A Third-Generation Superoxide Ion Sensor

Takeo Ohsaka, Yang Tian, Lanqun Mao
and Takeyoshi Okajima

Department of Electronic Chemistry, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, 4259 Nagatsuta, Midori-ku, Yokohama226-8502, Japan

This paper represents a third generation biosensor for superoxide anion (O_2^-) which is developed by immobilizing superoxide dismutase (SOD) on cysteine self-assembled monolayer (SAM) at gold electrode (Fig.1). A rapid and direct electron transfer of SOD was realized [1] at gold electrode by using cysteine molecule as an electron-transfer promoter and this direct electron transfer of SOD was thus utilized for the first time to develop a third-generation biosensor for sensitive and selective determination of O_2^-. At the SOD-immobilized cysteine-SAM gold electrode, O_2^- could be specifically oxidized and reduced through a catalytic reaction of SOD. The high efficiency of the direct electron transfer

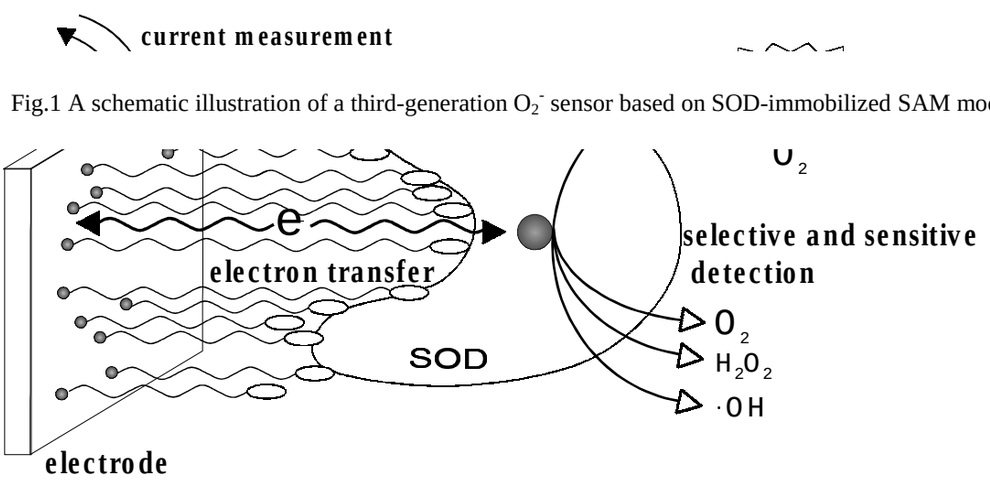

Fig.1 A schematic illustration of a third-generation O_2^- sensor based on SOD-immobilized SAM modified electrodes.

of SOD and the biomolecular recognition by the exploitation of specific and significant enzyme-substrate reactivity of SOD toward O_2^- facilitated sensitive measurements of O_2^- without interference from physiological levels of ascorbic acid (AA), uric acid (UA) and metabolites of neurotransmitters. Moreover the interference from hydrogen peroxide (H_2O_2) was also minimal; for example, at +300 mV no response was observed up to 10 μM H_2O_2 and 1.7% cathodic current relative to that of 14 nM O_2^- was obtained at –200 mV. While tested with amperometry at either +300 or –200 mV the sensor response was sensitive, linear and durable; a detection limit of 5 and 6 nM was obtained with a sensitivity of 0.44 and 0.56 nA/nM and a linear range up to 200 and 220 nM at +300 and –200 mV, respectively. The mechanism of the sensor response and its potential dependence will be presented and discussed.

Reference:

[1] Y. Tian, M. Shioda, S. Kasahara, T. Okajima, L. Mao, T. Hisabori, and T. Ohsaka, Biochim. Biophys. Acta, submitted.