Supporting Information

Detection of Toxic Cypermethrin Pesticides in Drinking Water by Simple Graphitic Electrode Modified with Kraft Lignin@Ni@g-C_3N_4 Nano-composite

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SEM and EDX Study of KL@Ni NPS

The field emission scanning electron microscopy (FESEM) was used to investigate the morphology of KL@Ni NPs and KL@Ni@g-C_3N_4 hybrid composite. The SEM images of Ni NPs stabilized by KL are shown in figure S1. KL@Ni NPS was achieved via encapsulating Ni NPs into the cavities provided through the macromolecular matrix KL exhibited nearly evenly

dispersed Ni NPs with less or more spherical morphology figure (A, B) [1]. The composition of KL@Ni NPS was estimated via energy dispersive X-ray (EDX) analysis. EDX spectrum is shown in figure S1. The EDX spectrum show signal at 7.5 and 0.8 keV of Ni (0) nanoparticles. The EDX spectrum also shows the peak of oxygen and carbon in figure (C). The EDX study indicates that 0.77% of Nickel (0) by mass accumulated on the surface of KL@Ni NPS table S1 [1].

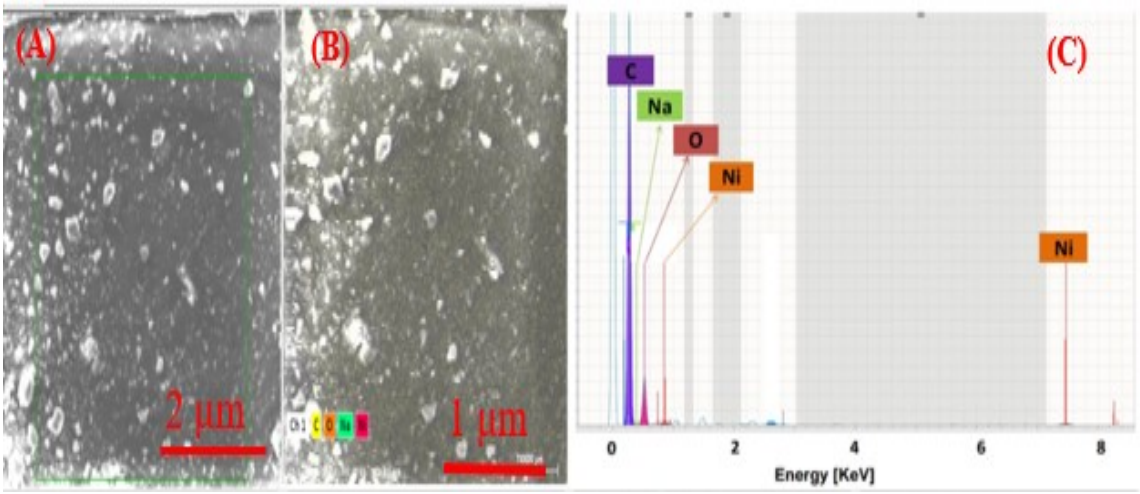

Figure S1. A and B SEM images and C EDX pattern of KL@Ni NPS.

Table S1: Composition of KL@Ni NPs obtained from EDX.

Element	Atomic number	Mass %	Atom %	Error %
CK	6	67.42	74.13	8.41
OK	8	25.52	21.07	4.14
NK	7	4.70	4.43	1.62
Cl K	17	0.52	0.19	0.05
Ni K	28	0.77	0.17	0.07
		Sum=98.93	Sum=100.00	

1.2. SEM and EDX Study of KL@Ni@g-C_3N_4 nanocomposite:

The micrographs of the KL@Ni@g-C_3N_4 hybrid composite are shown in figure S2. In the KL@Ni@g-C_3N_4 hybrid composite, g-C_3N_4 has ultrathin sheet-like morphology, and KL@Ni NPs are uniformly distributed on the surface of g-C_3N_4 [2] figure S2 (A, B). Hence, it confirms that KL@Ni@g-C_3N_4 hybrid composite is successfully synthesized, which causes the electro-catalytic activity of KL@Ni@g-C_3N_4 hybrid composite due to efficient electron transfer during the electrochemical reaction. The EDX spectrum shows the presence of carbon, nitrogen, oxygen, nickel, and sulfur in figure (C). The EDX study indicates 0.50% of Nickel (0) by mass accumulated on the surface of KL@Ni NPS table S2.

