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Optimal Fabrication Condition of Bacteriorhodopsin Thin Films Onto Modified Self-Assembled Monolayers

Hyun-Goo Choi [a], Junhong Min [a], Keon-Kook Han [a], Young-Kee Kim [a], Won Hong Lee [a] & Jeong-Woo Choi [a]

[a] Department of Chemical Engineering, Sogang University, C.P.O. Box 1142, Seoul, 100-611, Korea

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Optimal Fabrication Condition of Bacteriorhodopsin Thin Films Onto Modified Self-Assembled Monolayers

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Department of Chemical Engineering, Sogang University, C.P.O. Box 1142, Seoul 100-611, Korea

The optimal condition of bacteriorhodopsin (bR) adsorption onto the modified self-assembled monolayers (SAMs) was investigated. The SAMs of 11-mercaptoundecanoic acid (11-MUA) on the pre-treated gold substrate were used as a template, and modified with poly-L-lysine (PL) for the effective adsorption of bR. Based on the photoelectric responses of the bR thin films, it could be found that the optimal bR suspension concentration and buffer pH for bR thin film fabrication were determined as 5 mg/mL and pH 8, respectively.

Keywords: bacteriorhodopsin; self-assembled monolayers (SAMs); poly-L-lysine; photocurrent; optimal condition

INTRODUCTION

Ultrathin film preparation technology, such as Langmuir-Blodgett (LB) and self-assembly (SA), has been widely used as the most effective method for the fabrication of the highly ordered and close-packed molecular arrays of biological and/or organic molecules [1,2].

Bacteriorhodopsin (bR), the light-driven 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 [3-5].

In the present paper, the optimal fabrication condition of the bR thin films by SA technique was investigated based on the photoelectric responses of the bR thin films with the different fabrication conditions.

EXPERIMENTALS

Bacteriorhodopsin (bR), 11-mercaptoundecanoic acid (11-MUA), poly-L-lysine (PL), and other miscellaneous reagents were purchased from Sigma Chemical Company (St. Louis, USA). Self-assembled monolayers (SAMs) of 11-MUA were formed by soaking the prepared gold substrate into 2 mM ethanolic solution of 11-MUA for 24 hrs, and then rinsed with absolute ethanol and D.I. water before drying under the nitrogen atmosphere. The SAMs of 11-MUA on gold were immersed into 0.1 mM PL solution (pH 8.0) for 2 hrs, and then dried for 2 hrs. The prepared thin films of PL/SAMs/Au were then soaked into the bR suspensions with the various conditions of buffer pH and concentration. The bR/PL/SAMs/Au structured complex films were set into an electrochemistry cell equipped with ITO glass as a counter electrode, and a monochromatic light (550 nm) was illuminated onto the fabricated bR thin films using a 300 W Xenon Lamp (Oriel Co., USA). The resulting photoelectric responses were obtained through a current preamplifier (SR570, Stanford Research System, USA), an oscilloscope (HP54610B, Hewlett Packard, USA), and a personal computer.

RESULTS AND DISCUSSION

Figure 1(a) shows the typical photoelectric response of the bR thin films fabricated by SA technique. When a monochromatic light was

illuminated onto the prepared thin films (at about 1 sec.), the typical differential response could be obtained. The inverted photoresponse could also be obtained when the light was turned off (at about 2 sec.). The obtained responses were well consistent with the previously reported results except that the response time is much faster than others obtained from the LB films or electrophoretic sedimentation (EPS) films (data not shown). In order to validate the applicability of the fabricated bR thin films as a photoreceptor, the relationship between input light intensity and the photocurrent generation was also investigated. The magnitude of photocurrent was increased with the increase of the input light intensity, and a linear relationship could be obtained as shown in Figure 1(b).

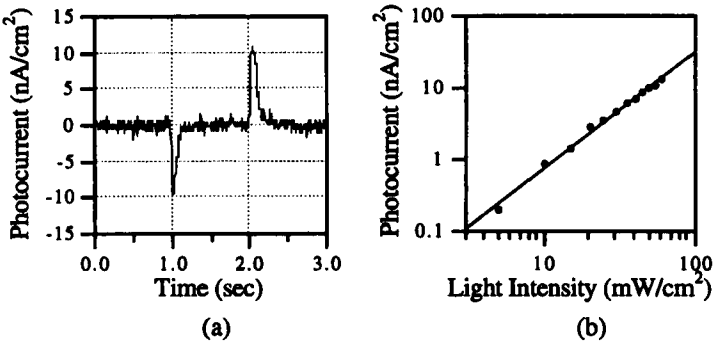

FIGURE 1. Photoelectric response characteristics of the bR thin films fabricated by SA technique; (a) typical response, (b) photocurrent as a function of the input light intensity.

Figure 2 shows the concentration and pH dependency of the photocurrent generation. As the bR suspension concentration was increased up to 5 mg/mL, the resulting photocurrent was increased. However, the magnitudes of the photocurrent were nearly same over 5 mg/mL as shown in Figure 2(a). These results indicate that the amount of the adsorbed bR molecules is not varied significantly when the

concentration is over 5 mg/mL, and thereby the photocurrent generation would not be affected by the bR suspension concentration.

In the case of the buffer pH variation, the maximum photocurrent could be obtained at pH 8. Since the isoelectric points of bR and PL are about 4.85 and 9.74, respectively, bR molecules can be effectively adsorbed onto the PL surface in the pH range of 6~8, and thereby the magnitude of photocurrent would become greater. From these results, the optimal bR suspension concentration and the buffer pH for the bR films fabrication by SA technique could be determined as 5 mg/mL and pH 8, respectively.

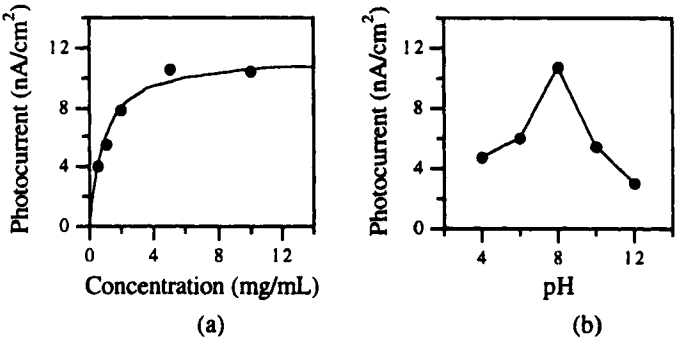

FIGURE 2. Photocurrent of the bR thin films fabricated by the different conditions; (a) bR suspension concentration (buffer pH = 8.0), (b) buffer pH (bR suspension concentration : 5 mg/mL).

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