$Zn@ZrO_2$ Nanoparticles Decorated on Naringin - Based Sensor for Electrochemical Detection of *p*-Nitrophenol and *o*-Nitrophenol

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1.1. Characterization

The crystalline planes of the $Zn@ZrO_2$/NG nanocomposite were analyzed by XRD (BRUKER Eco D8 advance with Cu - Kα radiations = 1.54 Å). The absorption spectrum were further analyzed by FT-IR (IRTRACER-100), HR-SEM and EDX measurements were performed on (HR - SEM, Thermo scientific Apreos), HR-TEM measurements were performed on (HR-TEM, JEOL, JEM - 2100 plus, Japan), XPS measurements were conducted on (PHI Versaprobe III).

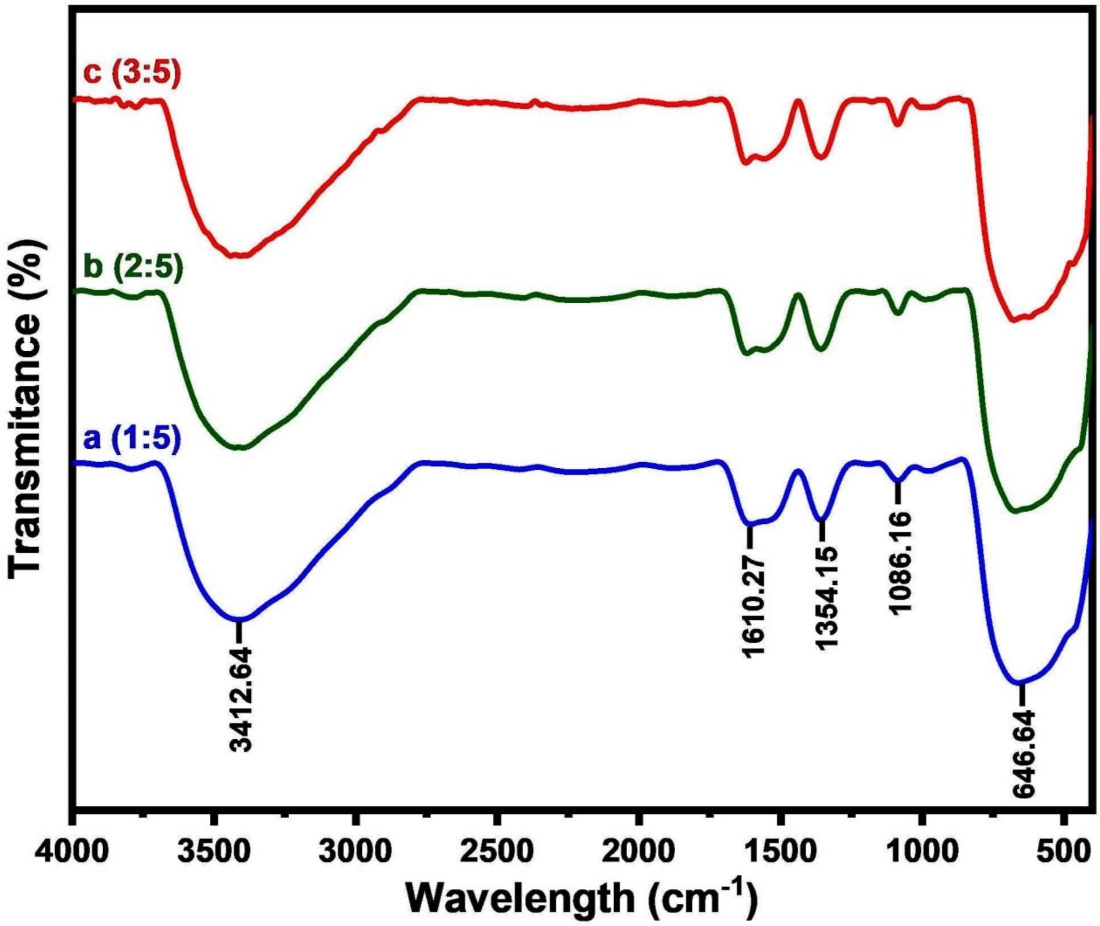

Fig. S1: FT-IR spectrum of different $Zn@ZrO_2$ combined with NG nanocomposites.

