Sensors and Materials, Vol. 20, No. 4 (2008) 191–200
MYU Tokyo

S & M 0717

Enhanced Sensor Capability of Juxtaposed β-Cyclodextrin Rings in TiO_2 Ultrathin Matrix as Determined by Cyclic Surface-Polarization Impedance Measurement

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(Received January 31, 2008; accepted May 8, 2008)

Key words: cyclodextrins (CDs); molecular imprinting; ultrathin TiO_2 layer; cyclic surface-polarization impedance (cSPI)

The present study was focused on the sensitive detection of organic substances by electrochemical impedance spectroscopy (EIS), i.e., cyclic surface-polarization impedance (cSPI) measurement that detects the difference in interactions between the electrode and chemicals in aqueous phase. For cSPI measurement, Pt electrodes were modified with three different types of self-assembled monolayer (SAM) of -OH, -COOH, and -pyridine (Py) terminal groups. Among them, the Pt/SAM-OH electrode was additionally modified with an ultrathin TiO_2 gel layer and a 2:1 complex of β-cyclodextrin (β-CD) and bisphenol A (BPA), and then the BPA moiety was removed by washing in methanol. A highly sensitive and selective detection of BPA was achieved by the synergic effect of molecular imprinting and host-guest interaction in the ultrathin TiO_2 layer. The resulting BPA-imprinted TiO_2/β-CD film showed a linear increase in ΔR_p at –0.1 V for BPA of 2×10^{-8} to 2×10^{-6} M. However, BPA was barely detected on the SAM-modified electrodes at low concentrations, although their sensor responses were markedly enhanced at a concentration of 2×10^{-6} M, compared with that of the bare Pt electrode. The current approach suggests the simple concept and use of sensor films for the sensitive detection of various organic molecules including environmental pollutants.

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