Cholate Adsorption Behavior at Carbon Electrode Interface and Its Promotional Effect in Laccase Direct Bioelectrocatalysis

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Results and Discussion

Simulated analysis of steady-state current density

The steady-state current density ($j_s$) for the adsorption model is given by [1-4]

$$j_s = nFk_cJ^\alpha / [1 + (k_c/k_t) + (k_b/k_t)]$$

$$k_t = k^\circ \exp[-\alpha (nF/RT) (E - E^\circ')]$$

$$k_b = k^\circ \exp[(1 - \alpha) (nF/RT) (E - E^\circ')]$$ (1)

where $n$ and $F$ are the number of electrons ($n = 1$ for the T1 Cu site of Lac) and the Faraday constant, respectively; $k_c$ is the catalytic constant (s$^{-1}$), and was assumed to be 2600 s$^{-1}$ because the theoretical rate of O$_2$ reduction by the T2/3 Cu site of bilirubin oxidase is expected to be as high as 2600 s$^{-1}$ under air-saturated conditions [5,6]; $k_t$ and $k_b$ are the surface electron transfer rate constants expressed by the Butler–Volmer equation; and $E^\circ'$ is similar to the formal redox potential for the T1 Cu site of Lac. In this study, $E^\circ'$ was estimated from the half-wave potential from the steady-state sigmoidal wave obtained at each modified SWCNT electrode. $k^\circ$ and $\alpha$ are the heterogeneous electron transfer rate constant (s$^{-1}$) at $E^\circ'$ between the adsorbed Lac and SWCNT electrode, and the transfer coefficient, respectively. In this study, $k^\circ$, $\Gamma_a$, and $\alpha$ were adjustable parameters. We assumed that the dependence of the catalytic reduction current on the mass transport of oxygen could be ignored.
References