National Institute of Technology Rourkela

Synopsis Seminar

Seminar Title	: Development of Transition Metal Oxide Nanostructures for Non-enzymatic Glucose Biosensors
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Venue	: BM Seminar Hall
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Abstract	: Transitional metal oxide has a significant role in developing biosensors due to the flexibility for structural modification with a large surface area that facilitates more electron transfer between the analyte and sensor surface, leading to improved sensor performance. The titanium dioxide (TiO_2) and zinc oxide (ZnO) nanostructures exhibit intrinsic peroxidase-like activity and have been potential catalysts for various biosensors. In this study, non-enzymatic glucose biosensors were fabricated based on multiple combinations of TiO_2 nanoparticles, 3D structures ZnO nanoflowers (ZNFs), reduced graphene oxide (rGO), iodine, and carboxyl methylcellulose (CMC). The developed nanocomposites were characterized by X-ray diffraction, X-ray photoelectron spectroscopy, field emission scanning electron microscopy, high resolution-transmission electron microscopy, energy-dispersive X-ray spectroscopy spectrum, ATR-Fourier transforms infrared, Raman spectroscopy, photoluminescence emission spectra, dynamic light scattering, and zeta potential. The developed TiO_2/I_2/CMC nanocomposite (TIC) film for non-enzymatic colorimetric glucose detection had a minimum detectable concentration (LOD) of 0.4 mM with a wide linear range (0.5 to 10 mM) at room temperature and a coefficient of determination (R^2) = 0.980 (n=3). The I-rGO@TiO_2 (TIR) sensor exhibited a wider linear detection range (0.5—10 mM) at room temperature. The LOD of the sensor was 0.23 μM (S/N=3), and the sensitivity was 221.69 μA $mM^{&minus1}$ $cm^{&minus2}$ with a R^2 = 0.985 (n=3). The ZNFs@TiO_2/I-PVA/CMC (ZTIPC) hybrid film was developed to detect glucose in human saliva. The novel ZTIPC glucose sensor exhibited a LOD of 0.2 mM with R^2 = 0.985 (n=3). The ZTIPC sensor had a linear glucose detection range of 0.5—10 mM with a detection limit of 0.2 mM and a limit of quantitation of 0.7 mM. The average fasting and postprandial glucose in human saliva detected by ZTIPC hybrid film was 0.30 ± 2.48 mM and 0.49 ± 0.16 mM, respectively. The ZTIR nanocomposite exhibited a LOD of 0.7 mM and a limit of quantification of 2.3 mM with R^2 = 0.985. The enhanced glucose sensitivity of developed nanocomposites was obtained due to the synergistic effect and higher surface-to-volume ratio, providing more active area and narrow bandgap that enhanced the catalytical performance. The structural modification of transitional metal oxides provides a suitable environment for immobilizing molecules and electron transfer charge carriers to enhance catalytic performances suitable for sensing applications.