Supporting Information

A Poly(3-methylthiophene)/Borophene Hybrid for Tartaric Acid Detection

Shahzad Ahmed [†,‡,Δ], *Sonal Gupta* [‡,Δ], *Arshiya Ansari* [†], *Tanmay Suresh More* [$], *Andrey N. Kuzmin* [Δ], *Amitava Banerjee* [†*], *Devendra Singh Negi* [†*], *Pranay Ranjan* [†*], *Mark T Swihart* [Δ,$*], *Paras N. Prasad* [‡,Δ*]

[†] Department of Materials Engineering, Indian Institute of Technology Jodhpur, Jodhpur, Rajasthan-342030, India.

[‡] Department of Chemistry, University at Buffalo, SUNY, New York 14260, USA.

[Δ] The Institute for Lasers, Photonics, and Biophotonics/Chemistry, The State University of New York at Buffalo, Buffalo, New York 14260, USA.

[$] Department of Chemical and Biological Engineering, University at Buffalo, The State University of New York, Buffalo, NY 14260, USA.

*Corresponding authors:

Paras N. Prasad; Email: pnprasad@buffalo.edu

Mark T Swihart; Email: swihart@buffalo.edu

Amitava Banerjee; Email: amitava@iitj.ac.in

Devendra Singh Negi, Email: devendra@iitj.ac.in

Pranay Ranjan; Email: pranay.ranjan@iitj.ac.in

Figure S1. Experimental setup showing the electrochemical workstation employed in this work.

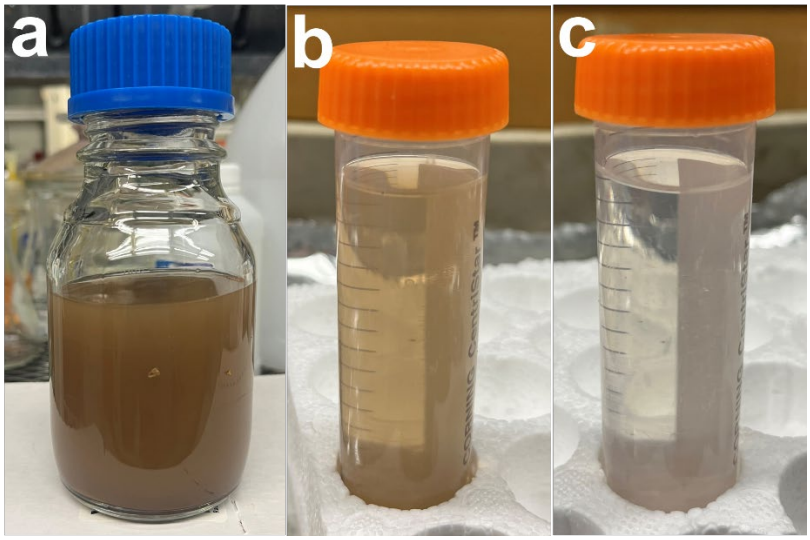

Figure S2. Camera images of (a) ultrasonicated borophene dispersion in acetone after 15 h; (b) dispersion of centrifuged borophene for 5 minutes at a speed of 3000 rpm; (c) dispersion of centrifuged borophene for 10 minutes at 7000 rpm.

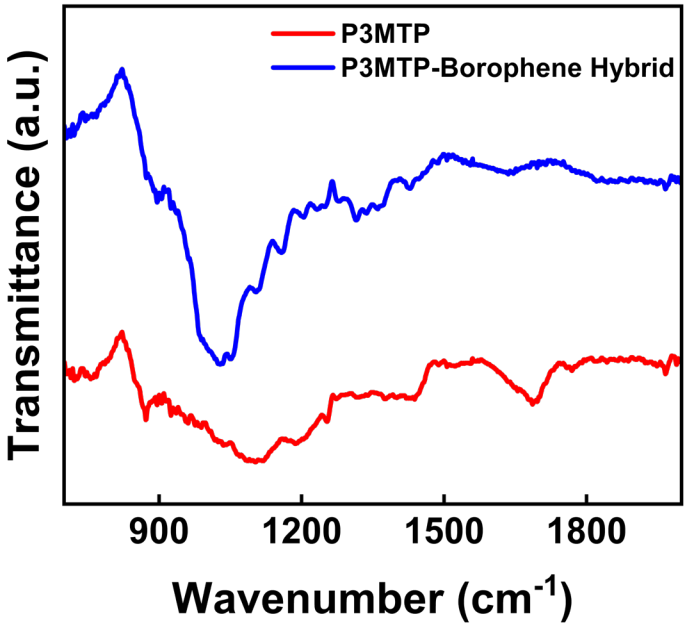

Figure S3. FTIR spectra of P3MTP and P3MTP-Borophene hybrid.

