

Selective and sensitive electrochemical sensor based on ion imprinting polymer and graphene oxide for detection of ultra-trace Cd(II) in biological samples

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Supplementary Material

Figure Caption

Figure. S1. FT-IR spectrum of compound 1.

Figure. S2. ¹H-NMR spectrum of compound 1.

Figure. S3. EIMS spectrum of compound 1.

Figure. S4. FT-IR spectrum of compound 2.

Figure. S5. ¹H-NMR spectrum of compound 2.

Figure. S6. The possible chelation pathways of the EAAP ligand.

Figure. S7. FT-IR spectra of NIP, leached and un-leached IIP for Cd(II).

Figure. S8. Comparison of the potentiometric responses of IIP/PVC@GCE and NIP/PVC@GCE for Cd(II) solution at pH 4.5.

Figure. S9. The effect of pH on the peak currents of Cd(II) template (5×10^{-5} mol L⁻¹) at scan rate 100 mVsec⁻¹

Figure. S10. Effect of pH on the potential responses of cadmium buffered templates (5×10^{-5} mol L⁻¹).

Figure. S11. The dynamic response of the potentiometric sensor for step changes in different concentration of Cd(II) solution.

Figure. S12. Effect of the elution time on IIP/GO@GCE for Cd(II).

Figure. S13. Effect of the scan rate on the current of modified GCE for Cd(II) template.

Figure. S14. Effect of scan rate on the potential of on the prepared IIP/GO@GCE for Cd(II) template.

Figure. S15. The potentiometric responses of IIP/PVC@GCE and NIP/PVC@GCE toward Cd(II), Ni(II), Co(II), Pb(II), Cu(II), Mg(II), Hg(II), Ca(II), and Zn(II).

Figure. S16. Effect of the deposition potential on the intensity of current for a solution containing 0.1 mol L⁻¹ acetate buffer (pH 4.5) and 4.0 μM Cd(II). Deposition time: 60 sec; scan rate: 100 mV.sec⁻¹; pulse amplitude: 50 mV; pulse width: 50 msec.

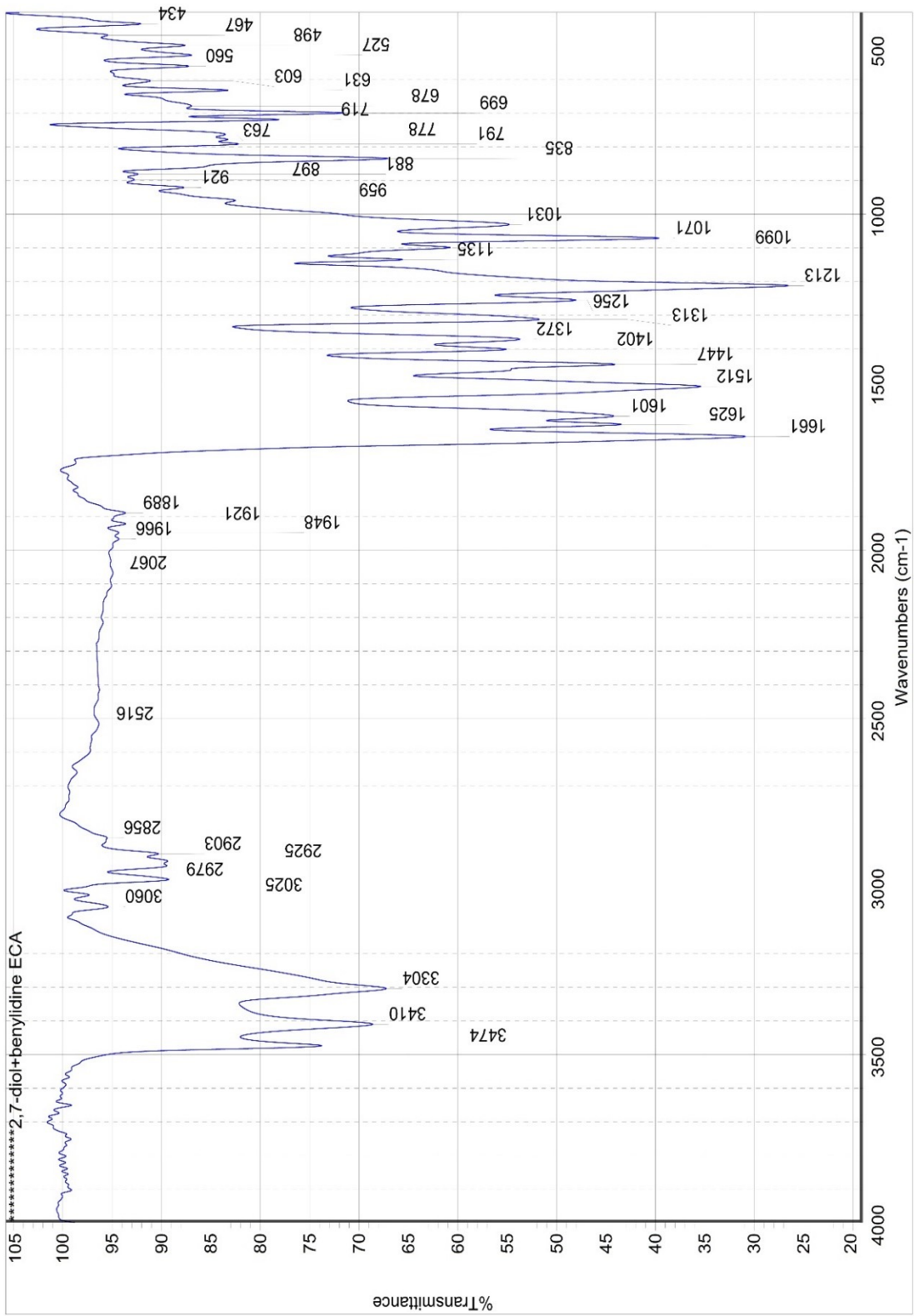
Figure. S17. Effect of the deposition time on current density for a solution containing 0.1 mol L⁻¹ acetate buffer (pH 4.5) and 4.0 μM Cd(II). Deposition potential: -1.5 V; scan rate: 100 mV.sec⁻¹; pulse amplitude: 50 mV; pulse width: 50 msec.

