Electronic Supplementary Material (ESI) for Sensors & Diagnostics.

Nanostructured zirconia@reduced graphene oxide based ultraefficient nanobiosensing platform for food toxin detection

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1. Chemicals and biomolecules: Natural graphite flakes, zirconium ethoxide, N-ethyl-N-(3-dimethylaminopropyl) carbodiimide (EDC), Aflatoxin B1 (AFB1) and bovine serum albumin (BSA) were purchased from Sigma-Aldrich (St. Louis, USA). Sodium hydroxide, cetyltrimethylammonium bromide (CTAB), sodium monophosphate, sodium diphosphate dihydrate and N-hydroxysulfosuccinimide (NHS) were purchased from Fisher Scientific (Maharashtra, India). 3-aminopropyl triethoxy silane (APTES) was procured from Alfa-aesar (Lancashire, UK). These materials were used without further purification. Milli-Q water (resistivity 18 MΩ cm) was used in all the buffer and solution preparation.

2. Characterization: The crystallinity and phase formation of the nanocomposite was examined through X-ray diffraction (XRD) studies [Bruker D-8 Advance] in which the spectrum was recorded through a monochromatic X-ray beam with Cu-kα radiation of wavelength (λ) 1.5406 Å. The structural and morphological studies were conducted through scanning electron microscopy (SEM, Hitachi SN-3700) and transmission electron microscopy (TEM, JEOL-JEM-2100F). Fourier transform infrared spectroscopy (FT-IR, Perkin-Elmer, model spectrum ATR accessory) was used to investigate the functional groups and bonds present on APTES/nZrO_2@RGO/ITO and anti-AFB1/APTES/nZrO_2@RGO/ITO electrodes. The electrochemical studies [cyclic voltammetry (CV) and differential pulse voltammetery (DPV)] were performed using Autolab, Potentiostat/Galvanostat (Netherlands). These measurements were conducted using a three-electrode system where modified ITO coated glass substrate was employed as the working electrode, platinum (Pt) as counter electrode and Ag/AgCl as the reference electrode in phosphate buffer saline (PBS) solution (50 mM, 0.9 % NaCl) of pH 7.0 containing 5 mM of [Fe $(CN)_6^{3-/4-}$] as redox species. All the electrochemical studies were conducted in triplicate.

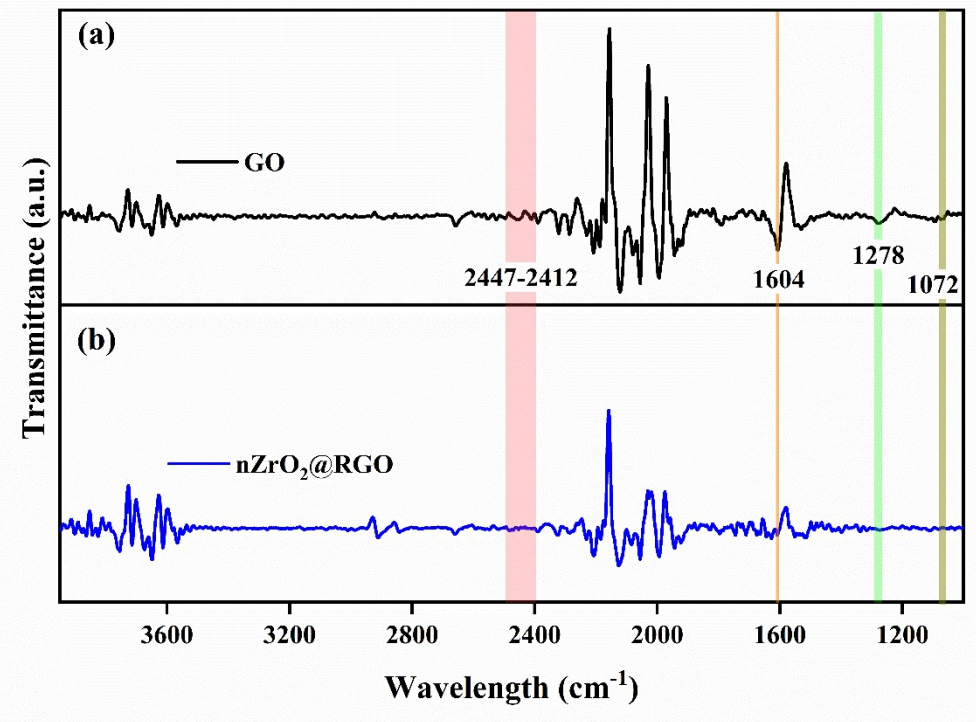

Figure S1: FT-IR spectra of (a) GO and (b) $nZrO_2$@RGO.