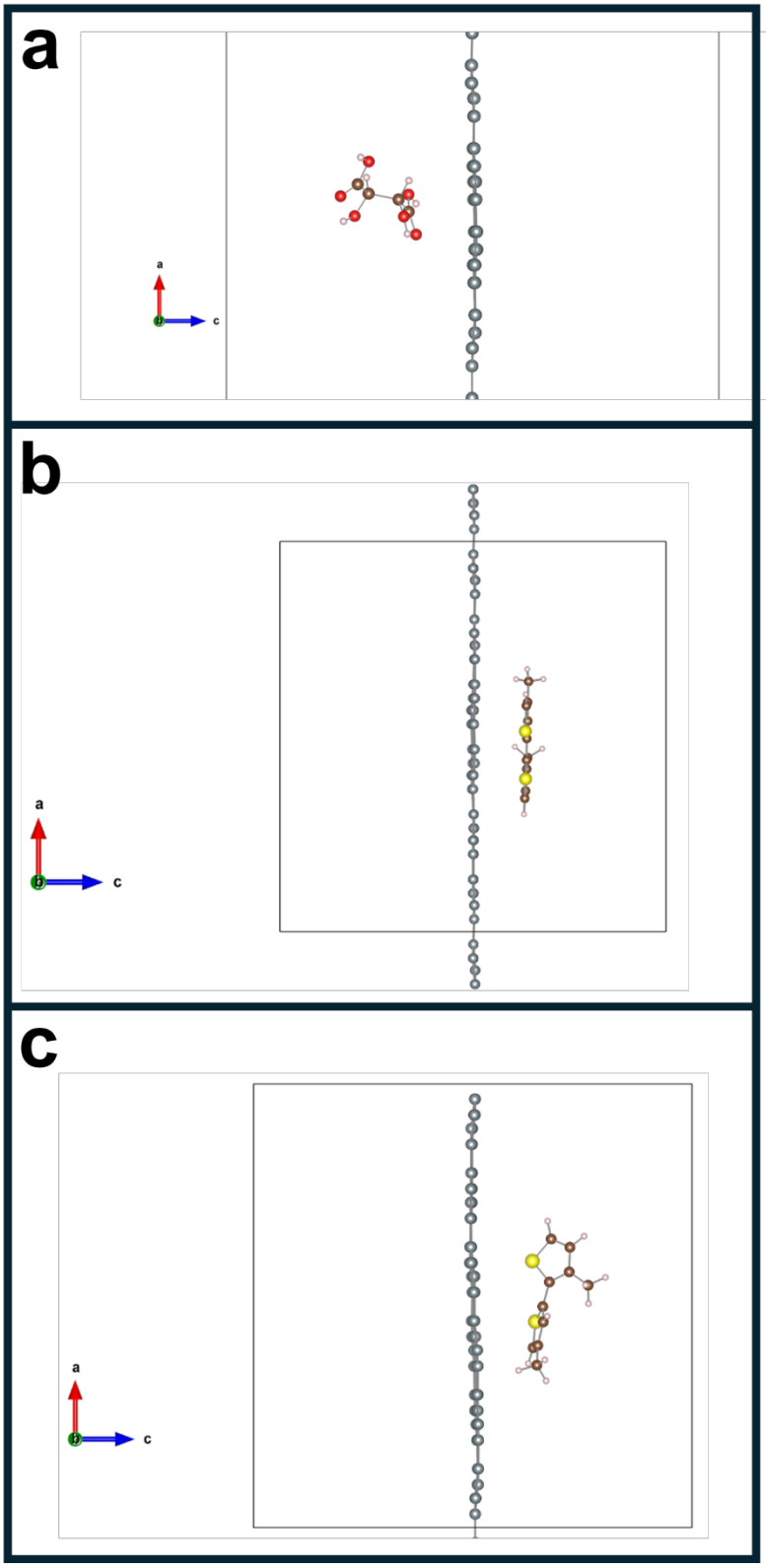

Figure S4. Optimized ground state structure of different orientations of a) TA on borophene (chai), b) and c) dimer of 3-methylthiophene on borophene (chai).