Effect of $Zn@ZrO_2$ concentration and pH

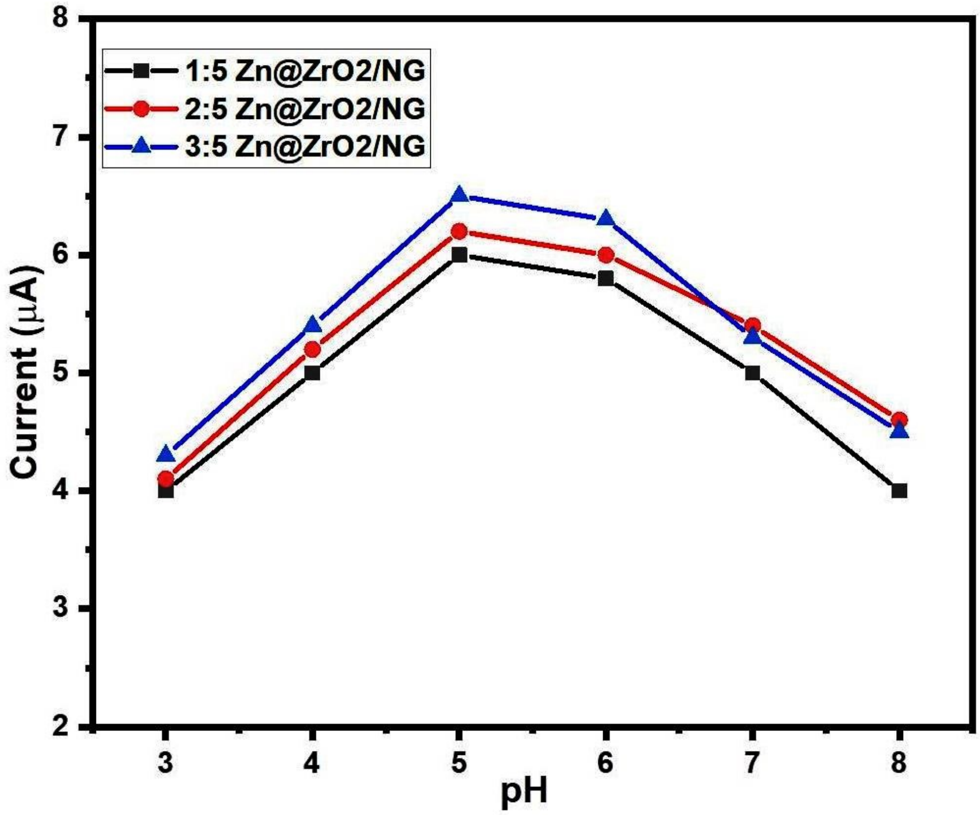

Fig. S2: Comparison plot of different $Zn@ZrO_2$ combined with NG with different pH.

In a bid to find the ideal operating pH and additive amount, the responses of $Zn@ZrO_2$/NG sensors with different $Zn@ZrO_2$ content (1:5, 2:5 and 3:5) combined with NG to 10 μM PNP were measured at various operating pH. The sensor exhibiting a concentration of $Zn@ZrO_2$/NG (3:5) displays the most significant reaction in detecting PNP when compared to the other concentrations. Additionally, the sensor's reaction to PNP detection is influenced by the operating pH. Each curve demonstrates a peak reaction at the optimal pH of 5. Based on the previously mentioned findings, it is evident that the $Zn@ZrO_2$/NG (3:5) sensor has a superior response and operates at a lower pH compared to the other sensors. Therefore, subsequent experiments were conducted using the identical composition $Zn@ZrO_2$/NG (3:5) and optimal pH (5) in order to examine the sensing capabilities of PNP and ONP.

Table. S1. Concentration of PNP and ONP for DPV analysis

S. No	Sets	PNP	ONP
1.	1	1 μM	1 μM
2.		2 μM	2 μM
3.		3 μM	3 μM
4.		4 μM	4 μM
5.		5 μM	5 μM
6.	2	10 μM	10 μM
7.		20 μM	20 μM
8.		30 μM	30 μM
9.		40 μM	40 μM
10.		50 μM	50 μM
11.	3	100 μM	100 μM
12.		200 μM	200 μM
13.		300 μM	300 μM
14.		400 μM	400 μM
15.		500 μM	500 μM