Figure. S18. ASV of GCE, GO@GCE, NIP/GO@GCE, un-leached IIP/GO@GCE and leached IIP/GO@GCE in a solution containing 0.1 mol L⁻¹ acetate buffer (pH 4.5) and 4.0 μM Cd(II). Deposition potential: -1.5 V; scan rate: 100 mV.sec⁻¹; pulse amplitude: 50 mV; pulse width: 50 msec.

Table Caption

Table. S1. Comparison of different voltammetric techniques for cadmium determination by using various modified electrodes.

Table. S2. Potentiometric responses of IIP/PVC@GCE and NIP/PVC@GCE toward Cd(II), Ni(II), Co(II), Pb(II), Cu(II), Mg(II), Hg(II), Ca(II), and Zn(II).



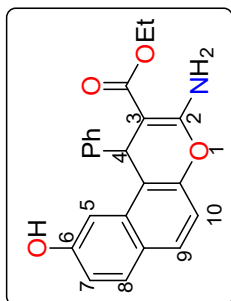


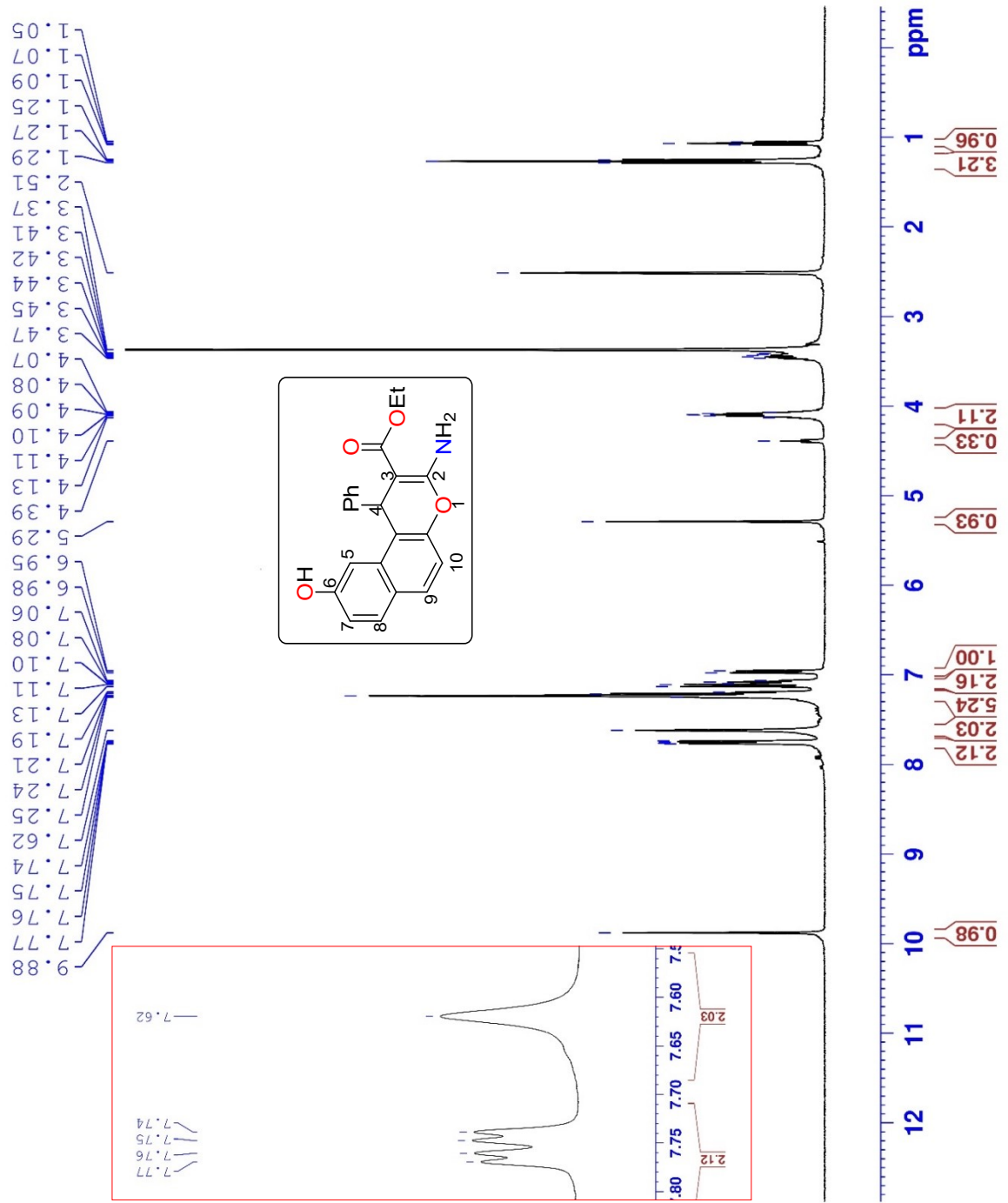
Figure. S1.



