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Lithium polyacrylate-polyacrylamide blend as polymer electrolytes for solid-state electrochemical capacitors

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ARTICLE INFO

Keywords:
Solid supercapacitor
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Neutral pH electrolytes
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ABSTRACT

A polymer electrolyte was developed by blending lithium (LiPAA) with non-ionic polyacrylamide (PAM). The LiPAA-PAM showed synergic effect and achieved an ionic conductivity of 13.8 ± 2.4 mS cm^{-1}, higher than previously developed neutral pH polymer electrolytes. Chemical and structural characterizations of the LiPAA-PAM films revealed a stable homogeneous amorphous structure. The performance of double layer capacitors using LiPAA-PAM electrolyte system was demonstrated using YP-50F activated carbon electrodes. These solid cells demonstrated wide voltage window (1.5 V), good cycle life (> 10,000 cycles), and excellent rate capability (up to 500 mV s^{-1} in cyclic voltammetry).

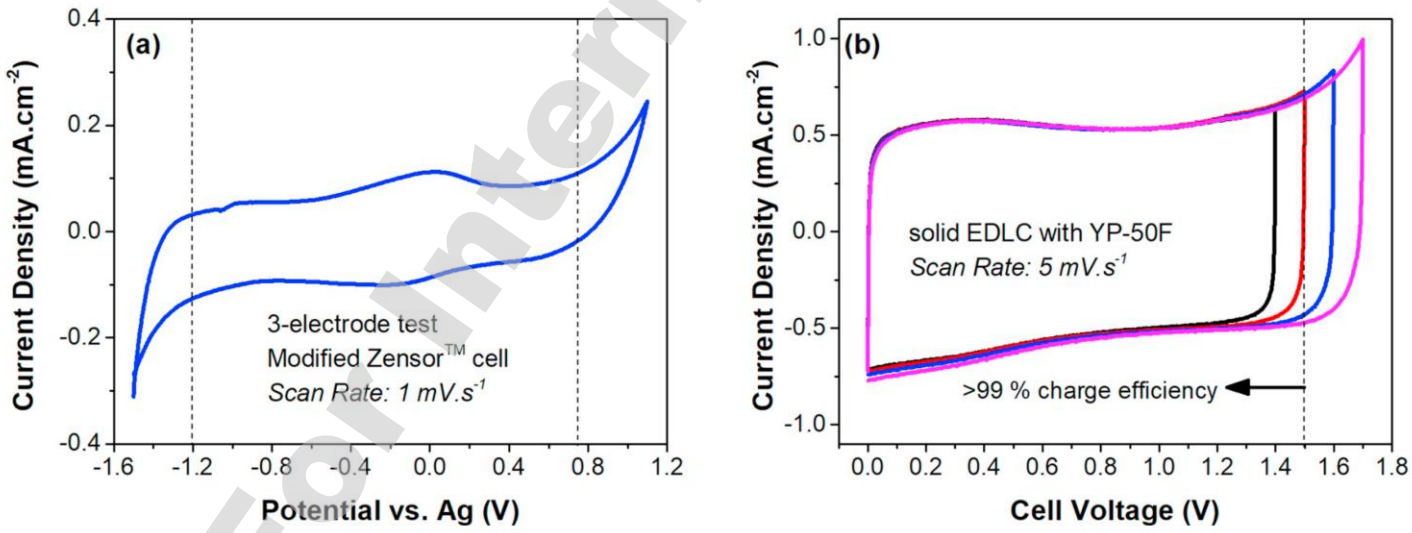

Fig. 3. Electrochemical stability window of 40–60 LiPAA-PAM with YP-50F electrode analyzed in (a) modified Zensor™ 3-electrode cells (1 mV s^{-1} sweep rate) and (b) solid-state 2-electrode EDLC cell (5 mV s^{-1} sweep rate).

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Electrochemical study and extraction of Pb metal from Pb oxides and Pb sulfate using hydrophobic Brønsted acidic amide-type ionic liquid: A feasibility demonstration

