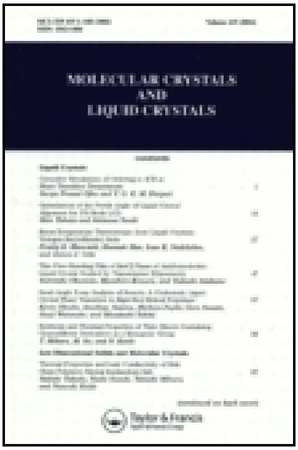

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Characterization and Optimization of Device Configuration Composed of Bacteriorhodopsin-Flavin Complex LB Films

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A dual-band photoreceptor using complex Langmuir-Blodgett (LB) films of bacteriorhodopsin (bR) and flavin was constructed. Several conditions such as the number of layers, the electrolyte pH, and the deposition order of two molecules, were examined and analyzed. The optimal fabrication conditions for the proposed dual-band photoreceptor were determined as 10 layers of bR LB films, 6 layers of flavin LB films, the electrolyte pH 7, and the deposition order of ITO/bR/flavin, respectively.

Keywords: dual-band photoreceptor; complex LB films; bacteriorhodopsin; flavin; photocurrent

INTRODUCTION

Bacteriorhodopsin (bR), the proton pumping protein embedded in the purple membrane of *Halobacterium salinarium*, is one of the most widely studied proteins due to its long-term stability and availability in many fields of applications. Practical applications of bR have been reported in the development of bioelectronic devices such as artificial photoreceptors, optical memory devices, and image processing systems [1-3].

Flavin, the constituent of flavin mononucleotide (FMN), has been used as a crucial component of an artificial photoinduced electron transport system. By mimicking the biological electron transport system, such as bacterial photosynthetic reaction center, the artificial molecular photodiode using flavin films as an electron sensitizing component have been demonstrated [4,5].

In the present paper, the photoelectrical characteristics of the dual-band photoreceptor using bR-flavin complex LB films capable of detecting almost all visible light (400 nm ~ 650 nm) was investigated. In order to obtain the optimal performance of the proposed photoreceptor, several fabrication conditions which mainly dominate the device characteristics were examined and analyzed.

EXPERIMENTALS

Bacteriorhodopsin was purchased from Sigma Chemical Company (St. Louis, USA), and flavin was synthesized according to the method described in the previous works [5,6]. The deposition of bR and flavin LB films were carried out onto ITO glass (surface resistance < 20 Ω) with a circular-type Langmuir trough (Model 2022, Nima Tech., UK). Two types of the photoreceptors were fabricated by depositing bR and flavin in order of ITO/bR/flavin and ITO/flavin/bR, respectively. The photoreceptor consisting of bR-flavin complex LB films was set into an electrochemistry cell, and connected to the photocurrent measurement system composed of a low-noise current preamplifier (SR570, Stanford Research System, USA), an amplifier (DC10000H2O, B&H Electronics, USA), and an oscilloscope (Gould, UK) [6]. Xenon lamp system (Oriel Co., USA) with optical filters (550 nm for bR and 400 nm for flavin) was used as an input light source.

RESULTS AND DISCUSSION

Figure 1 shows the effect of the number of layers on the photocurrent generation of bR and flavin LB films. As the number of layers was increased, the photocurrent of bR was gradually increased and saturated at around 10 layers. Over than 10 layers, the photocurrent of bR was not affected by the number of layers. On the other hand, the photocurrent generation of flavin was not affected by the number of layers. It might be resulted from the different mechanisms of photocurrent generation of bR and

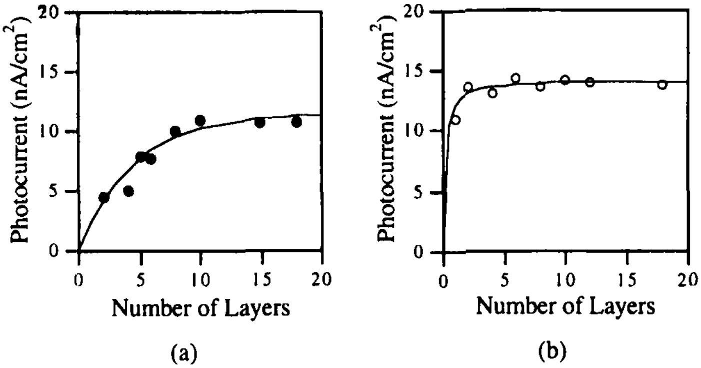

FIGURE 1. Magnitude of photocurrent as a function of the number of layers. (a) bR LB films (surface pressure, 30 mN/m; pH = 7) (b) flavin LB films (surface pressure, 39 mN/m; pH = 7).

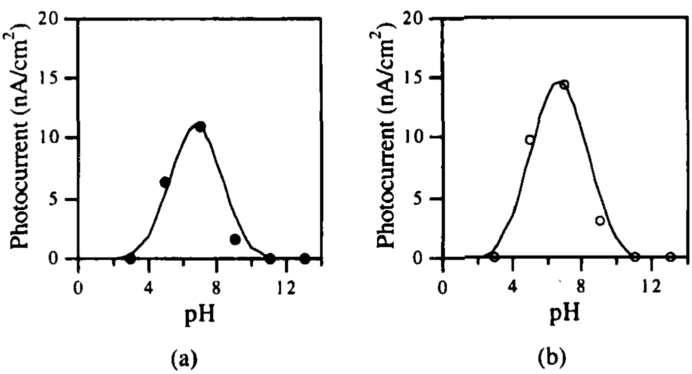

FIGURE 2. Magnitude of photocurrent as a function of the electrolyte pH. (a) bR LB films (surface pressure, 30 mN/m; number of layers, 10) (b) flavin LB films (surface pressure, 39 mN/m; number of layers, 6).

flavin. While the photocurrent generation of bR is mainly dependent on the proton gradient across the deposited films, that of flavin is dominated by the interfacial electron transfer at flavin/electrode interface. Based on the results, the optimal number of layers for bR and flavin LB films was determined as 10 and 6, respectively.

Figure 2 shows the effect of the electrolyte pH on the photocurrent generation of bR and flavin LB films. In both cases, the maximum net outputs of the photocurrent were obtained at around pH 7 (neutral pH), in which the biological activity of the functional molecules can be maximized.

TABLE 1. Photocurrent generation by the proposed dual-band photoreceptor with two different configurations (bR LB films, 10 layers; flavin LB films, 6 layers; electrolyte pH, 7).

Device Configuration	Photocurrent (nA/cm^2)	
	bR	flavin
ITO/bR/flavin	10.7	14.3
ITO/flavin/bR	7.2	19.2

The photocurrent generation by the proposed dual-band photoreceptor with two different configurations was also investigated, and the results were shown in Table 1. In the case of ITO/bR/flavin, the magnitude of photocurrent of bR was greater than that of ITO/flavin/bR. It might be due to the difference of the electrical resistance of bR and flavin LB films. The magnitude of electrical resistance of the flavin LB films was 1000 times larger than that of bR LB films. Therefore, the flavin LB films can act as a resistive layer in the ITO/flavin/bR configuration. It can be considered that the deposition order of ITO/bR/flavin is more advantageous than that of ITO/flavin/bR since the detection error can be caused by the small magnitude of photocurrent. From these results, the suitable configuration of the complex LB films for the dual-band photoreceptor was determined as ITO/bR/flavin.

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