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Preparation, antibacterial activity, and electrocatalytic detection of hydrazine based on biogenic $CuFeO_2$/PANI nanocomposites synthesized using *Aloe barbadensis miller*

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S1. Materials

All the used materials in the work were of analytical grade; they could be used immediately without additional purification. Copper sulphate pentahydrate ($CuSO_4.5H_2O$; and MW: 249.68 g/mol), Iron (III) chloride hexahydrate ($Cl_3FeH_{12}O_6$; and MW: 270.33 g/mol), sodium chloride (NaCl; MW: 58.44 g/mol), potassium hexacyanoferrate (III) ($C_6FeK_3N_6$; MW: 329.25 g/mol), Aniline (1L=1.02 kg and MW: 249.68 g/mol), Potassium hexacyanoferrate (II) trihydrate ($C_6FeK_4N_6.3H_2O$; MW: 422.39 g/mol), hydrazine solution (N_2H_4; MW: 32.05; CAS number: 302-01-2), and Whatman filter paper (I-Grade) all these materials were purchased from the Sigma Aldrich. Sodium hydroxide (NaOH; MW: 40.00 g/mol) and ammonia liquor (NH_3; MW: 17.03 g/mol) were purchased from the Qualigens, Thermo Fisher Scientific. Luria Bertani Agar, ampicillin (SD002), Miller (GM1151), monosodium phosphate (NaH_2PO_4; MW: 119.98) and disodium phosphate ($Na_2HPO_4.H_2O$; MW: 177.99) were obtained from the Hi-media. The indium-tin-oxide (ITO) glass sheets were procured from Sigma-Aldrich with a surface resistivity of 30–60 Ω/sq for electrophoretic deposition of biologically synthesized nanocomposites. All of the solutions in this investigation were made with the highly purified Milli-Q water from the Milli-Q water purification system, Surepro Dual filter prefiltration system, USA, with a resistivity of not less than 18Ω. Different pure cultures of the gram-negative bacteria (*E. coli*) and gram-positive bacteria *(Microbacterium testaceum*) were obtained in the laboratory. *Aloe barbadensis miller* was obtained from the Dr. Singh's herbal garden at IGNTU, Amarkantak, Madhya Pradesh, India.

S2. Characterization

UV-vis absorption spectroscopy was employed to investigate the optical characteristics of B-$CuFeO_2$ NCs and B-$CuFeO_2$/PANI NCs in the 200–800 nm wavelength range using Shimadzu, Japan. An FT-IR spectrophotometer was used to determine the vibration spectrum of B-

$CuFeO_2$ NCs and B-$CuFeO_2$/PANI NCs in the 400–4000 cm^{-1} spectral region (Nicolet iS5, Thermo Fisher Scientific). The nature of the B-$CuFeO_2$ NCs and B-$CuFeO_2$/PANI NCs were investigated using an X-ray diffractometer (Bruker D8 Advance). Using an EVO 18 system (Zeiss, Germany), the nanomaterial's elemental conformation and surface morphology were determined by the energy dispersive X-ray analysis (EDX) and SEM, respectively. By using a Genetix DC power supply, electrophoretic deposition of desired material was done on the bare ITOs. An electrochemical workstation (Kanopy Techno Solutions Pvt Ltd, India) with a three-electrode setup was used to electrochemically detect hydrazine using the B-$CuFeO_2$/PANI NCs modified electrode.

S3. XRD pattern of B-$CuFeO_2$/PANI NCs/ITO electrode

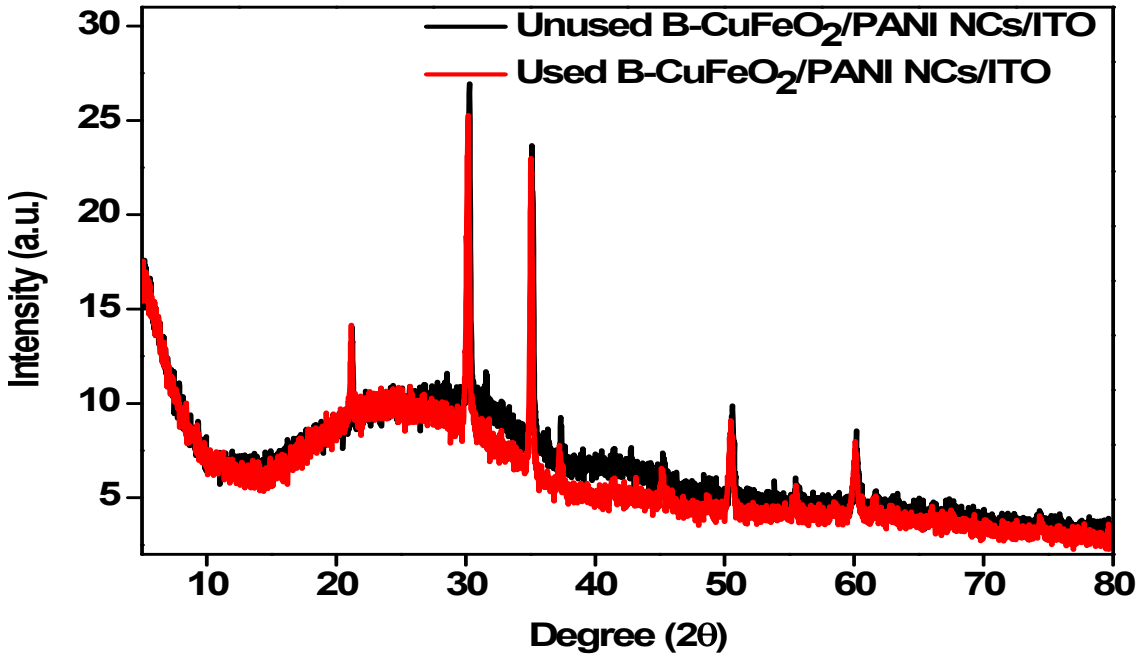

Fig. S1 XRD pattern of B-$CuFeO_2$/PANI NCs/ITO electrode (red and black color represents used and unused electrode, respectively; here used represents the electrode after hydrazine sensing).

