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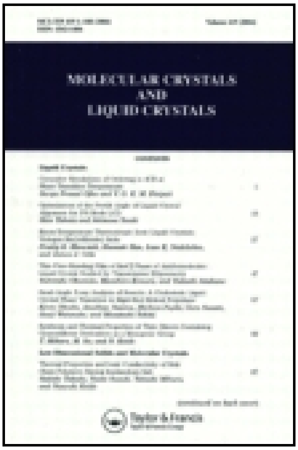


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# Photoelectric Response Characteristics of Molecular Photoreceptor Using Bacteriorhodopsin/Flavin Complex LB Films

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# Photoelectric Response Characteristics of Molecular Photoreceptor Using Bacteriorhodopsin/Flavin Complex LB Films

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The photoelectric response characteristics of the artificial photoreceptor composed of bacteriorhodopsin (bR)/flavin complex Langmuir-Blodgett (LB) films were investigated. It could be found that three distinctive regions existed in the obtained action spectrum. According to the obtained results, it was possible to organize the basic rules and to interpret the wavelength of the input light. It can be suggested that the proposed photoreceptor with the rule-based algorithm would be applicable to the bioelectronic device for color recognition.

*Keywords:* bacteriorhodopsin; flavin; complex LB films; photocurrent; action spectrum; artificial photoreceptor

## INTRODUCTION

Bioelectronics has been considered as one of the most challenging fields capable of providing new concepts and technologies for the development of electronic devices and systems. By mimicking the specific functions of the biological systems, bioelectronic devices have been demonstrated in the many fields of applications, such as biosensors, memory devices, and image processing systems [1-3].

In the present paper, the photoelectric response characteristics of the artificial photoreceptor using bR/flavin complex LB films were investigated. By analyzing the action spectrum of the proposed photoreceptor, the potential applicability of the proposed device as an artificial photoreceptor for color recognition was validated.

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## EXPERIMENTALS

Bacteriorhodopsin was purchased from Sigma Chemical Company (St. Louis, USA), and flavin was synthesized according to the method described in the previous works [2,3]. The complex LB films were prepared by depositing bR (10 layers) and flavin (6 layers) onto ITO glass (surface resistance < 20 Ω). The artificial photoreceptor was fabricated by setting the prepared bR/flavin complex LB films into an electrochemistry cell (0.1 M KCl) equipped with Pt electrode as a counter electrode. Using a 300 W Xenon lamp (Oriel Co., USA) and several optical filters, a series of monochromatic lights were illuminated onto the photoreceptor. The generated photocurrent was detected through a current preamplifier (Stanford Research System, USA), an oscilloscope (Hewlett Packard, USA), and a personal computer.

## RESULTS AND DISCUSSION

With the monochromatic light illumination, the impulse-like differential response of bR (550 nm) and the pulse-like response of flavin (400 nm) were obtained as shown in Figure 1(a) and (b), respectively. Since the signal shapes are different from each other, it can be used as a crucial factor to interpret the wavelength of the input light.

The photoelectric responses of the proposed photoreceptor were represented in Figure 2. It was found that three distinctive regions exist in the action spectrum. In the region of 400 ~ 500 nm, the flavin signal

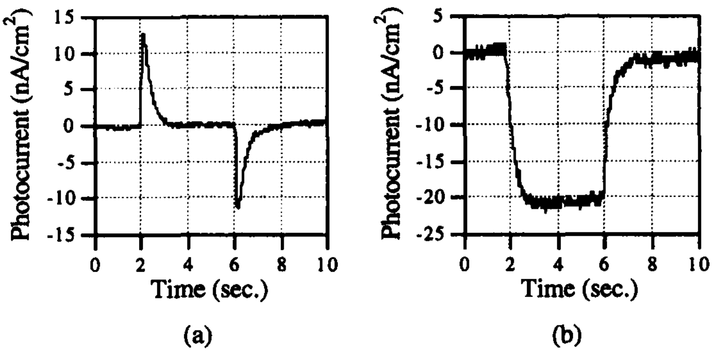


FIGURE 1 Typical photoelectric response of bR (a) and flavin (b).

was dominant one, and the photocurrent was linearly proportional to the wavelength of the input light. At around 500 nm, the mixed signal shape was obtained due to the combined effect of the photoelectric conversion by bR and flavin molecules. In the region of 550 ~ 650 nm, the bR signal was dominant one, and the photocurrent was linearly proportional to the wavelength of the input light.

Based on the action spectrum analysis, the following equation can be suggested to interpret the wavelength of the input light.

$$\lambda = \alpha I + \beta \tag{1}$$

where, $\lambda$ is a wavelength of the input light, $I$ is a photocurrent obtained from the photoreceptor, and $\alpha$ and $\beta$ are the constant. If the signal has a pulse-like shape, the wavelength of the input light is corresponding to the region **A**. Then, the values of $\alpha$ and $\beta$ in Eq.(1) become -3.922 and 499.61, respectively. On the other hand, if the signal has a impulse-like shape, the wavelength of the input light is corresponding to the region **C**. Then, the values of $\alpha$ and $\beta$ in Eq.(1) become -9.921 and 679.96, respectively. If the signal has a mixed shape of pulse-like and impulse-like one, it is considered that the wavelength of the input light is corresponding to the region **B**. Therefore, it is possible that the

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wavelength of the input light can be interpreted by analyzing the signal shape and the magnitude of photocurrent based on the obtained relationship. It is concluded that the proposed photoreceptor with an appropriate algorithm can be applied to the development of the bioelectronic device for color recognition.

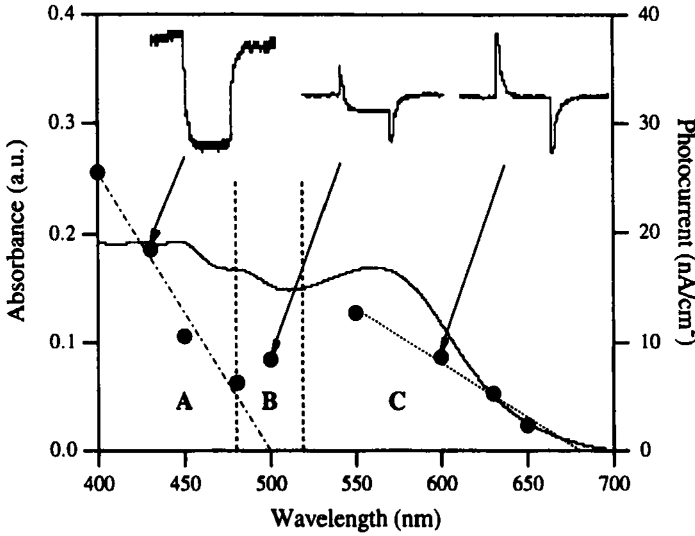


FIGURE 2. Absorption spectrum (solid line) and the resulting photocurrent (filled circle) of the proposed photoreceptor; **A**, **B**, and **C** represent three distinctive regions corresponding to the different signal shapes.

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