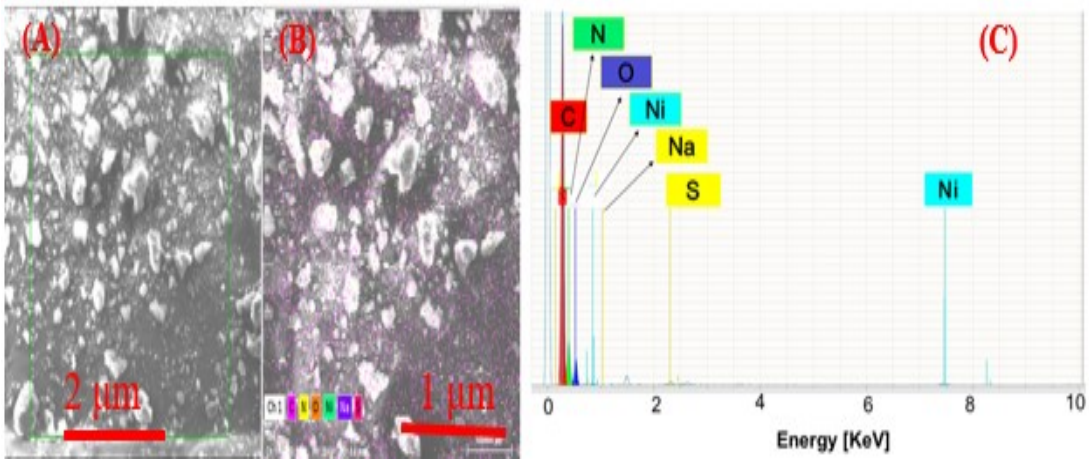

Figure S2: A and B SEM and C EDX pattern of KL@Ni@g-C_3N_4 hybrid composite.

Table S2: Composition of KL@Ni@g-C_3N_4 hybrid composite obtained from EDX.

Element	Atomic number	Mass %	Atom %	Error %
CK	6	48.96	53.95	6.23
NK	7	35.83	33.85	6.23

OK	8	14.51	12.00	2.82
Ni K	28	0.50	0.11	0.06
SK	16	0.17	0.07	0.04
Na K	11	0.03	0.01	0.01
		Sum= 100.00	Sum= 100.00	

2. Calculation of the electroactive surface area of KL@Ni@g-C_3N_4 modified graphitic electrode:

To illustrate that prepared KL@Ni@g-C_3N_4 nanocomposite could improve the conductivity and surface area of the graphitic electrode (GE), the electroactive surface area of bare GE and the modified electrode is determined using CV in 10 mM (K_3 [Fe (CN) $_6$]) containing 0.1 M KCl at different sweep rates according to Randles-Sevcik equations:

$$I_p = (2.69 \times 10^5) n^{3/2} A C D^{1/2} V^{1/2} \qquad (1)$$

Here C, v, D, A, and n are the concentration of electrolyte, scan rate, the diffusion coefficient of K_3 (Fe (CN) $_6$), and the number of electrons, respectively [3]. It noted that the electroactive surface area of fabricated KL@Ni@g-C_3N4@GE is 56.52 mm^2 and is higher than the bare electrode surface area of 31.52 mm^2. This difference is due to the increase in the active surface area of the electrode because of the porous structure and conductive nature of the KL@Ni@g-C_3N_4 hybrid composite.

References

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3. P. Y. Khashaba, H. R. H. Ali and M. M. J. R. a. El-Wekil, 2017, **7**, 3043-3050.