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Detection of pH/H_2O_2 and prostrate/breast cancer biomarker by using nickel-oxide/iridium-oxide sensing membrane in electrolyte-insulator-semiconductor structure

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Quantification of pH/H_2O_2 attracts a lot of attention due to its importance in chemical industries as well as biomedical diagnostic. For the detection of pH and H_2O_2, using electrolyte-insulator-semiconductor (EIS) is preferred due to label-free detection, easy fabrication process, and low cost. The NiO_x based sensor has shown good pH sensitivity of 50.25 mV/pH. X-ray photo-electron spectroscopy of Ni $2p_{3/2}$ has shown two different oxidation states of NiO_x membrane and those are Ni^{2+} and Ni^{3+} having binding energy 854.5 eV and 856.5 eV, respectively. Existence of these two oxidation states resembles the reduction-oxidation (redox) characteristics of NiO_x membrane toward the electroactive species like H_2O_2. A reference voltage shift of 41 mV is obtained for H_2O_2 concentration of 10 μM and has shown good linearity up to 100 μM for the first time. In addition, the IrO_x membrane shows a record pH sensitivity of 150.4 mV/pH for the first time. This IrO_x sensor demonstrated good catalytic behavior as well as the breast cancer biomarker LOXL2 with a concentration of approximately 150 nM is detected. This IrO_x nano-net sensor demonstrates good catalytic behavior for H_2O_2 reduction with a concentration of 100 fM because the oxidation state changes from Ir^{3+} to Ir^{4+}, whereas a pure SiO_2 membrane could not sense H_2O_2. The oxidation states are confirmed by X-ray photo-electron spectroscopy (XPS). Similarly, prostate cancer is also detected by using NiO_x membrane. Therefore, good pH response and redox characteristics of the IrO_x/NiO_x sensing membrane allow it to diagnose human disease in future.

Biography

Siddheswar Maikap has completed PhD in Department of Physics and Meteorology at IIT Kharagpur in February, 2003. He is Professor at Chang Gung University, Taiwan, since August 2014. He is the holder of three US patents on memory/bio-sensor, eight US/Taiwan patent files, and has more than 100 SCI journal papers, more than 150 international conference papers, 26 keynote/invited talks, and four best paper awards. His recent research focuses on cross-point resistive switching memory for high-density memory as well as bio-sensor applications.

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