the merocyanine dye molecules with Cd salt contribute to the formation of J-aggregate on air/water interface.

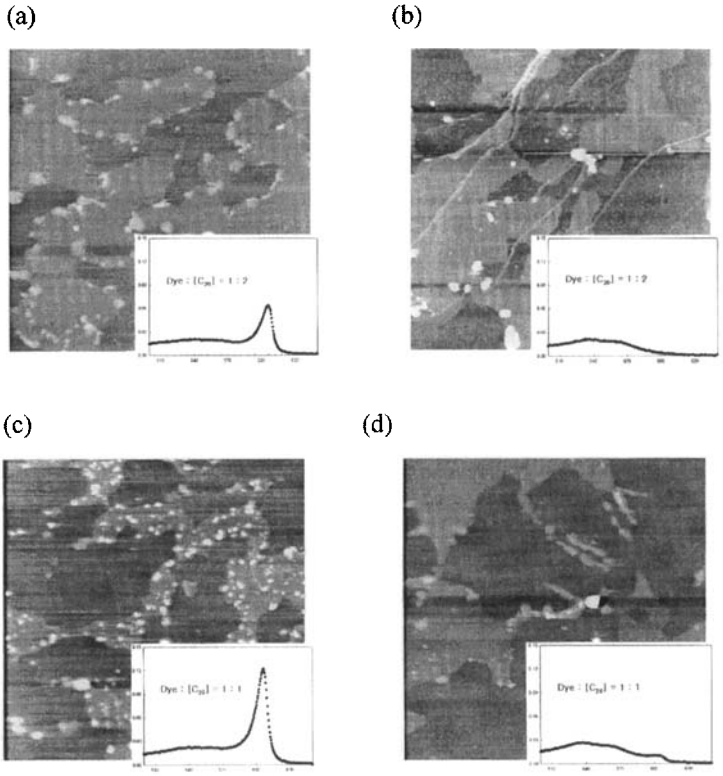

Figure 2. The AFM image of merocyanine dye before UV irradiation (a), (c), after UV irradiation (b), (d)

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Figure 2 (a) and (c) show the AFM images as to the mixing ratio. In this figure, domain with well defined structure and good roughness around or in irregular grain can be easily recognized. These domains are considered as the J-aggregated structure, their height was from 30 to 50Å above that of monolayer. But it was very homogenous, that is, its average roughness was calculated by 1.27Å and irregular background grain below 10Å. Also the domain size was resulted from the mixing ratio and affected to the absorbance peak of visible range. Figure 2 (b) and (d) represent the typical images obtained after UV irradiation respectively. The domain had smaller size or disappeared compared with that before UV irradiation, which can suggest the modulation of structure by light. Also the narrow 3 dimensional structures could be occasionally found. This phenomenon was reported by some researcher[4]. Now we are considering the method to obtain the regular size domain with reproducibility. It is thought that this kind of approach may be necessary and useful to develop the photo-electric device based on the nano particle.

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