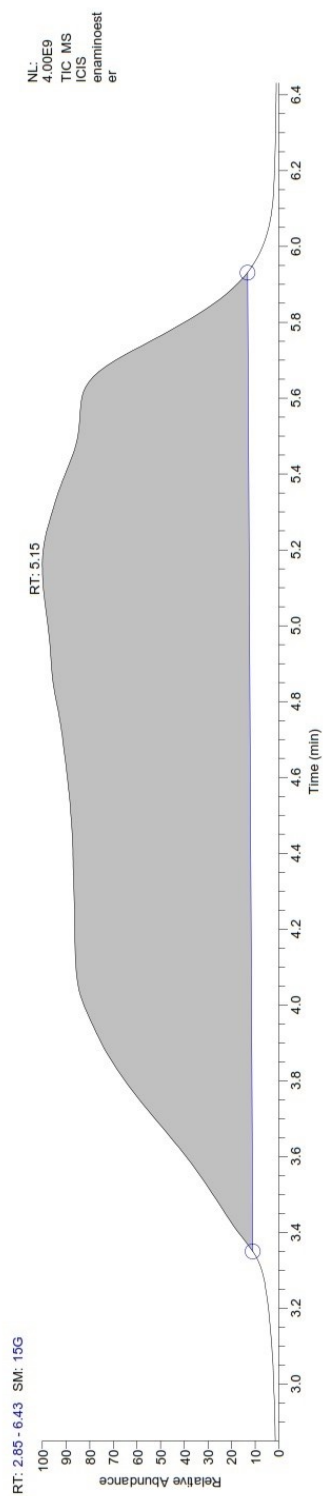
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 AQ 4.0894465 sec
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F2 - Processing parameters
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 PC 1.00



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Central Laboratory



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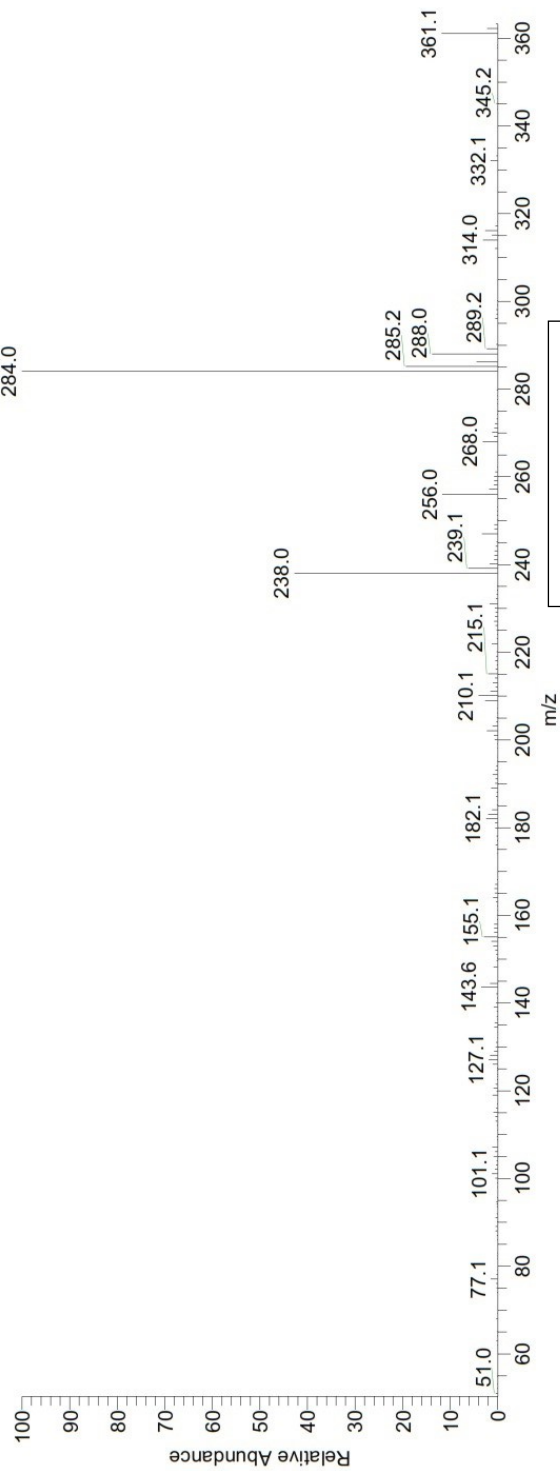
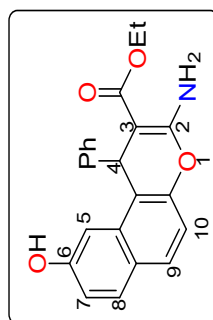
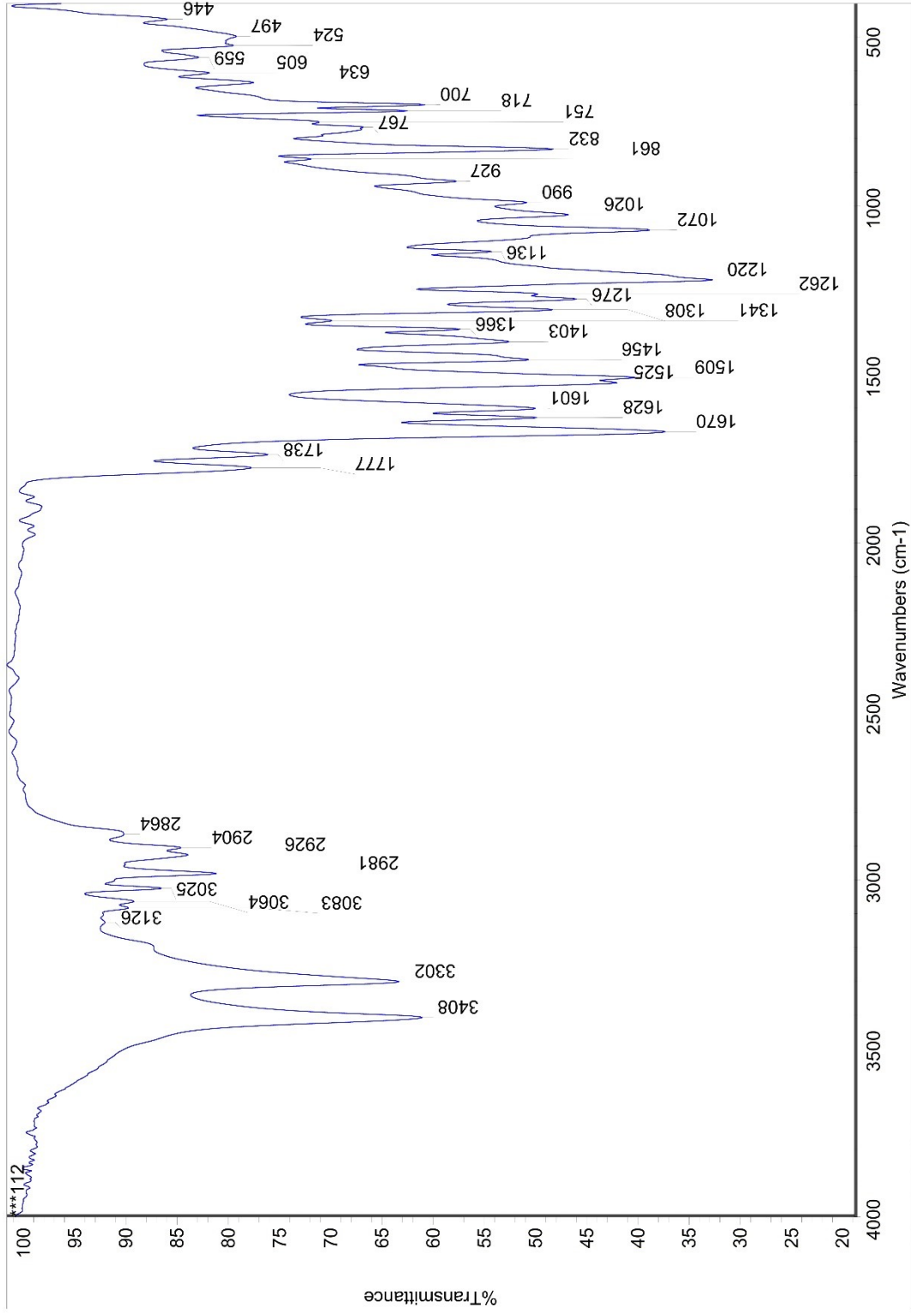