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ARTICLE INFO

Keywords:
Amide
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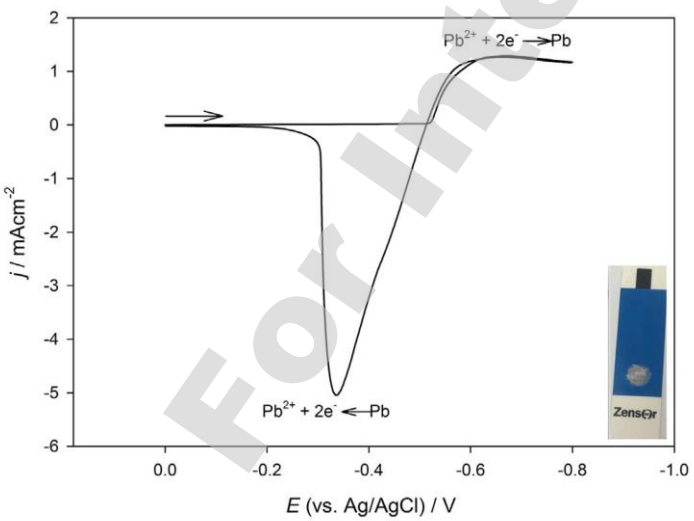
ABSTRACT

Electrodeposition of lead (Pb) is important because of the application for energy storage and Pb recovery. Water, however, is not a good solvent because many Pb compounds, such as Pb oxides used in Pb storage batteries, are insoluble. Ionic liquids (ILs), especially for deep eutectic solvents (DESs), have been used for Pb electrodeposition. However, most DESs are water-miscible. Here, a hydrophobic Brønsted acidic amide-type IL, protonated betaine bis((trifluoromethyl)sulfonyl)amide ([Hbet][TFSA]), was used to dissolve PbO and PbO_2 under an ambient air for the voltammetric study and electrodeposition. $PbSO_4$ was only slightly soluble but extraction of Pb metal was achieved from the $PbSO_4$/[Hbet][TFSA] paste. Very smooth, uniform, and crystalline electrodeposits were obtained from the PbO and PbO_2 baths, respectively, regardless of potentiostatic or galvanostatic electrodeposition but dendritic Pb was obtained from DESs. The Pb species in the IL was carefully studied, and the different species might explain why different morphologies of Pb were obtained from this IL and DESs, respectively. This study demonstrates that a protic IL is appropriate to be used as the electrolyte for electrochemically extracting Pb from various water-insoluble Pb compounds.



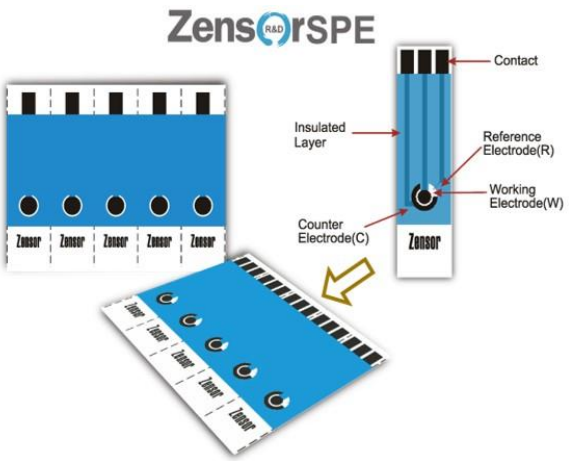


Fig. 9. CV recorded at a SPCE coated of a paste (1.6 mg) composed of $PbSO_4$ and [Hbet][TFSA] in a molar ratio of 1:0.41 in a deaerated 0.1 M KCl at 25 °C. Scan rate: 50 mVs^{-1}. Inset shows the appearance of the paste-coated SPCE.

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A novel sensitive and reliable electrochemical determination of palmatine based on CeO_2/RGO/MWCNT ternary composite

