Solid-State Environmental Chemical Sensor for Eutrophication-Ion in Closed Natural System

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Summary

A new function of perovskite-type oxide based electrode was proposed for electrochemical chemical sensor device. A novel sol-gel processing technique was developed for the preparation of La-based perovskite-type fine-powders and thin-films using an acetylacetone - poly(vinyl alcohol) (PVA) polymeric precursor method. The PVA-based gel made it possible to deposit a thin-film as well as to lower the sintering temperature as low as 500°C. Carbon-based electrodes loaded with perovskite-type oxides showed good sensing properties to hydrogen-phosphate ion. Amperometric sensing to HPO$_4^{2-}$ of the carbon electrodes loaded with various perovskite-type oxides have been also investigated. The anodic current of a carbon-based electrode loaded with La-Co based perovskite-type oxide, the sensing signal, was increased with increasing the concentration of hydrogen-phosphate. The LaCoO$_3$ thin-film sensor device showed high sensitivity and high anion selectivity with fastest response time to HPO$_4^{2-}$. A new solid-electrolyte ion sensor device using a Na$^+$-ion conductor (Na$_5$DySi$_4$PO$_{12}$: NDSO) as an impedancemetric transducer and a perovskite-type oxide thin-film as a receptor has been also developed. The AC impedance of the device with a LaCoO$_3$ receptor was found to vary logarithmically with increasing K$_2$HPO$_4$ concentration between $1.0 \times 10^{-5}$ and $1.0 \times 10^{-2}$ M at 10 kHz. The 90% response time was ca. 2 min at room temperature. The sensor showed a little sensitivity to NO$_3^-$ at higher concentration, while no response was observed to the examined anions of Cl$^-$ and ClO$_4^-$.