Figure. S1.





Spectral Analysis Unit
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 Faculty of Science
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 Operator: Sherif Abd El Fattah

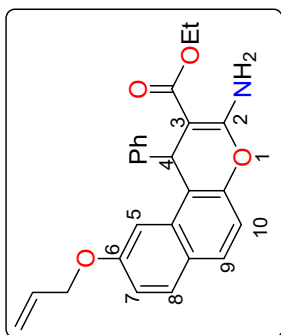


Figure. S4.

Mohammed Reda-112-proton-DMSO-D

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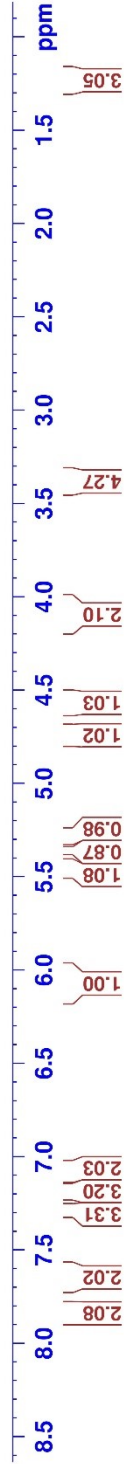
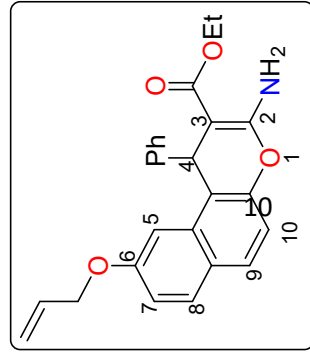


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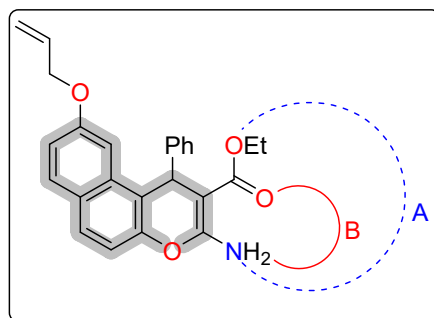