S4. SEM analysis at higher magnification

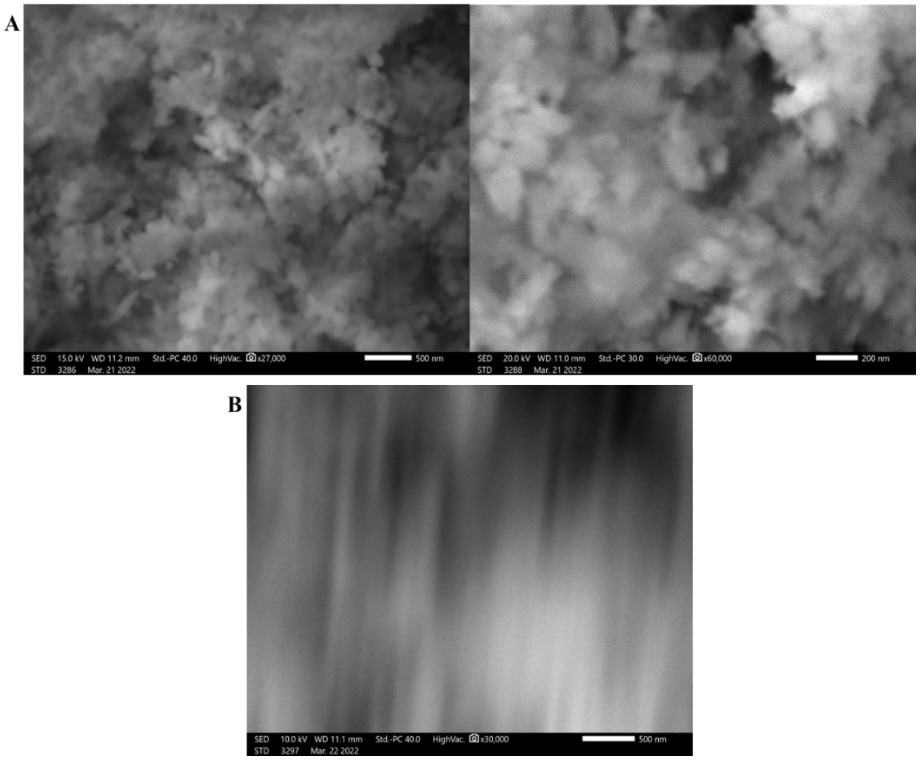

Fig. S2 SEM micrograph at lower magnifications: **A)** B-$CuFeO_2$/PANI NCs and **B)** B-$CuFeO_2$.

S5. Reproducibility and stability studies of B-$CuFeO_2$/PANI NCs/ITO electrode

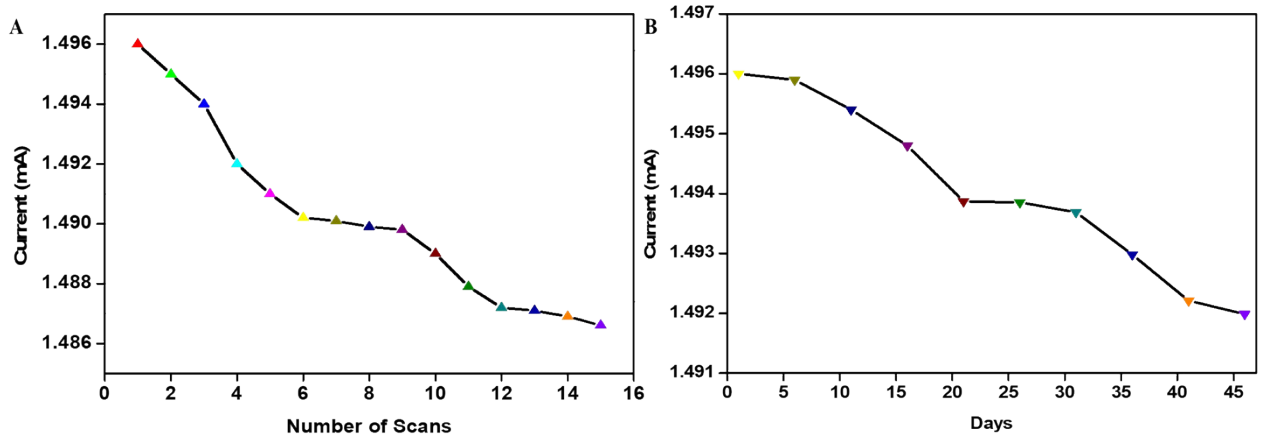

Fig. S3 B-$CuFeO_2$/PANI NCs/ITO electrode: **A)** Reproducibility/reusability study and **B)** Stability/durability study up to 46 days at interval of 5 days.