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Fe Modified Tin Oxide Thin Film Based Matrix for Reagentless Uric Acid Biosensing

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Abstract : Biosensors have found potential applications ranging from environmental testing and biowarfare agent detection to clinical testing, health care, and cell analysis. This is driven in part by the desire to decrease the cost of health care and to obtain precise information more quickly about the health status of patient by the development of various biosensors, which has become increasingly prevalent in clinical testing and point of care testing for a wide range of biological elements. Uric acid is an important byproduct in human body and a number of pathological disorders are related to its high concentration in human body. In past few years, rapid growth in the development of new materials and improvements in sensing techniques have led to the evolution of advanced biosensors. In this context, metal oxide thin film based matrices due to their bio compatible nature, strong adsorption ability, high isoelectric point (IEP) and abundance in nature have become the materials of choice for recent technological advances in biotechnology. In the past few years, wide band-gap metal oxide semiconductors including ZnO, SnO_2 and CeO_2 have gained much attention as a matrix for immobilization of various biomolecules. Tin oxide (SnO_2), wide band gap semiconductor (Eg =3.87 eV), despite having multifunctional properties for broad range of applications including transparent electronics, gas sensors, acoustic devices, UV photodetectors, etc., it has not been explored much for biosensing purpose. To realize a high performance miniaturized biomolecular electronic device, rf sputtering technique is considered to be the most promising for the reproducible growth of good quality thin films, controlled surface morphology and desired film crystallization with improved electron transfer property. Recently, iron oxide and its composites have been widely used as matrix for biosensing application which exploits the electron communication feature of Fe, for the detection of various analytes using urea, hemoglobin, glucose, phenol, L-lactate, H_2O_2, etc. However, to the authors' knowledge, no work is being reported on modifying the electronic properties of SnO_2 by implanting with suitable metal (Fe) to induce the redox couple in it and utilizing it for reagentless detection of uric acid. In present study, Fe implanted SnO_2 based matrix has been utilized for reagentless uric acid biosensor. Implantation of Fe into SnO_2 matrix is confirmed by energy-dispersive X-Ray spectroscopy (EDX) analysis. Electrochemical techniques have been used to study the response characteristics of Fe modified SnO_2 matrix before and after uricase immobilization. The developed uric acid biosensor exhibits a high sensitivity to about 0.21 mA/mM and a linear variation in current response over concentration range from 0.05 to 1.0 mM of uric acid besides high shelf life (~20 weeks). The Michaelis-Menten kinetic parameter (Km) is found to be relatively very low (0.23 mM), which indicates high affinity of the fabricated bioelectrode towards uric acid (analyte). Also, the presence of other interferents present in human serum has negligible effect on the performance of biosensor. Hence, obtained results highlight the importance of implanted Fe:SnO_2 thin film as an attractive matrix for realization of reagentless biosensors towards uric acid.

Keywords : Fe implanted tin oxide, reagentless uric acid biosensor, rf sputtering, thin film
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