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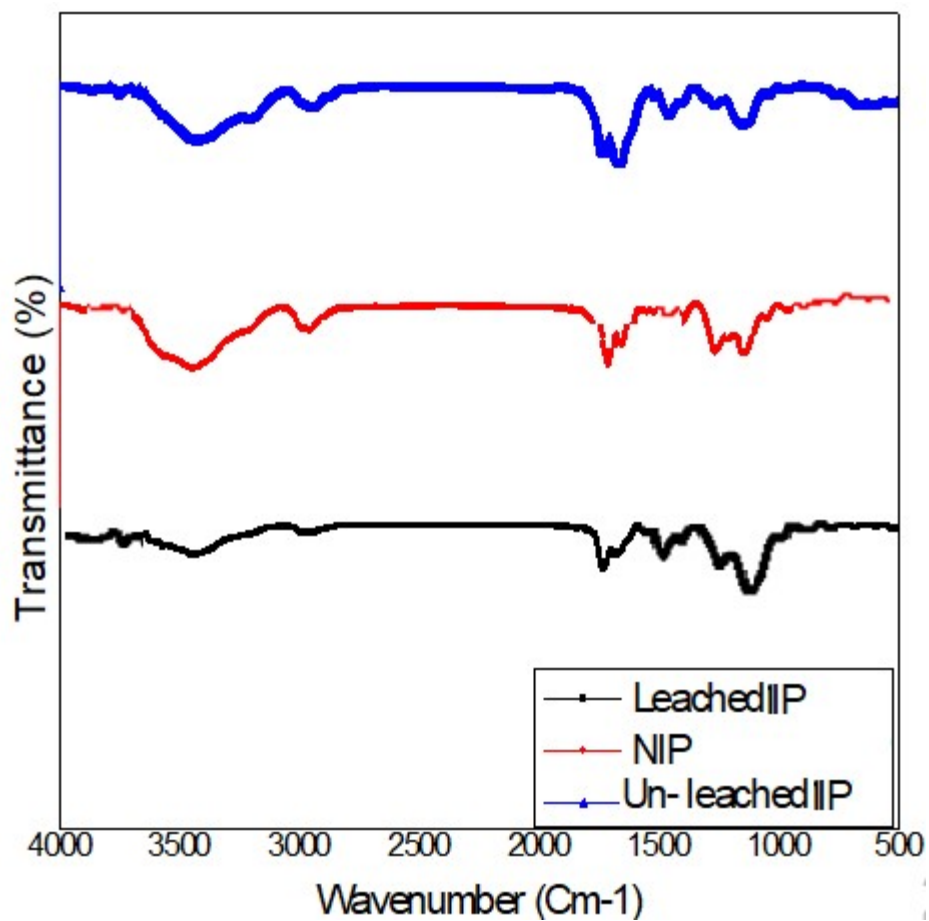


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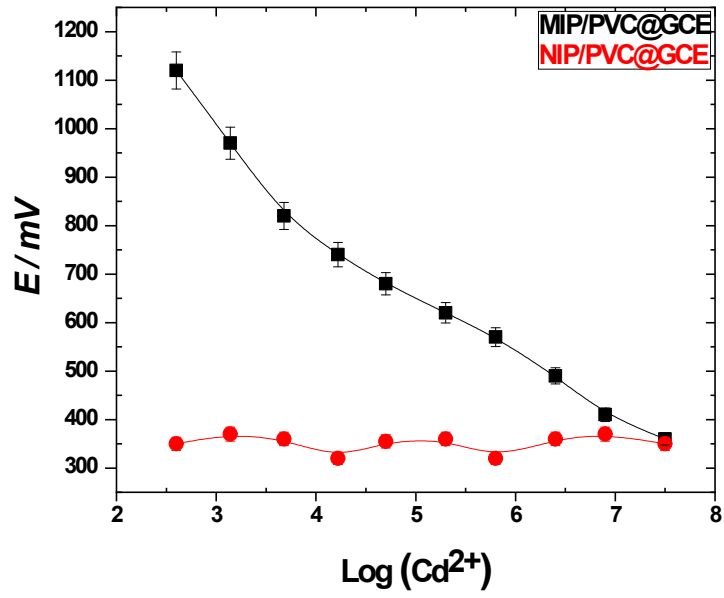


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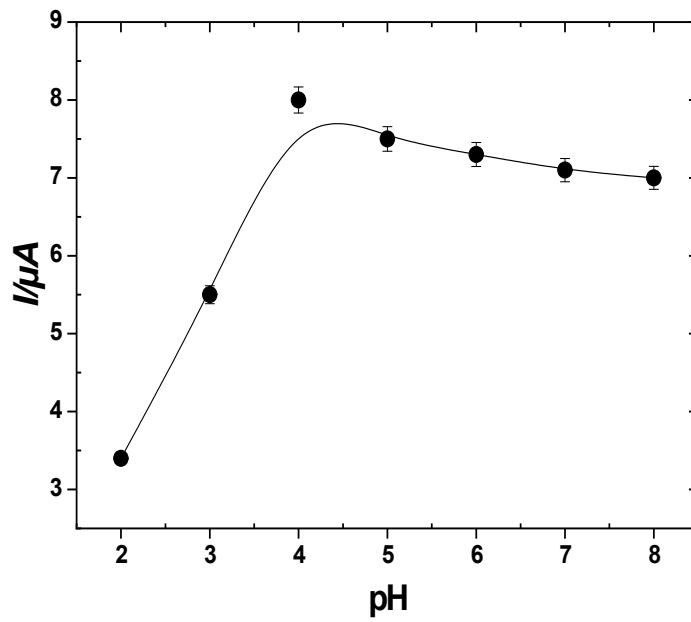


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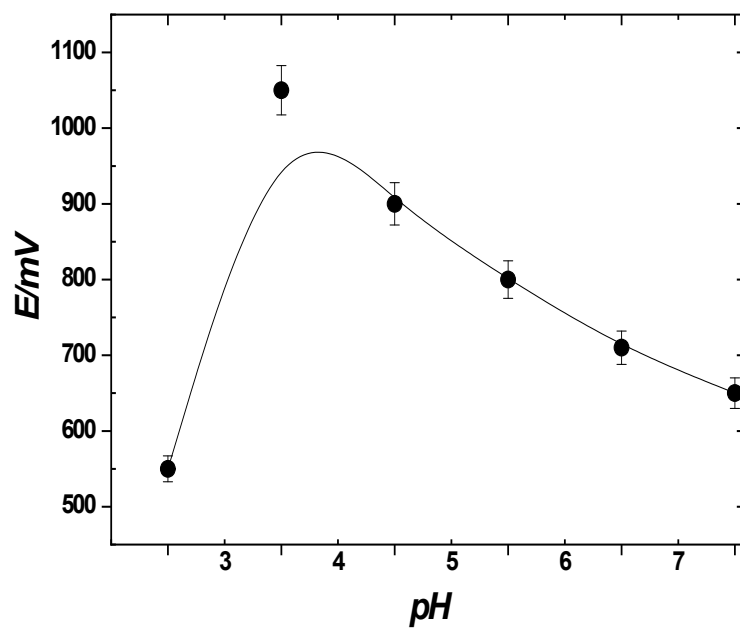


