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Photo-Enzyme Cell using Fuel of Carbonate in Sea Water with the Function of Methanol Production

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Summary

Energy utilization of the biomass resources is important in the environmental science and the development of energy source research fields. Biomass resources based biofuel cells have been paid much attention for renewable energy utilization. We previously reported some photo-operated saccharide-O_2 biofuel cell. In these reports, the photo-operated glucose and sucrose-O_2 biofuel cells using chlorophyll-*a* derivative chlorin-e_6 (Chl-e_6) adsorbed onto TiO_2 layer with optical transparent conductive glass plate electrode, platinum electrode and solution with enzymatic saccharide hydrolysis. By using formate dehydrogenase FDH and viologen immobilized electrode instead of platinum electrode, photo-operated saccharide-CO_2 enzyme fuel cell with formic acid production will be developed. Thus, CO_2 or HCO_3^- (including sea water) reduces and the fuel produces while generating electricity with visible light irradiation to this enzyme-fuel cell.

In this work, new visible light operated HCO_3^- (including sea water)-glucose enzyme fuel cell consisting of chlorin-e_6 (Chl-e_6) adsorbed on TiO_2 layer onto optical transparent conductive glass electrode (OTE) as an anode, formate dehydrogenase (FDH) and viologen immobilized OTE as a cathode, and the solution containing glucose, glucose dehydrogenase (GDH) and NAD^+ as a fuel are developed.

The short-circuit photocurrent and the open-circuit photovoltage of this cell are 38 μA cm^{-2} and 380 mV, respectively.

After 1 h irradiation to cell, 10 mM formic acid is produced. Thus, HCO_3^- reduces and the fuel (formic acid) produces while generating electricity with visible light irradiation to this enzyme-fuel cell.