

Notes

Photovoltage Generation in Dye-probed Bilayer Lipid Membranes

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The photovoltage generated across a bilayer lipid membrane of oxidised cholesterol, probed with a cyanine dye has been measured both in symmetric and asymmetric bathing solutions. The maximum photovoltage obtained is approximately 200 mV.

Charge separation in an illuminated photosensitive dye is a well studied phenomenon¹. Under normal circumstances, the separated charges recombine producing no net effect. However, if the dye is incorporated in a bilayer lipid membrane (BLM), the separated charges move towards the electrodes kept across the membrane and a photovoltage is obtained². The hydrophobic barrier of the BLM hinders the flow of charges preventing recombination. The photovoltage produced, is related to the nature of the dye and that of the bathing solution³⁻⁵. We report herein the photovoltage production in a BLM, probed with a cyanine derivative dye in symmetric as well as in asymmetric bathing solutions.

The dye used presently (a gift from Prof. H. Kühn) is a stearyl substituted monomethin cyanine compound⁶. Its lipid like structure (I) makes it very suitable for incorporation into BLM. The chloroform solution of the dye was evaporated to dryness to make a thin film and oxidized cholesterol dissolved in *n*-decane was added to it. The mixture was sonicated for 1 hr and centrifuged at 2000 g for 10 min. The clear supernatant was used for membrane formation⁷. The BLM, stable at least for 30 min, was illuminated by a tungsten lamp at an intensity of 0.4 mW/cm². The photovoltage was measured by a sensitive microvoltmeter between a pair of platinum electrodes placed across the BLM. Upon illumination, the photovoltage registered an increase according to the relation (1)

$$V_t = V_o (1 - \exp - \alpha_1 t) \quad \dots (1)$$

where the symbols have their usual meaning⁵. The maximum increase in V_t was about 21 mV, when 0.1 M KCl was used as the bathing solution (Fig. 1). When light was switched off, the voltage decayed as in accordance with relation (2)

$$V_t = V_o (\exp - \alpha_2 t) \quad \dots (2)$$

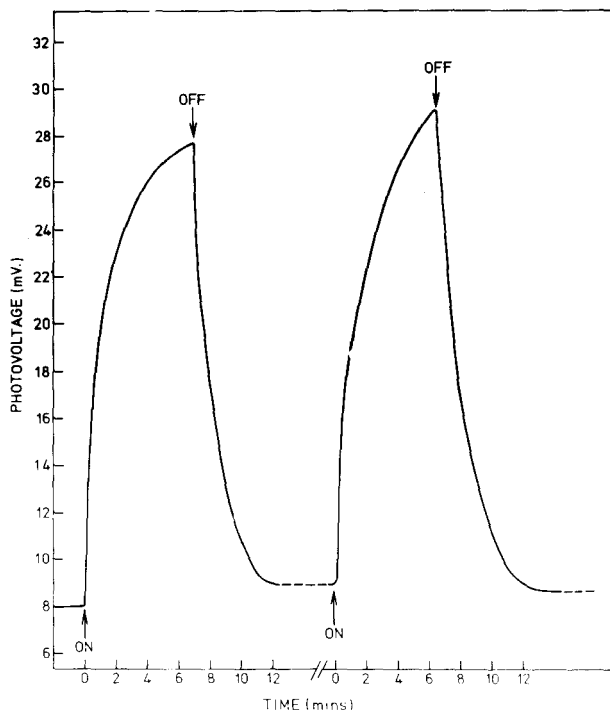
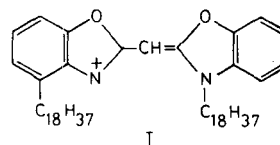


Fig. 1—Photovoltaic effect in dye-probed BLM of oxidized cholesterol in symmetric bathing solution of 0.1 M KCl



and the cycle was almost reversible (Fig. 1). The average values of α_1 and α_2 , calculated from five to six cycles were $1.6 \times 10^{-2} \text{ s}^{-1}$ and $0.6 \times 10^{-2} \text{ s}^{-1}$ respectively. In each consecutive cycle the rise in V_t was little more than in the previous cycle until the membrane ruptured after few cycles.

When FeCl_3 was added to one side of the dye-probed BLM and ascorbic acid to the other side⁸, the photovoltage shot up in the asymmetric bathing solution instantaneously and reached a maximum of approximately 200 mV, which then slowly decreased by 5-8 mV. The polarity was reversed when the chemicals exchanged sides. Unfortunately due to such a high voltage gradient across the membrane ($\sim 10^5 \text{ V/cm}$), it ruptured and the cycle could not be continued further. The rise in photovoltage under such an asymmetric condition may be due to the fact that FeCl_3 and ascorbic acid act as electron acceptor and electron donor respectively with reference to the constituent of the BLM, i.e. oxidized cholesterol and

help to facilitate the charge separation in the illuminated membrane⁵.

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