Hierarchical Bimodal Nanoporous Gold (hbNPG)-Modified GCE (Glassy Carbon Electrode) for Sensitive Detection of Emerging Contaminants

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OVERVIEW

- Modification of Glassy Carbon Electrode (GCE) with Hierarchical bi-modal nanoporous gold (Hb-NPG@GCE)
- Electrochemical detection of Acetaminophen (APAP) was carried out on the Hb-NPG.

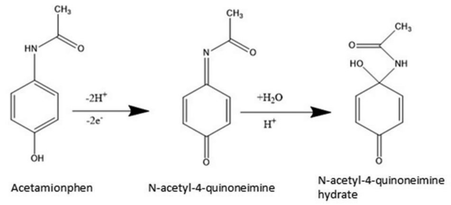

Figure 1: oxidation of acetaminophen[1]

INTRODUCTION

- Emerging Contaminants (ECs): Diverse, unregulated pollutants (e.g., pharmaceuticals) posing ecological and human health threats.
- Pharmaceutical ECs: Biologically active compounds from human/animal use contaminate water, raising environmental concerns .
- Acetaminophen (APAP): A common analgesic widely detected in global water sources due to high usage.
- Environmental Impact of APAP: Presence in water may harm aquatic organisms; potential for synergistic effects with other pollutants.
- Current research suggests Acetaminophen and NSAIDs may affect fetal endocrine function, increases the risk of cryptorchidism in newborn males [2].
- Hence, a speedy, simple, highly selective, and reliable method is required for the detection of acetaminophen.

EXPERIMENTALS

Fabrication of hbNPG:

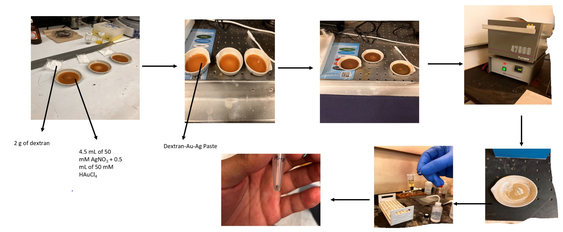

Figure 2: Fabrication of hbNPG

Preparation of hbNPG@GCE:

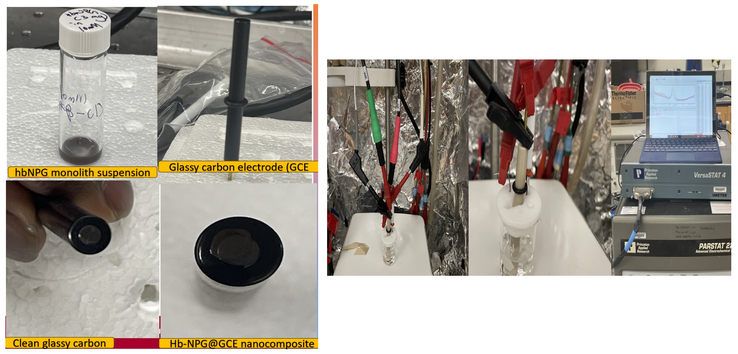

Figure 3: suspension of hbNPG in Nafion/alcohol mixture, followed by dropcasting on GCE and the electrochemical setup used in the electrochemical detection of Acetaminophen

