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## **Manuscript ID:** NJ-ART-01-2017-000278 **Title:** Xanthine sensor development based on ZnO-CNT, ZnO-CB, ZnO-GO and ZnO nanoparticles: An electrochemical approach

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## **Electronic Supporting Materials**

## **(Φ)** Preparation of nanocomposites:

The following reactions (i)~(iii) were summarized the formation ofZnO–CNT NCs:

$$ZnCl_{2(s)} \longrightarrow Zn^{2+}_{(aq)} + 2Cl_{(aq)}^{-}$$
 (i)

$$Zn^{2+}_{(aq)} + 2NaOH_{(aq)} \longrightarrow Zn(OH)_2 + 2Na^+_{(aq)}$$
 (ii)

$$Zn(OH)_2 + CNT_{(Disp)} \longrightarrow ZnO-CNT_{(s)} + H_2O_{(l)}$$
 (iii)

The reaction is forwarded slowly according to the proposed equation (i) to equation (iii). During preparation, the pH value of the reaction medium plays an important responsibility in the nanocomposites of ZnO-CNT, ZnO-CB, ZnO-GO, and ZnO formation. At a particular pH, when ZnCl<sub>2</sub> is hydrolyzed with basic solution (sodium hydroxide), zinc hydroxide is formed instantly according to the equation (ii). During the synthesis of nanocomposites, NaOH is used to control the pH value (alkaline phase) as well as supplied the hydroxyl ions (OH<sup>-</sup>) slowly in reaction system. When the concentration of Zn<sup>2+</sup> and OH<sup>-</sup> ions is reached to critical value, Zn(OH)<sub>2</sub> nuclei formation becomes started. As the high concentration of Zn<sup>2+</sup> ions [reactions (iii)], the nucleation of Zn(OH)<sub>2</sub> crystals become slower due to the lower activation energy barrier of heterogeneous nucleation with dispersed CNT, GO, and CB. In presence of Zn<sup>2+</sup> concentration in reaction system, a number of larger ZnO crystals with aggregated morphology with CNT, GO, and CB were formed according to the reactions [equation (iii)]. In the final stage, ZnO-CNTs, ZnO-GO, ZnO-CBs are co-precipitate. Finally,

the resultant nanocompoistes were washed thoroughly with acetone, ethanol, and water consecutively and kept for drying at room conditions. Then the as-prepared co-precipitates were dried to remove the water from the samples to prepare the ZnO-CNT, ZnO-CB, ZnO-GO, and ZnO separately.



(ω) Band-gap energy of ZnO

Fig. S1. UV/vis. Spectra and band gap energy of ZnO.

## $(\Psi)$ FTIR study:

FT-IR spectra were employed only in the region of 400–4000 cm<sup>-1</sup>. FT-IR spectrum of ZnO–CNT NCs, ZnO-CB NCs, ZnO-GO, and ZnO nanocomposite (**Fig. S2**) showed absorption peak at 486 cm<sup>-1</sup>, which was assigned to Zn-O stretching. This absorption peak indicates the formation of metal oxygen bond. It also (**Fig. S2**) showed peaks at 1405 cm<sup>-1</sup>, 1585 cm<sup>-1</sup>, and 3242 cm<sup>-1</sup> are assigned to C–H band stretching vibrations, O=C stretching, and O-H band stretching, respectively.



Fig. S2. FT-IR spectrum of ZnO–CNT, ZnO-CB, ZnO-GO, and ZnO nanocomposites.

(β) Selectivity study



Fig. S3. Selectivity study in presence of various cations by ZnO-CNT NCs/Nafion/GCE sensor

	Observed Current (µA) at 0.5 V						
Biochemical Compounds	R1	R2	R3	average	Interference Effect (%)	SD (n= 3)	RSD (%) (n= 3)
Xanthine	74.46	78.57	88.60	80.54	100	7.27	9.03
Ascorbic acid	17.44	19.719	20.94	19.35	24	1.75	9.17
Uric acid	17.63	14.32	13.73	15.21	19	2.11	13.81
Billirubin	17.56	20.79	19.49	19.25	23	1.62	8.43
D-glucose	11.29	16.37	10.49	12.68	15	3.22	25.08
Folic acid	15.87	12.92	11.62	13.46	16	2.18	16.17
Glycine	12.73	12.66	13.69	12.66	15	0.52	4.42
L(+)-Lactic acid	7.62	13.16	11.29	10.66	13	2.80	26.23
L-Cystine	4.55	2.46	2.84	3.27	4	1.12	33.91
L-Glutathione	6.84	8.27	7.71	7.60	9	0.71	9.47

**Table S1.** Interference effect of different biochemical compounds with ZnO-CNT

 NCs/Nafion/GCE sensor

Interference effect of Xanthine is considered to be 100%; R, reading; SD, standard deviation; RSD, relative standard deviation.