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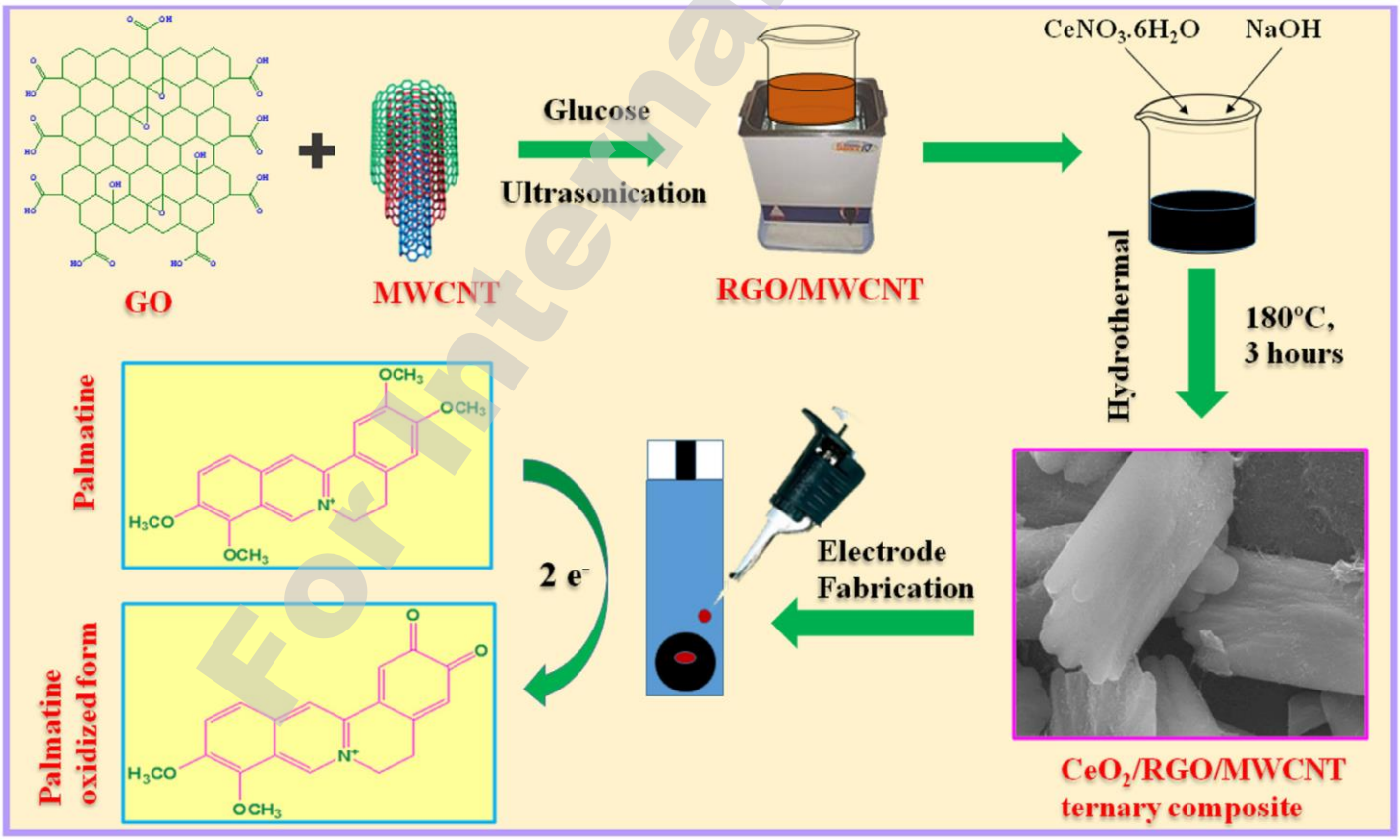
ABSTRACT

A sensitive and reliable electrochemical determination of natural alkaloid palmatine was proposed based on CeO_2/RGO/MWCNT ternary composite modified screen printed carbon electrode. The proposed ternary composite was prepared via simple hydrothermal synthesis method without using of hazardous chemicals. The surface morphology, elemental compositions, functional group moieties, crystalline structure and defects and disorder of the prepared CeO_2/RGO/MWCNT ternary composite was confirmed by various spectrometric techniques. In addition, the electrochemical properties of the modified electrodes were investigated by voltammetry techniques. Notably, the proposed CeO_2/RGO/MWCNT modified electrode exhibited two linear concentration ranges from 0.1 to 118 µM and 118 to 1198 µM with the lowest detection limit of 0.03 µM for the determination of palmatine at neutral condition. Additionally, the proposed electrode material showed a good sensitivity of 1. 791 µA μM^{-1} cm^{-2} and detects the palmatine with good selectivity in the presence of interfering substances. Furthermore, the practical feasibility of the sensor was analyzed in human serum and urine samples.



Scheme 1. The preparation, fabrication and application of CeO_2/RGO/MWCNT ternary composite.

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Voltage-Activated Adhesion through Donor−Acceptor Dendrimers