RESULTS AND DISCUSSIONS

A. Surface characterization of hbNPG

1. Scanning electron microscopy

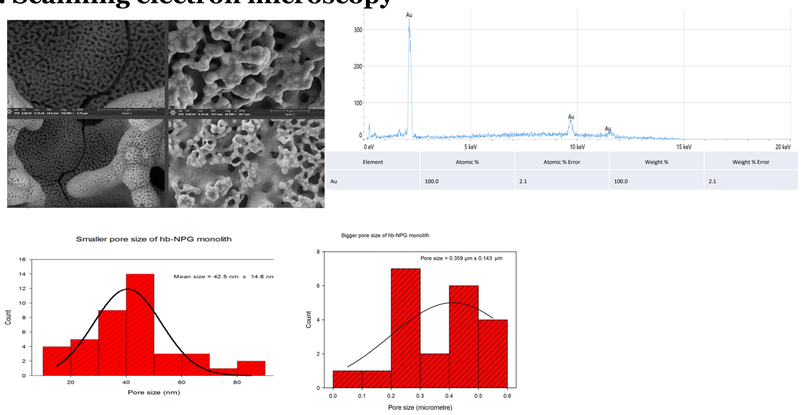

Figure 4: SEM and EDX analysis

B. Impedance Spectroscopy of the modified electrodes and electrochemical behavior of APAP at the electrodes

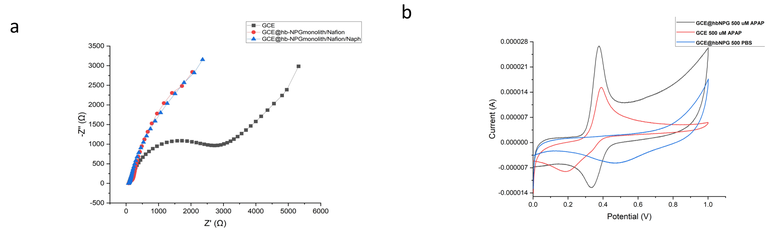

Figure 5: (a) Impedance measurement of **GCE and hbNPG@GCE** (b)Cyclic voltammetry scan for theElectrochemical behavior of **500 µ M acetaminophen at GCE and hbNPG@GCE** electrode in PBS buffer.

C. Voltammetric detection of acetaminophen

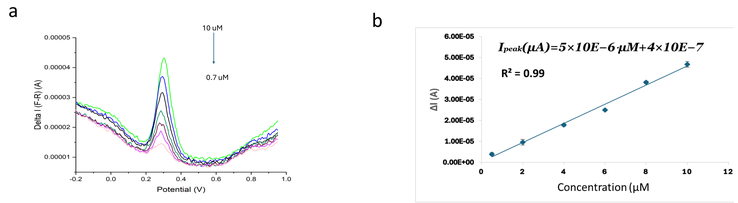

Figure 6: (a) Voltammetric detection of acetaminophen on hbNPG@GCE using square wave voltametric (SWV) technique (b) Linear regression curve for the responses at each different concentrations of acetaminophen. **(LOD = 100 nM)**

D. Simultaenous detection of APAP with Bisphenol-A (BPA) and Reproducibility of hbNPG@GCE electrodes in acetaminophen detection

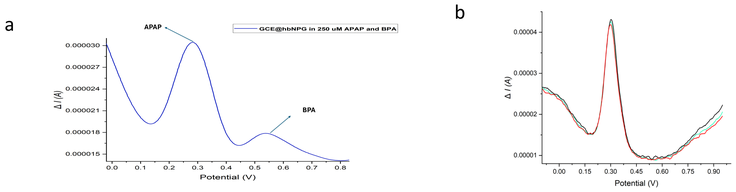

Figure 7: (a) Simultaenous detection of APAP and BPA b) Reproducibility of acetaminophen detection on the same electrode 3 times at the same conditions.

FUTURE DIRECTIONS

- Extending this detection method to other emerging contaminants like Bisphenol-A (BPA) and per and polyfluoro alkyl substances (PFAS).

References

1. Qian, Lanting & Elmahdy, Reem & Thiruppathi, Antony Raj & Chen, Aicheng. (). An Ultrasensitive Electrochemical Sensor for the Detection of Acetaminophen via a Three-Dimensional Hierarchical Nanoporous Gold Wire Electrode. The Analyst. 146, **2021**.
2. O. Albert, C. Desdoits-Lethimonier, L. Lesné, A. Legrand, F. Guillé, K. Bensalah, N. Dejucq-Rainsford, B. Jégou, Paracetamol, aspirin and indomethacin display endocrine disrupting properties in the adult human testis in vitro, Human Reproduction, 28, **2013**,1890–1898,.

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