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# Direct Electron Transfer Reactions of Enzymes at Carbon Nanotubes Synthesized on an Electrode Surface

Masato Tominaga*, Shinya Nomura, Toshifumi Nishimura,
Shingo Sakamoto and Isao Taniguchi
*Graduate School of Science and Technology,*
*Kumamoto University, 2-39-1 Kurokami, Kumamoto 860-8555, Japan*
**Tel/Fax: +81-96-342-3656, E-mail: masato@gpo.kumamoto-u.ac.jp*

Carbon nanotubes (CNTs) have been one of the most actively studied materials because of their many unique properties for not only fundamental studies of atomically ordered materials, but also promising materials for technological applications. Their unique electronic properties make these nanotubes ideal candidate materials for nano-electronic and biosensor components. In this study, the direct electron transfer reactions of glucose oxidase (GOx), bilirubin oxidase (BOD) and fructose dehydrogenase (FDH), were performed on the CNTs-synthesized electrodes.

CNTs were synthesized on a Pt plate electrode (CNT-Pt electrode) by chemical vapor deposition (CVD) method using iron nanoparticles derived from ferritin protein used as a catalyst. Diameters of individual CNTs were evaluated to be *ca*. 5 to 10 nm by TEM, which were multi-walled CNTs. The electrochemical measurements were investigated by cyclic voltammetry.

Well-defined catalytic current was observed from *ca*. -0.45 V (vs. Ag/AgCl/sat'd KCl) at GOx-immobilized CNT-Pt electrode in a phosphate buffer (pH 7) solution in the presence of glucose, as shown in Fig. 1. No catalytic current was observed at Pt and CNT-Pt electrodes. Oxidation of hydrogen peroxide was not observed at the CNT-Pt electrode in the potential range from -0.5 to 0 V at pH 7. The result indicated that the obtained catalytic oxidation current at GOx-immobilized CNT-Pt electrode was not due to the oxidation current of hydrogen peroxide generated by GOx, when oxygen existed in the solution. The direct electron transfer reactions of BOD and FDH adsorbed CNTs-synthesized electrode were also observed.

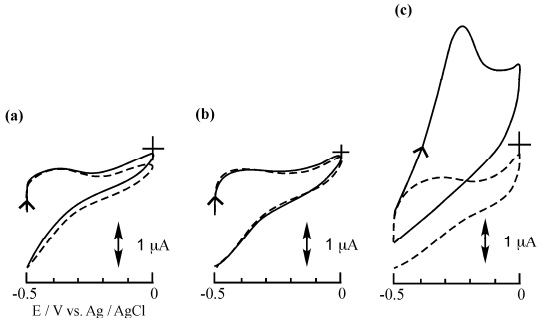


Fig. 1 Typical cyclic voltammograms at (a) Pt, (b) CNT-Pt and (c) GOx-immobilized CNT-Pt electrodes in a phosphate buffer (pH 7.0) in the presence (solid lines) and absence (broken lines) of 3 mmol $dm^{-3}$ glucose. Potential sweep rate was 5 mV $s^{-1}$. Geometric electrode area: 0.246 $cm^2$.