

Novel biochemical powered actuators with an intelligent organic (enzymatic) engine.

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Introduction

In living organism, protein molecule such as muscle molecule actin/myosin and ATP synthetase functioned directly as the devices for energy conversion and transfer with high efficiency. Since some biocatalyst could be catalyze chemical reaction with volume change at room temperature and pressure, mechanical force would be expected to be provided directly from chemical energy. In this paper, an organic (enzymatic) engine with active pressure system was developed by using asymmetric enzyme immobilized membrane, thus inducing novel biochemical powered actuators with intelligent analytical functions. Hydrogen peroxide and glucose (sugar) were selected as model chemicals of environmental friendly and biological energy.

Experimental

The organic engine as novel muscle was constructed by using two funnel type glass tubes separated by the enzyme membrane as diaphragm, in which catalase was immobilized onto the single side of the porous membrane [1-3]. By applying hydrogen peroxide (H₂O₂) solution into the non-enzyme side of the glass tube, the active pressure of the novel muscle was measured at the enzyme side continuously for evaluating the biochemo-mechanical energy conversion. Then, the biochemical powered actuators were also constructed using the organic engine system.

Results & Discussion

The active pressure of the novel muscle increased following the application of hydrogen peroxide solution into the non-enzyme side of the glass tube in the organic engine system at normal temperature. The output pressure was linearly related to the concentration of hydrogen peroxide over a range of 11.8 to 123.6 mmol/l, with a correlation coefficient of 0.994 deduced by regression analysis as shown by the following equation:

$$\text{pressure (Pa)} = -15.56 + 4.35 [\text{H}_2\text{O}_2 \text{ (mmol/l)}]$$

The novel biochemical powered actuators with the organic engine system also performed the intelligent and amazing biochemo-mechanical behaviours with not only hydrogen peroxide but also glucose solution (independently or simultaneously) at normal temperature. We will show some movies of the intelligent behaviours of the artificial biochemical actuators (intelligent nektons, biochemical tweezers, etc) as the novel organic and soft machines with the environmental friendly and biological energy chemicals.

Acknowledgment: This study was supported in part by JSPS (Japan Society for the Promotion of Science) Grants-in-Aid for Scientific Research on Priority Areas, No. 438 (Next-Generation Actuators Leading Breakthroughs).

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