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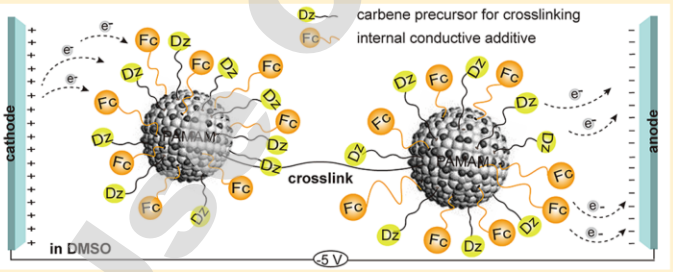
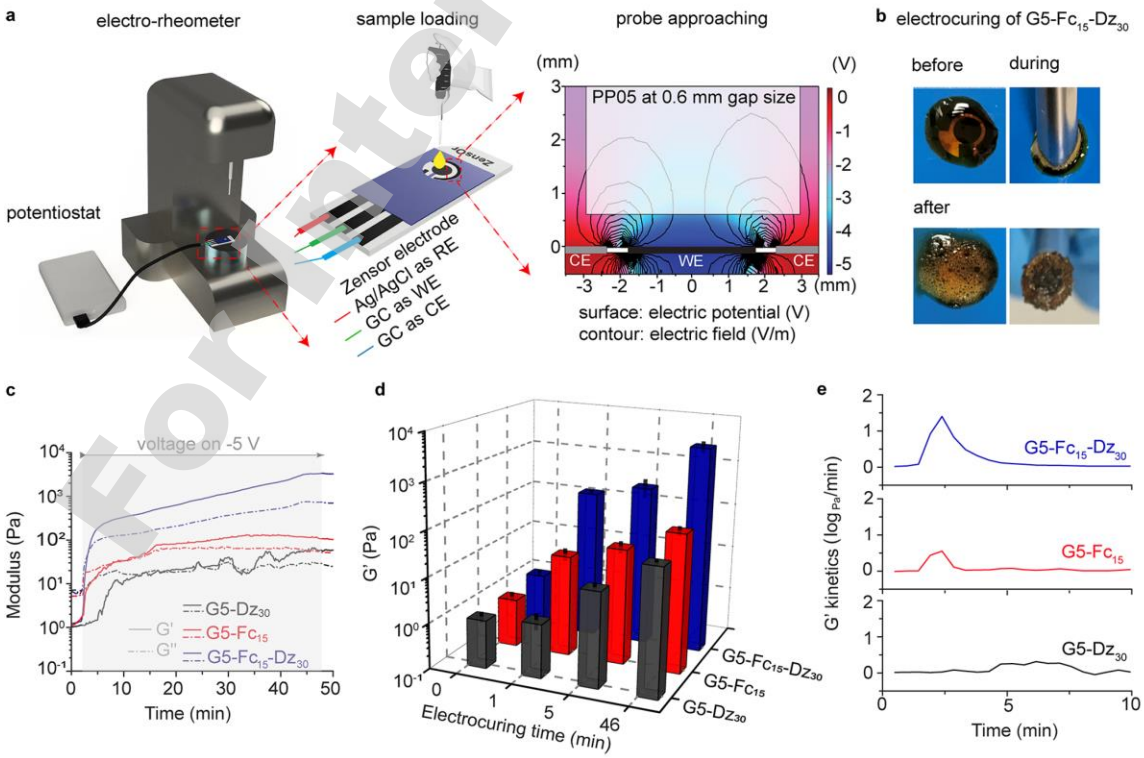
Supporting Information

ABSTRACT: Previous investigations on voltage-activated adhesives were restricted to aqueous solvents, where current-directed cross-linking competed with water electrolysis. Replacing aqueous would expand applications of electrocuring technology and avoid excessive foaming, but many organic solvents have high ohmic resistances that prevent electrical conduction. These impediments were overcome through internal grafting of ferrocene (Fc) and diazirine (Dz) donor−acceptor pairs on fifth-generation polyamidoamine (G5-PAMAM) dendrimers, forming G5-Fc-Dz cografted conjugates, where Fc internal additives provided an instantaneous conductive hole (+) network toward the redox conversion of diazirine to carbene insertion adhesion in nontoxic organic solvents of DMSO, DMF, and PEG400. Size exclusion chromatography, ^{1}H NMR, and ^{19}F NMR evaluated the formulations before and after electrocuring to quantitate grafting ratios and cross-linked dendrimers. Cyclic voltammetry confirmed the retained redox behavior of grafted Fc and Dz. Real-time electrorheology established the dependence of cross-linking kinetics and adhesion strength on applied voltage. Liquid G5-Fc_{15}-Dz_{30} conjugates reached gelation within 2 min and with a storage modulus up to 3.4 ± 0.5 kPa. For the first time, a model system demonstrates the design components necessary toward organic, voltage-activated one-pot adhesives. This has broad implications for adhesives, cosmetics, implantable biomaterials, and flexible biosensors.





