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Bioelectronic Device Consisting of Bacteriorhodopsin for Pattern Recognition

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Bioelectronic Device Consisting of Bacteriorhodopsin for Pattern Recognition

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Signals of a photoreceptor consisting of various configurations of bacteriorhodopsin (bR) and lipid films were analyzed to achieve the data (signal) transfer between molecular basic units without wiring. The signal shapes of the photoreceptor varied with different film fabrication conditions and film configurations. The possibility of data processing without pattern for pixelization in bioelectronic devices was presented.

Keywords: pattern recognition; bacteriorhodopsin; photocurrent; photoreceptor

INTRODUCTION

The development of new information-processing devices has emerged by utilizing the information-processing functions of living organisms and by using the molecular organization. Various artificial molecular devices have been fabricated by mimicking the functions of specific material recognition in many enzymes or photoelectic conversion in biological membranes. One of the most outstanding characteristics of bioelectronic device is the specific functionality of the biomolecules which can act as a basic unit of electronic devices. But, in order to achieve these characteristics, molecular wiring is needed for the data or

information transfer between molecules. Thus, the simple concepts for the data transfer and processing in bioelectronic device are required.

In this paper, the input images with several shapes were projected onto the photoreceptor consisting of bacteriorhodopsin (bR) and lipid. The output signals from the photoreceptor were different from one another as the different input images were projected. It would be possible that the photoreceptor without pixelization has capability of pattern recognition.

PRINCIPLES

The total signal from a photoreceptor consisting of bR films is the result of the summation of signals from individual bR molecule. If molecules are deposited with different conditions, the signal from each molecule is different from one another. Therefore, the discrimination of individual signal of specific region from total signal is possible if a photoreceptor is fabricated by various deposition conditions and different film configurations.

EXPERIMENTALS

Bacteriorhodopsin (bR) was deposited by Langmuir-Blodgett (LB) technique with various configurations. The three basic types of film configurations (1. bR/ITO; 2. bR/lipid/ITO; 3. lipid/bR/ITO) were selected. The layer of lipid was used as a diffusion limitation layer for H^+ ion. All experiments were performed in an electrolyte solution (0.1M KCl) with ITO electrode as a counter electrode.

RESULTS AND DISCUSSION

The output signals from the photoreceptor consisting of bR films deposited with various configurations were investigated with respect to the various input images. Input images have same shapes with different direction as shown in Figure 1 (a) and (c), but the output signals were different from one another. This result is due to the fact that each part of bR film was deposited under different configurations and environments. Thus, this photoreceptor is capable of recognizing pattern and sensing position.

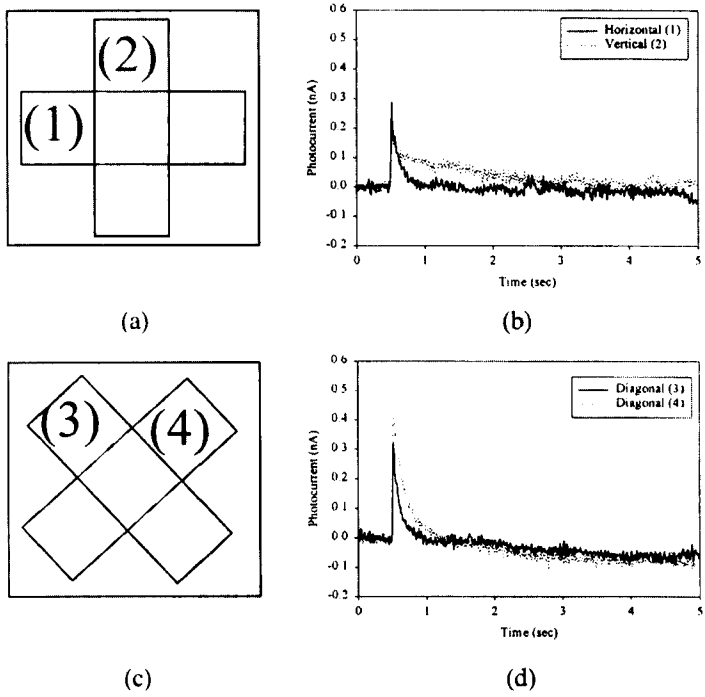

FIGURE 1. The several input images and the resulting output signals from the photoreceptor consisting of bR films fabricated with several configurations; (a) input images of horizontal and vertical rectangles (1) and (2); (b) output signals by (1) and (2); (c) input images of diagonal rectangles (3) and (4); (d) Output signals by (3) and (4).

Figure 2 represents that the total signal of the photoreceptor resulted from the summation of individual part of the photoreceptor. As shown in Figure 2(a) and (b), the signal by input image of one half circle was different from that by the other half circle. Figure 2(c) and (d) represent that the signal by input image of whole circle was well consistent with the summation of two half circles, (1) and (2). Using the proposed photoreceptor, the input image can be recognized by analyzing the output signal without wiring and pixelization. It is concluded that the signal transfer of bioelectronic device in molecular level is possible and this

property can be applied to bioprocessor without wiring and pixelization.

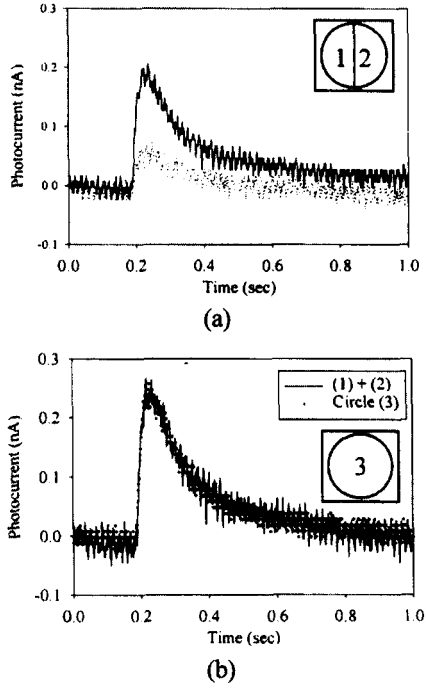

FIGURE 2. The several input images and the resulting output siganls from photoreceptor consisting of bR fabricated with several configurations; (a) Output signals with respect to input images of left-side half circle,1 and right-side half circle, 2 ; (b) Output signal with respect to whole circle, 3 and summation result of signals for input images, 1 and 2.

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