Investigation on light-addressable potentiometric sensor as a possible cell-semiconductor hybrid

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Introduction

The light-addressable potentiometric sensor (LAPS) [1] is a semiconductor-based chemical sensor with an electrolyte-insulator-semiconductor (EIS) structure. Variation of the width of the depletion layer, which is a function of the surface potential, is read out in the form of photocurrent generated by illumination.

LAPS can perform spatially resolved measurement using a scanning laser beam.

characteristics of the sensor

Characteristics of the fabricated sensor was compared with those of the SiO₂ sensor and the SiO₂ + Si₃N₄ sensor.

With this technique, two-dimensional distribution of the potential on the sensor surface can be visualized [2].

For the application of LAPS as an interface between electronic and biological systems, it is necessary to establish a method of culture that realizes excellent adhesion and efficient signal transfer.

Coating of the sensor surface

In this study, poly-L-ornithine + laminin (PLOL) coating of the sensing surface was tested.

Firstly, a 30-nm-thick oxide layer was thermally grown on the n-type silicon substrate. The sensor was kept in phosphate-buffered saline with 100μg/ml poly-L-ornithine for 24h at room temperature. After rinsing, the sensor was kept in phosphate-buffered saline with 8μg/ml laminin for another 24h at 37 °C under 5% CO₂ atmosphere.

The thickness of the resultant PLOL layer was 4nm.

Characteristics of the sensor

The PLOL-coated sensor maintained a high sensitivity for over 10 days, suggesting that the PLOL layer works as a passivation layer for the underlying SiO₂ layer. Considering the noise level of the system, it is estimated that a variation of 2mV at the sensor surface is detectable.

Culture on the PLOL-coated surface

PC12 cells and a neuron of Lymnaea Stagnalis were successfully cultured on the PLOL-coated surface.

Summary

For application of the light-addressable potentiometric sensor (LAPS) to the cell-semiconductor hybrid, poly-L-ornithine + laminin (PLOL) coating of the sensor surface was tested. The PLOL-coating is a good passivation of the underlying SiO₂ layer against the culture medium and maintained high sensitivity for over 10 days. Neural cells could be successfully cultured on the sensing surface.

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References


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