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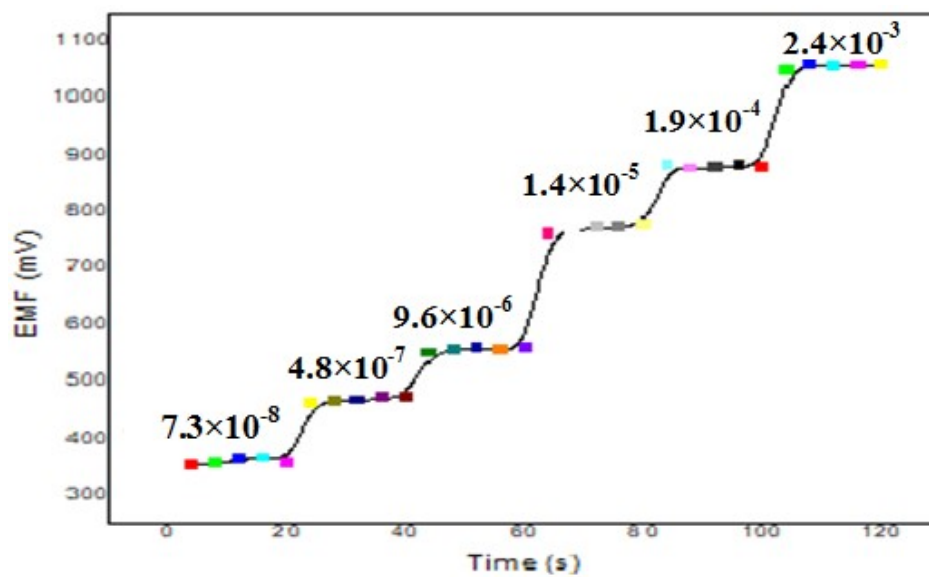


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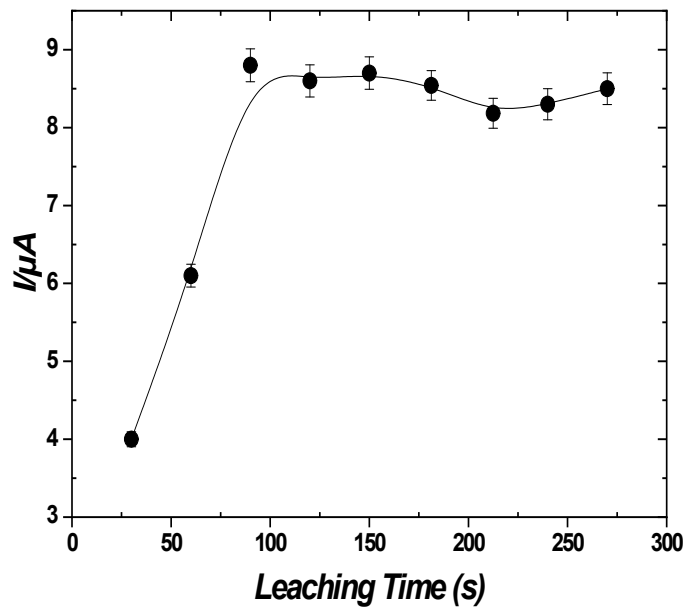


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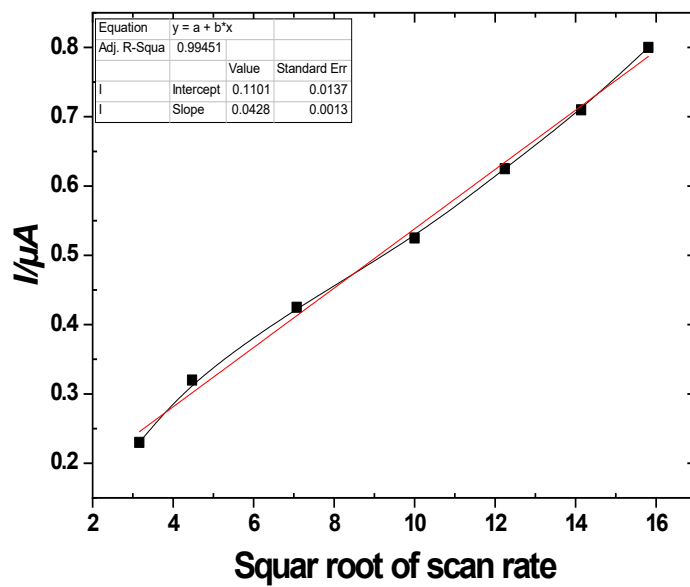


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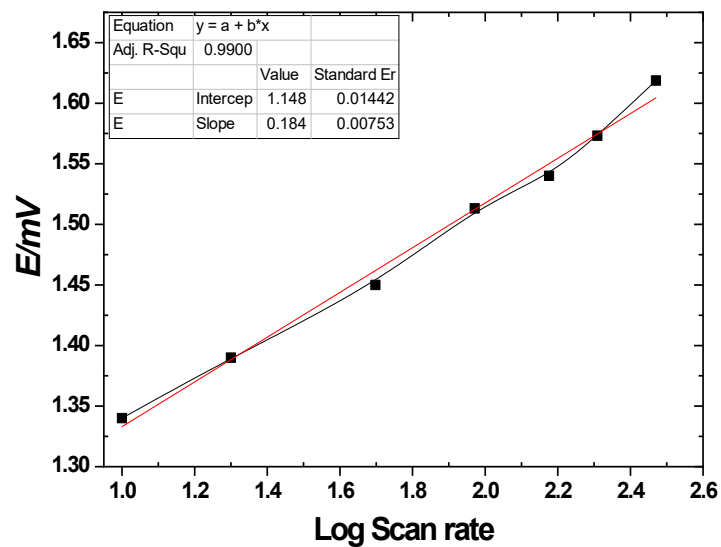


