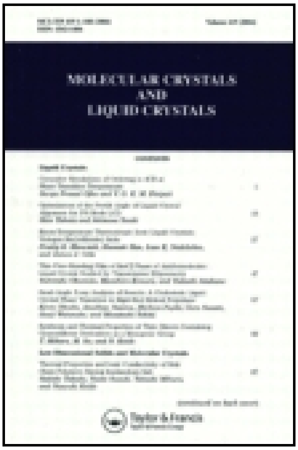

Molecular Crystals and Liquid Crystals Science and Technology. Section A. Molecular Crystals and Liquid Crystals

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/gmcl19

Fabrication of Protein Adsorbed Organic LB Film by Electrophoretic Sedimentation Technique and Analysis of Morphology by using AFM

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Version of record first published: 24 Sep 2006

Mol. Cryst. and Liq. Cryst., 2000, Vol. 349, pp. 291-294
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The formation of molecular hetero-film consisting of green fluorescence protein (GFP) and viologen LB film using the electrophoretic sedimentation technique (EPS) is investigated. The fabrication condition by EPS such as the exposure voltage affects the topology and photoresponse of GFP films. Based on the surface topology measured by atomic force microscopy (AFM), the optimal electric field for the fabrication of GFP film was found as 4.5V.

Keywords: green fluorescent protein; viologen; electrophoretic sedimentation technique

INTRODUCTION

The green fluorescent protein(GFP) is the final light emitting protein in the bioluminescent jellyfish *Aequorea victoria*[1]. The GFP absorbs blue light and emits green light. Molecular electronic device consisting of GFP films for one-way electron transport has been developed due to their high response and excellent stability in photoelectric properties[2].

To construct the molecular electronic devices with GFP films, the formation of aggregated molecular films of GFP has been considered as one of the most important factors dominantly affecting the device performance. The film formation of protein by the electrophoretic sedimentation technique(EPS) using static force difference of molecules provided a high degree of density without loss of activity. The objective of this study is to investigate the optimal fabrication conditions of GFP films by EPS technique. The effects of film fabrication conditions on the electrical response and surface morphology of GFP films are verified.

EXPERIMENTAL DETAILS

GFP was purchased from CLONTECH Co.(rEGFP, USA). N-Allyl-N'-[3–propylamido-N",N"–di(n-octadecyl)]-4,4'-bipyridium dibromide (violo gen), were synthesized. In pH 8.0, GFP has the negative net charge because of the isoelectric point of GFP is 5.0. And viologen has been positive net charge. Because of net charge difference two molecules were easily interacted. The deposition of viologen LB film was carried out using a circular Langmuir trough (Type 2022, NIA Tech., England). 11 layer LB film of viologen were deposited onto the ITO glass substrate. GFP suspension was injected between the electrodes by a syringe and then various electric potential was applied across the electrodes. After the GFP film was dried, aluminum as a top electrode was deposited by vacuum evaporation with slow rate to minimize the film damage. Thus metal/insulator/metal(MIM) structured device was constructed. The photocurrent of GFP films was measured using a low-noise current preamplifier(Stanford Research Systems, SR570, USA), an amplifier (B&H, DC 10000-H20, USA) and an oscilloscope(HP 54610B, USA). The 500W Xenon arc lamp(Oriel Co., USA) was used as a light source. The topologies of GFP films under various electric fields were obtained by AFM(Autoprobe CP, PSI, USA).

RESULTS AND DISCUSSION

Fig.1 shows the topologies of GFP films fabricated by the EPS technique under various electric fields, which were obtained by AFM. As shown in

Fig.1(a), the aggregations of GFP molecules are observed and the GFP molecules are partially adsorbed onto viologen surface. This result might be due that the small aggregations of GFP molecules are already constructed by molecular-molecular interaction in solution. In Fig.1(b), the large aggregations of GFP molecules is observed. In Fig.1(c), spherical type of aggregations of GFP molecules is observed and the aggregation size of GFP molecules is about 0.1~0.5μm. In Fig1.(d), the degradation of GFP molecules is observed due to the high applied voltage.

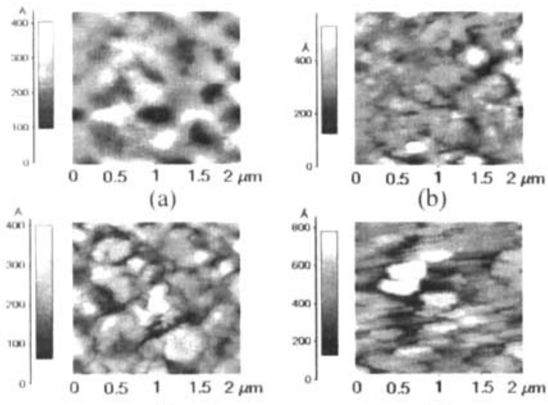

FIGURE 1. 2μm size AFM Topography of GFP film surface fabricated by EPS technique with various electric fields: a, 1.5V; b, 3V; c, 4.5V; d, 6V.

The effect of the electric field on the photoresponse of the GFP film is shown in Fig.2. In Fig.2(a) and (b), the photocurrent of the GFP film is fairly low since the partially interacted GFP molecules are adsorbed onto the viologen surface under the low electric field. In Fig.2(c), the peak value of photocurrent is slightly larger than that of Fig.2(b) and the slope of current decay is similar to that of Fig.2(a) and (b). It can be considered that the increase of electric field causes an increase in the adsorption of GFP molecules, which induces the increase of the peak value of photocurrent. The peak value of photocurrent of the GFP films increased with the increase of the applied electric field. The rising slope of the photocurrent of the GFP film formed at 4.5V of electric field is more stable and the decay time of the photocurrent is shorter and intensity of the photocurrent is higher compared to those obtained from other conditions. Thus the optimal electric field for the fabrication of GFP film is found as 4.5V.

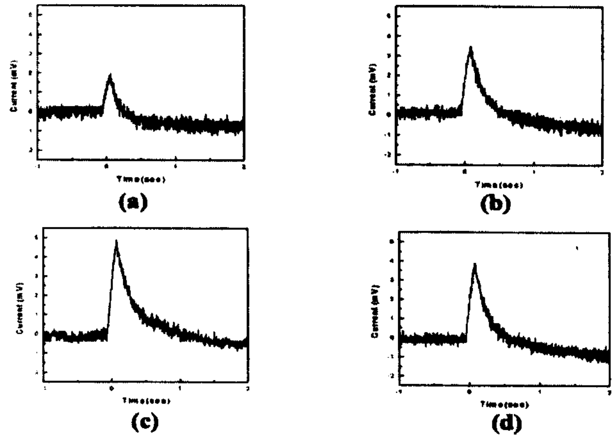

FIGURE 2. Photoelectric response of GFP films fabricated by the EPS technique with various electric fields : a, 1.5V; b, 3V; c, 4.5V; d, 6V

The EPS technique using electrostatic force difference was useful method for ultra-thin film formation of GFP.

Acknowledgement

This work was supported by grants from Korea Science and Engineering Foundation (KOSEF : 98-0502-08-01-3).

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