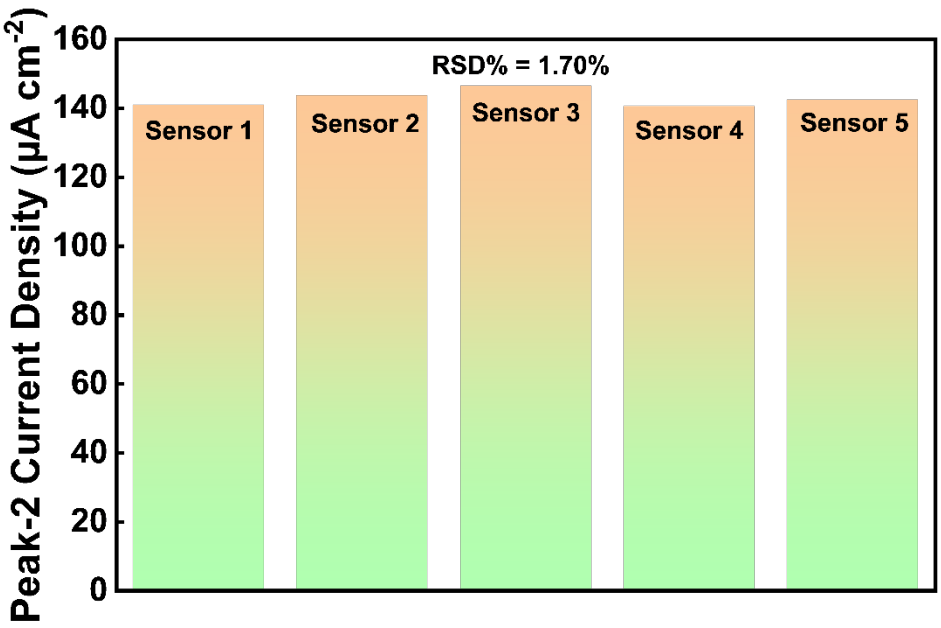

Figure S5. Bar plot illustrating the reproducibility of the fabricated borophene/P3MTP/ITO@glass-based sensors.

Table S1: A comprehensive overview of the most recent developments in borophene composites and hybrid-based biosensors.

Electrode Materials	Target Analyte	Medium/Electrolyte	Linear Range (μM)	LOD (μM)	Authors
β-rhombohedral Borophene/PAN NC	Glucose	PBS	1,500-12,000	99	Taşaltın [1]
Borophene-Decorated PPy NC	Glucose	PBS	250-20,000	0.04	Baytemir [2]
NiPc-Borophene NC	Glucose	PBS	1,500-24,000	0.15	Baytemir et al. [3]
PANI:Borophene nanonetwork	Glucose	PBS	1,000–12,000	500	Taşaltın et al. [4]
PANI/Borophene NC	Dopamine	PBS	0.15625–5	0.017	Baytemir et al. [5]
CuPc-Borophene NC	Urea	PBS	250 to 1000	0.05	Güngör et al. [6]
UOx@MOF/borophene-DOX/GCE	Uric Acid	PBS	0.1 to 200	0.025	Yang et al. [7]
PANI/borophene NC	VOCs (Ethanol)	Synthetic Air	-	1302	Taşaltın et al. [8]

PAN: polyacrylonitrile; NC: nanocomposite; PPy: polypyrrole; NiPc: nickel phthalocyanine; PANI: polyaniline; CuPc: copper phthalocyanine; UOx: urate oxidase; MOF: metal-organic

framework; DOX: doxorubicin; GCE: glassy carbon electrode; VOCs: volatile organic compounds; PBS: phosphate-buffered saline

References

[1]. Taşaltın C. Glucose sensing performance of PAN: β-rhombohedral borophene based non-enzymatic electrochemical biosensor. Inorganic Chemistry Communications. 2021 Nov 1;133:108973.

[2]. Baytemir G. Highly Selective and Sensitive Non-enzymatic Glucose Biosensor Based on Polypyrrole-Borophene Nanocomposite. Sakarya University Journal of Science. 2022 Dec 1;26(6):1093-103.

[3]. Baytemir G, Gürol İ, Karakuş S, Taşaltın C, Taşaltın N. Nickel phthalocyanine-borophene nanocomposite-based electrodes for non-enzymatic electrochemical detection of glucose. Journal of Materials Science: Materials in Electronics. 2022 Jul;33(20):16586-96.

[4]. Taşaltın C, Türkmen TA, Taşaltın N, Karakuş S. Highly sensitive non-enzymatic electrochemical glucose biosensor based on PANI: β12 Borophene. Journal of Materials Science: Materials in Electronics. 2021 Apr;32:10750-60.

[5]. Baytemir G. A non-enzymatic electrochemical sensor based on polyaniline/borophene nanocomposites for dopamine detection. Applied Physics A. 2023 Feb;129(2):85.

[6]. Güngör S, Taşaltın C, Gürol İ, Baytemir G, Karakuş S, Taşaltın N. Copper phthalocyanine-borophene nanocomposite-based non-enzymatic electrochemical urea biosensor. Applied Physics A. 2022 Jan;128(1):89.

[7]. Yang M, Sun Z, Jin H, Gui R. Urate oxidase-loaded MOF electrodeposited on boron nanosheet-doxorubicin complex as multifunctional nano-enzyme platform for enzymatic and ratiometric electrochemical biosensing. Talanta. 2022 Jun 1;243:123359.

[8]. Taşaltın N, Taşaltın C, Güngör S, Karakuş S, Gürol İ, Teker M. Volatile organic compound detection performance of Borophene and PANI: β Borophene nanocomposite-based sensors. Journal of Materials Science: Materials in Electronics. 2022 Nov;33(31):24173-81.