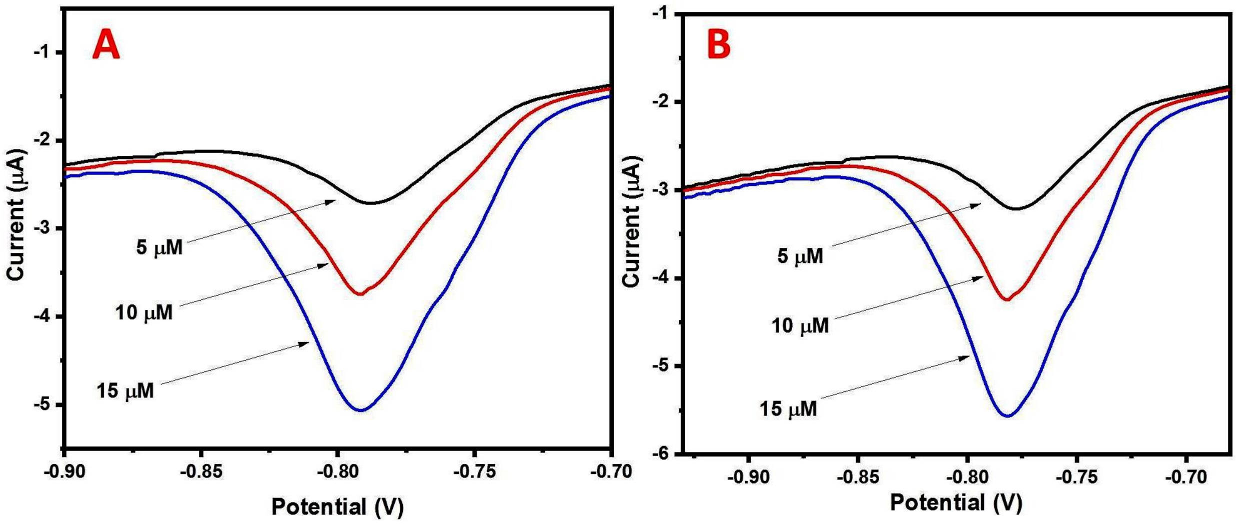

Fig. S3: A) PNP detection in tap water samples. B) PNP detection in river water samples.

Table. S2. Comparison of previously reported electrochemical detection of PNP

Materials	**Linear range (µM)**	**LOD (µM)**	**Sensitivity (µA mM^{-1} cm^{-2})**	**References**
ZnO/GCE	10 –1000	13	404.35	1
meso-$ZnCo_2O_4$/GCE	1– 4000	0.3	0.318	2
Fe_3O_4@AT-COFs	10 –3000	0.2361	–	3
Nano–gold/GCE	10 – 100	8	–	4
AgPd@UiO-66-NH_2	100 –370	0.032	–	5
Cu-curcumin	0.1–1030	0.068	1.57	6
DVD@NP.Au/Hg	5 – 250	1	–	7
ɤ-Fe_2O_3-N-rGO	0.1 – 1000	0.1	0.6	8
GCE/Ag NPs–chi	0.07 – 2	0.07	–	9
Zn@ZrO_2/NG-GCE	1 – 500	1.14	5.05	**Present work**

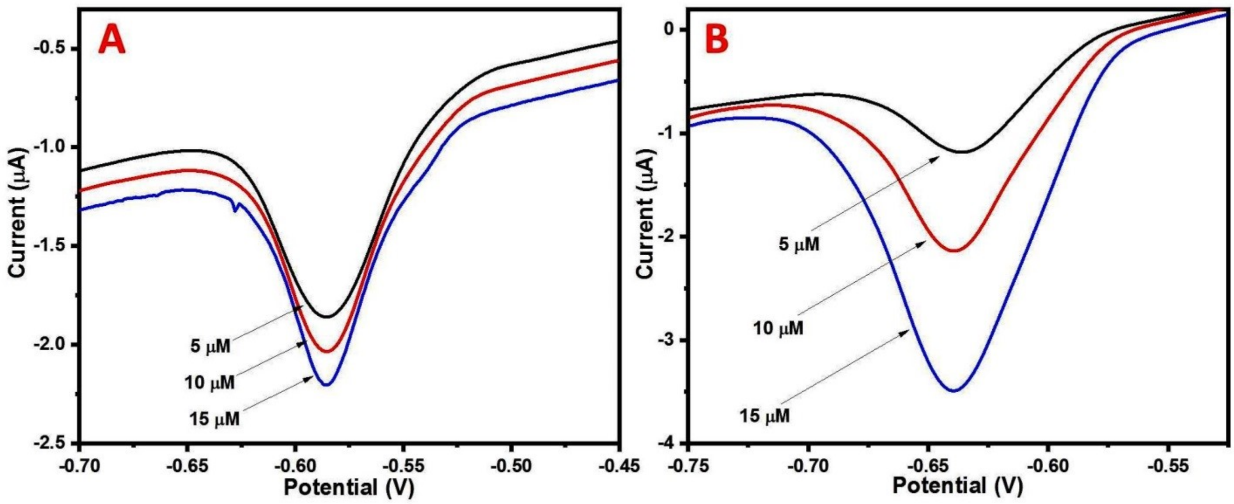

Fig. S4: A) ONP detection in tap water samples. B) ONP detection in river water samples.

Table. S3. Comparison of previously reported electrochemical detection of ONP

Materials	Linear range (µM)	LOD (µM)	Sensitivity (µA mM^{-1} cm^{-2})	References
RGO@CuO@Mn_2O_3	0.5 – 126	0.021	4	10
Fe_3O_4@AT-COF	10 – 3000	0.657	0.041	11
C/N-Au-600e/GCE	0.1 – 320	0.043	–	12
C/N-Au	0.1 – 320	0.049	–	13
$FeSe_2$	10 – 100	0.036	–	14
Mn-MOF@RGO/GCE	0.5 – 180	0.078	–	15
CoC@Mn	5 – 100	0.16	–	16
Zn@ZrO_2/NG-GCE	1 – 500	1.03	3.38	Present work

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