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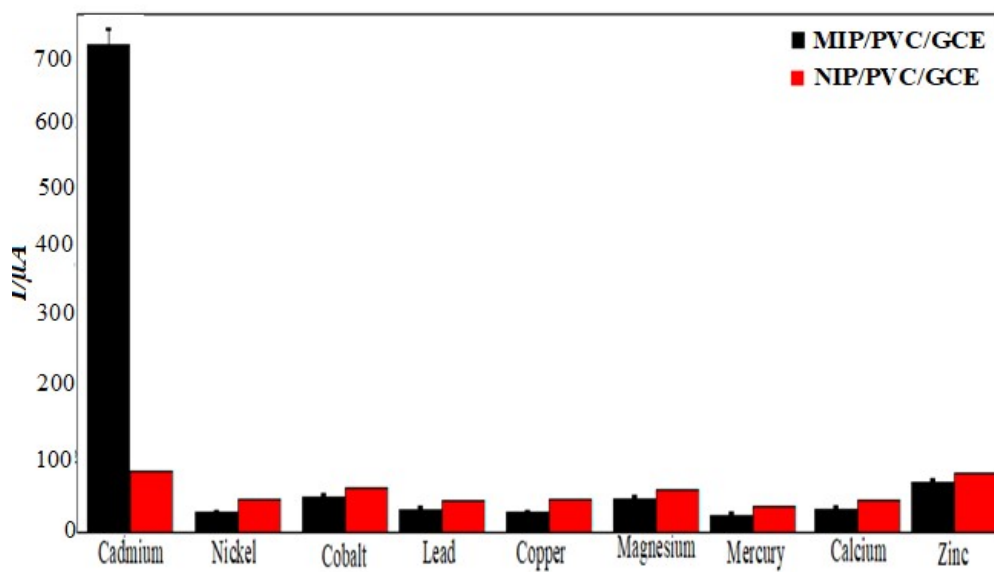


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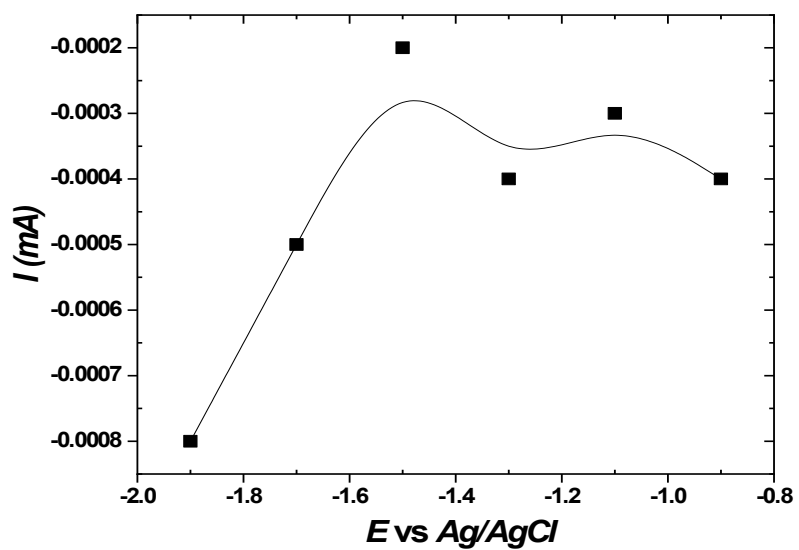


Figure. S16.

