A Capillary Photocell

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A photocell with a small sample volume was prepared to study photo-induced electric response of photosynthetic apparatus. The photocell has a narrow gap between an SnO2 electrode and a window glass plate as a sample chamber. Sample solutions were introduced into the chamber by capillary action. In this work, photosynthetic reaction center (RC) from *Rhodopseudomonas viridis* was used to examine photocurrent generation and the effect of herbicide.

Chromatophores, the photosynthetic membrane, were prepared from *R. viridis* (ATCC 15657) as reported previously.13 RCs were solubilized from the chromatophore (optical density at 1010 nm = 100) in the presence of 10% (w/v) *N*,*N*-lauryldimethylamine *N*-oxide (LDAO) in 10 mM Tris-HCl buffer, pH 8.2, and were purified through a Sepharose CL-6B column (φ 26 × 800 mm) with the buffer containing 0.1% LDAO.

Figure 1 shows the photocell structure. The distance between the window and the SnO2 coated glass plate (Furuuchi Chemicals, Tokyo) was kept at 0.15 mm by inserting a sheet of Parafilm (American Can Co., U.S.A.) as a spacer. The counter electrode was a Pt wire of φ 0.4 mm placed in the lower end of the chamber. The size of SnO2 electrode was 20 × 40 mm of which 10 × 25 mm was in contact with the RC solution to give the chamber volume of about 40 μl. The chamber can be easily taken apart for cleaning. A sample solution of ca. 200 μl was put into the reservoir to allow the solution go into the capillary chamber.

Illumination was given by a 50 W halogen lamp through a glass fiber with a cut-off filter at 600 nm (Fuji Film SC 60 Filter). Light intensity was 6,000 W/m2 at the surface of the window.

The sample solution contained 5 μM RC, 1 μM ubiquinone 0 (UQ-0) and 0.1% LDAO in the 10 mM Tris-HCl buffer. The short circuit current response was recorded using a Keithley model 617 electrometer where no bias potential was poised on the electrodes.

Figure 2 shows a typical current response from the RC. The response raised and dropped rapidly at the time of light-on and off. During the illumination, the photocurrent was stable. Without UQ-0, a mediator of electron transfer, the photocurrent was much reduced (Fig. 2B). Alone with UQ-0, no response was generated.

Repeated illumination with intervals of 2 min light and 2 min dark, 3 times each for each light intensity, was given to examine the reproducibility. Responses were 3.15 ± 0.13, 2.68 ± 0.04 and 1.51 ± 0.01 nA (average ± standard deviation, N = 3) for light intensities of 2150, 1800, and 880 W/m2, respectively. Results show that the deviations were small and the responses were reproducible.

In this cell, the SnO2 electrode worked as a cathode: electrons transferred from SnO2 to RC solution. It has been known that horse heart cytochrome c transfers electrons with SnO2 electrode but substantially not with Pt electrode.2,4,25 The RC of *R. viridis* has a c-type cytochrome subunit26 that is oxidized after electron supply to bacteriochlorophyll dimer. Electron flow in the cell could be explained if the oxidized cytochrome subunits accept electrons from the SnO2 electrode.

Using of the RC photocell was examined for sensing herbicides. Because the RC has a simple structure compared to chromatophores or chloroplasts, the effects could be easily analyzed. We used *o*-phenanthroline (*o*-phen), a well-known inhibitor of the electron transfer *via* the quinone of RC. Figure 2C demonstrates that 1 mM *o*-phen suppressed the current response. The effects of *o*-phen on RC have been reported using a planar lipid membrane technique.29 The same effect was clearly observed in this study.

These results show that this photocell, with a small volume to save samples, could be useful for detection of light-induced electron transfer of photosynthetic apparatus and effects of herbicide.

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**References**

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