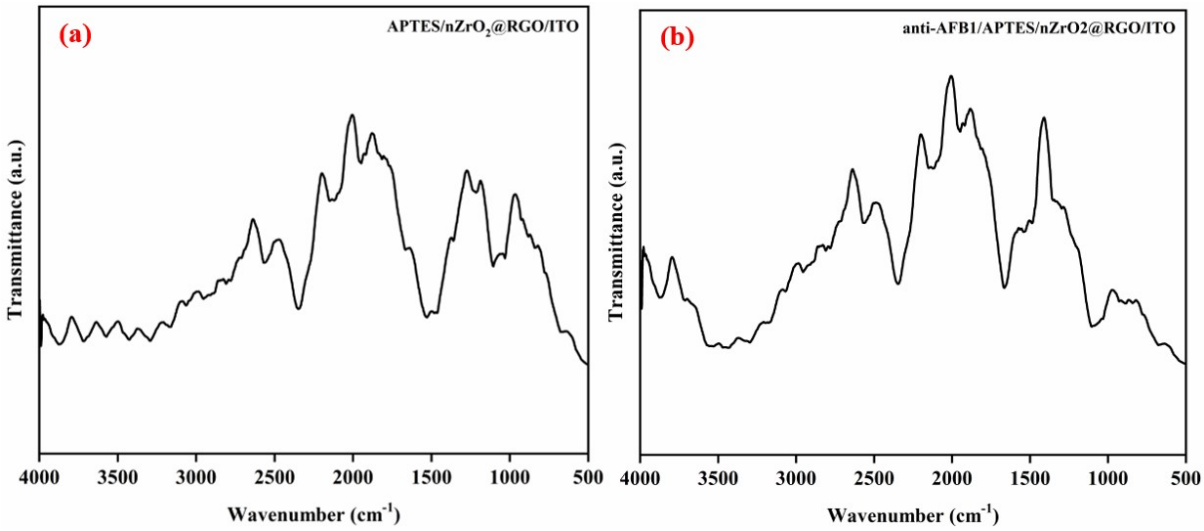

Figure S2: FT-IR spectra of (a) APTES/$nZrO_2$@RGO/ITO and (b) anti-AFB1/APTES/$nZrO_2$@RGO/ITO electrodes.

Equations

$I_{pa\ (APTES/nZrO2@RGO/ITO)}$ (mA) = [0.048 ± 0.0004 (mA $mV^{-1/2}$ $s^{1/2}$) $\upsilon^{1/2}$ ($mV^{1/2}$ $s^{-1/2}$)] + [0.141 ± 0.004 mA], R^2 = 0.99……....(S1)

$I_{pc\ (APTES/nZrO2@RGO/ITO)}$ (mA) = –[0.033 ± 0.0003 (mA $mV^{-1/2}$ $s^{1/2}$) $\upsilon^{1/2}$ ($mV^{1/2}$ $s^{-1/2}$)] – [0.155± 0.003 mA], R^2 = 0.99.....(S2)

$I_{pa\ ((BSA/anti-AFB1/APTES/nZrO2@RGO/ITO)}$ (mA) = [0.047 ± 0.0003 (mA $mV^{-1/2}$ $s^{1/2}$) $\upsilon^{1/2}$ ($mV^{1/2}$ $s^{-1/2}$)] + [0.136 ± 0.003 mA], R^2= 0.99…….(S3)

$I_{pc\ (BSA/anti-AFB1/APTES/nZrO2@RGO/ITO)}$ (mA) = –[0.035 ± 0.0002 (mA $mV^{-1/2}$ $s^{1/2}$) $\upsilon^{1/2}$ ($mV^{1/2}$ $s^{-1/2}$)] – [0.127± 0.002 mA], R^2=0.99……..…...(S4)

$\Delta E_{p\ (APTES/nZrO2@RGO/ITO)}$ (V)= [0.024 ± 0.0002 ($V^{1/2}$ $mV^{-1/2}$ $s^{1/2}$) $\upsilon^{1/2}$ ($mV^{1/2}$ $s^{-1/2}$)] + [0.1536 ± 0.002 V], R^2 = 0.99……(S5)

$\Delta E_{p\ (BSA/anti-CYFRA-21-1/APTES/nZrO2@RGO/ITO)}$ (V)= [0.032 ± 0.0004 ($V^{1/2}$ $mV^{-1/2}$ $s^{1/2}$) $\upsilon^{1/2}$ ($mV^{1/2}$ $s^{-1/2}$)] + [0.185 ± 0.004] V, R^2= 0.99, ……..….(S6)