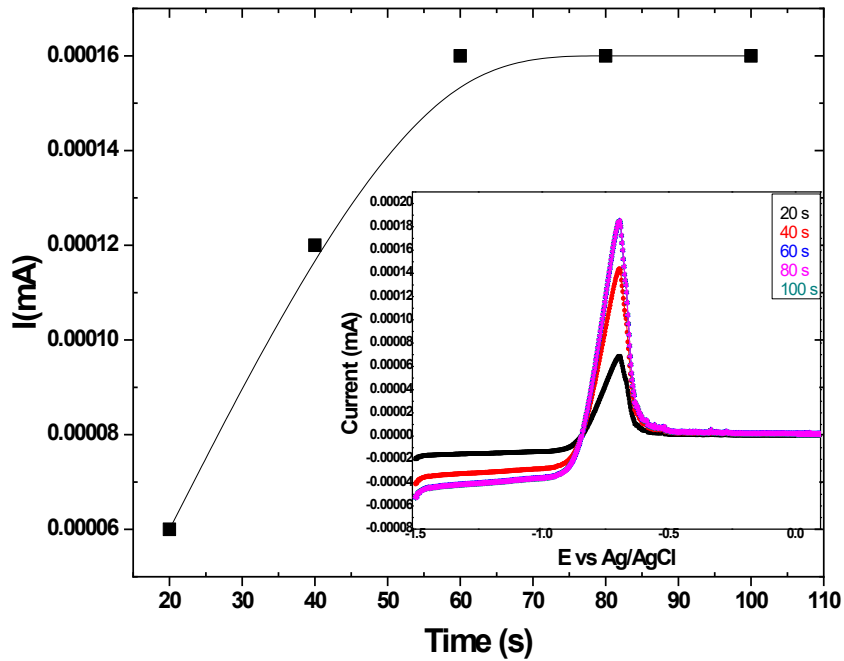


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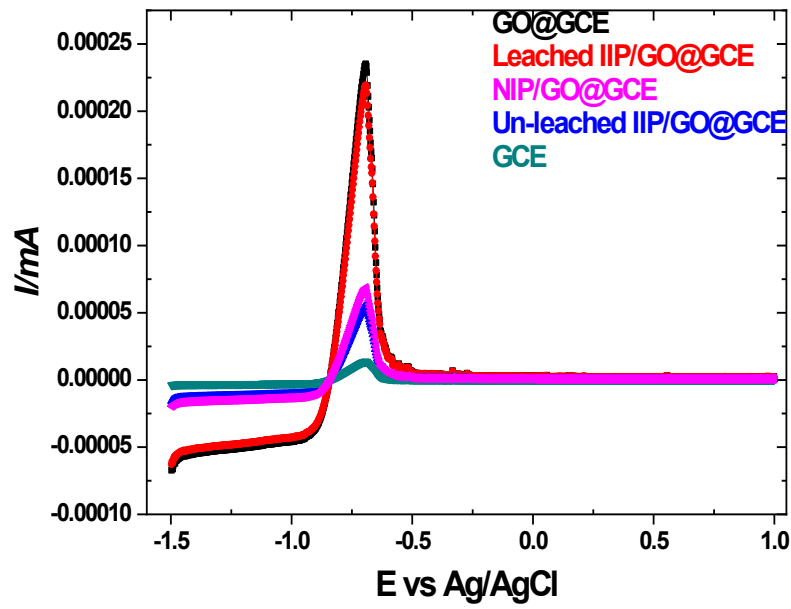


Figure. S18.

Table. S1.

Electrode	Modification	MD	Analysis method	DT (min)	DP (V)	Linear range	LOD	RT	Stability	Interference	RSD %	Ref
GCE	Fe ₃ O ₄ @SiO ₂ @IIP	Cd	DPSV	5	-1.2	0.008 - 0.8 μM	1×10 ⁻⁴ μM	5 min	-	Zn(II), Cr(III), Pb(II), Ni(II), Ag(I), Hg(II), K(I)	2.7	22
CPE	Cd-IIP	Cd	DPASV	5	-1.1	0.5 - 40 μg L ⁻¹	0.15 μg L ⁻¹	-	4 weeks	(>100 fold of Cd(II)) Cu(II) (>100 fold) Pb(II) (>30 fold) (Co(II), Zn(II), Hg(II), Ag(I)) (>50 fold)	2.82	23
CPE	Cd-IIP	Cd	DPASV	6	-1.2	2.0 - 200 ng mL ⁻¹	0.31 ng mL ⁻¹	-	-	Cu(II), Zn(II), Pb(II)	3.4	24
CPE	Chromium oxide	Cd Pb Cu Zn	SWASV	1.6	-1.3	10 - 800 μg·L ⁻¹ 10 - 800 μg·L ⁻¹ 10 - 800 μg·L ⁻¹ 80 - 800 μg·L ⁻¹	3 μg·L ⁻¹ (Cd) 3 μg·L ⁻¹ (Pd) 3 μg·L ⁻¹ (Cu) 25 μg·L ⁻¹ (Zn)	-	-	Fe(III), Mg(II), K(I), Ca(II), Na(I), NO ₃ ⁻ , SO ₄ ²⁻ , Cl ⁻	< 9.5	25
GCE	SnS-Bi ₂ O ₃	Cd	SWASV	4	-0.8	0.01 - 0.1 μg·mL ⁻¹	1.7×10 ⁻⁴ μg·mL ⁻¹	-	-	Ba(II), Hg(II), K(I), Pb(II), Mg(II), Mn(II), Na(I) (>60 fold)	1.2	26
CPE	IIP	Cd	DPV	3.5	-1.2	10.1 - 2750 and 2750 - 6690 μg L ⁻¹	4.95 μg L ⁻¹	-	-	Sn(II)	3.4	27
CPE	IIP	Cd	DPV	0.5	-1.2	1.0×10 ⁻⁹ - 5.0×10 ⁻⁷ M	5.2×10 ⁻¹⁰ M	-	-	Pb(II), Hg(II)	3.3	15
GCE	IIP/RGO	Cd	SWASV	10	-1.5	1 - 50 μg L ⁻¹	0.13 ng mL ⁻¹	-	more than 10 measurements	Cu(II), Zn(II), Mn(II), Fe(II), Mg(II), Ni(II), Hg(II)	< 5	16
GCE	IIP/RGO	Cd	SWASV	2	-1.2	1 - 100 μg L ⁻¹	0.26 μg L ⁻¹	-	12 h	Cr(III), Cr(VI), Mg(II), Zn(II), Mn(II)	< 4.6	18
CPE	Bi-Sb film	Cd	SWASV	3.5	-1.3	1.0 - 220.0 μg L ⁻¹	0.15 μg L ⁻¹	-	-	Cu(II) (1 fold) Ni(II) (4 fold) Pb(II) (80 fold) Co(II) (20 fold)	< 4.4	28

RGO (reduced graphene oxide), DPASV (differential pulse anodic stripping voltammetry), SWASV (Square wave anodic stripping voltammetry), MD (metal detection), DT (deposition time), DP (deposition potential), LOD (limit of detection), RT (response time), RSD (relative standard deviation).

Table. S2.

The interfering ions	Cd(II)	Ni(II)	Co(II)	Pb(II)	Cu(II)	Mg(II)	Hg(II)	Ca(II)	Zn(II)
Ratio between the potentiometric responses of IIP/PVC@GCE to NIP/PVC@GCE	8.6	1.1	1.05	0.87	1.09	1.1	0.86	1.4	1.03