ACS APPLIED BIO MATERIALS

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Article

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Improved Electrical Wiring of Glucose Oxidase Enzyme with an *in-Situ* Immobilized Mn(1,10-Phenanthroline)$_2$Cl$_2$-Complex/Multiwalled Carbon Nanotube-Modified Electrode Displaying Superior Performance to Os-Complex for High-Current Sensitivity Bioelectrocatalytic and Biofuel Cell Applications

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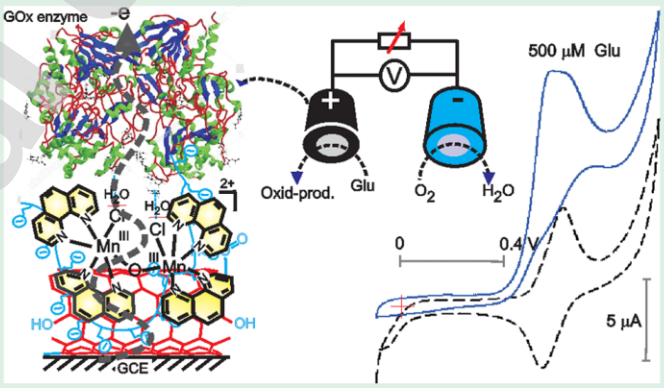
Supporting Information

ABSTRACT: The search for a new and efficient transducer that can electrically connect enzyme active sites, like flavin adenine dinucleotide in glucose oxidase (GOx), with the electrode surface is a cutting-edge research area. Currently, Os(bpy)-complex pendent polyvinylpyridine/polyvinyl imidazole/pyridinium hydrogel based chemically modified electrodes have been widely used for this purpose (bpy = 2,2'-bipyridine). Herein, we report, a $[Mn_2^{III}(phen)_4(O)(Cl)_2]^{2+}$ complex/Nafion-immobilized carboxylic acid-functionalized multiwalled carbon nanotube modified glassy carbon electrode (GCE/f-MWCNT@$Mn_2(Phen)_4O(Cl)_2$-Nf, phen = 1,10-phenanthroline), prepared by an *in-situ* electrochemical method using the precursor, $Mn(phen)_2Cl_2$, as an efficient and low cost alternate to the Os-complex transducer, for the glucose oxidase enzyme (GOx) based bio-electro-catalytic system. The existence of the key active site, $[Mn_2^{III}(phen)_4(O)(Cl)_2]^{2+}$, on the modified electrode was confirmed by physicochemical characterizations using transmission electron microscope, Raman, infrared, and UV−vis spectroscopes and electrospray ionization mass spectrometry techniques. The Mn-complex modified electrode showed a redox peak at $E^{o\prime}$ = 0.55 V vs Ag/AgCl in neutral solution with a surface excess (Γ_{Mn}) value of 5.6×10^{-9} mol cm^{-2}. The GOx enzyme bioanode prepared by adsorbing GOx on the Mn-complex modified electrode has shown an efficient bioelectrocatalytic oxidation of glucose with a Tafel slope value of 111 mV dec^{-1}. Amperometric *i*−*t* analysis of glucose showed a calibration plot in a linear range of 50−550 μM and with current sensitivity of 316.7 μA mM^{-1} cm^{-2}. The current sensitivity value obtained here is about 2−80 000 times higher than that of the Os(bpy)-complex based transducers used for GOx based bio-electro-catalytic applications. Utilizing this new bioanode system along with a Pt-based oxygen reduction electrode, a new biofuel cell was constructed and achieved a power density value 7.5 μW cm^{-2}.



KEYWORDS: *electrical wiring, glucose oxidase enzyme, $Mn(phen)_2Cl_2$ complex, in-situ surface confinement, MWCNT surface, bio-electro-catalytic oxidation, biofuel Cell*

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Highly Redox-Active Hematin-Functionalized Carbon Mesoporous Nanomaterial for Electrocatalytic Reduction Applications in Neutral Media

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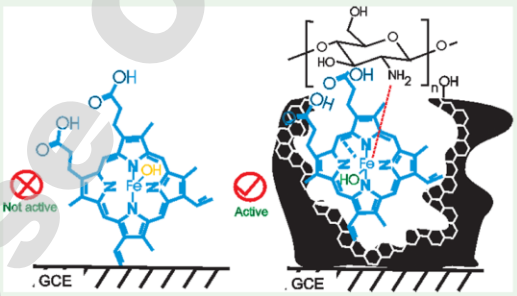
ABSTRACT: Hematin is a hydroxyl group linked heme site (hydroxyl heme) of the natural enzymes/proteins like hemoglobin, cytochrome c, catalase, and horseradish peroxidase, and it has an important role in the physiological function. Because of problems like poor electron-transfer functionality (on solid electrodes), poor solubility, and molecular aggregation in aqueous solution, limited electrochemical studies have been reported in the literature. A new electrode modification method for hematin using graphitized mesoporous carbon nanomaterial and chitosan for enhanced redox-active and efficient electrocatalytic reductions of hydrogen peroxide and dissolved oxygen in neutral pH was demonstrated in this work. The hematin-modified electrode showed a highly stable redox peak at $E^{o\prime} = -0.390$ V versus Ag/AgCl with a heterogeneous rate constant value of 1.34 s^{-1}. Calculated hematin-active loading concentration ($\Gamma_{hemat} = 126 \times 10^{-10}$ mol cm^{-2}) is ~20 times higher than the reported values. Physicochemical and electrochemical characterizations revealed trapping of the hematin via axial bond coordination and intermolecular hydrogen bonding with amino functional groups of chitosan and $\pi-\pi$ interactions with the graphitic site of mesoporous carbon within the matrix. The new hematin electrode showed ~400 mV reduction in the overpotential with current sensitivity/detection range of 570 nA μM^{-1}/100−900 μM and 6.7 μA ppm^{-1}/1−10 ppm, respectively, for H_2O_2 and dissolved oxygen reduction reactions in pH 7 phosphate buffer solution. Michaelis−Menten kinetics were applied for the H_2O_2 reduction reaction and estimated the rate constant values as $K_M = 0.78$ mM and $k_s = 1.15$ s^{-1}. No marked interference was noticed with common biochemicals such as nitrite, nitrate, glucose, uric acid, ascorbic acid, xanthine, hypoxanthine, cysteine, and dopamine on amperometric $i-t$ detection of H_2O_2 indicating the activity similar to the heme-based proteins/enzymes.



KEYWORDS: *hematin, redox function, surface confinement, graphitized mesoporous carbon, chitosan, chemically modified electrode, electrocatalytic reduction reactions*

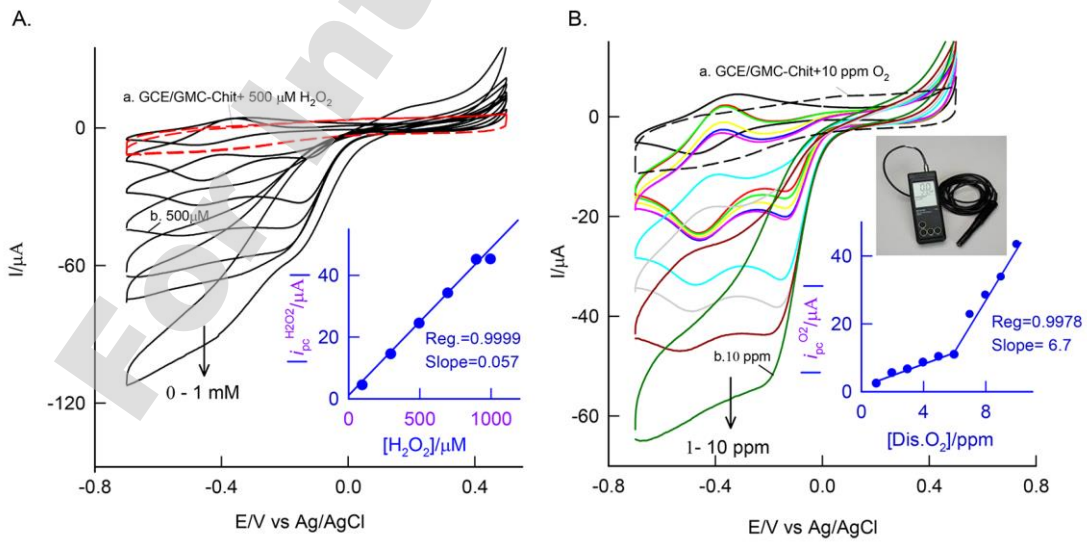


Figure 6. (A) CV of GCE/GMC@Hemat-Chit with increasing H_2O_2 concentrations at $v = 10$ mV s^{-1}. (inset) The corresponding calibration plot. (B) CV of GCE/GMC@Hemat-Chit with increasing concentration of DO. (insets) Calibration plot and photograph of the DO meter. Control electrocatalytic reduction reactions based on GCE/GMC-Chit were given as dotted lines (curves a). Curve b is the electrocatalytic response with 500 μM of H_2O_2 and 10 ppm of O_2, respectively.