Novel MOF-Integrated MXene-Magnetite Electrochemical Platform for Effective Detection of Chloramphenicol

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Section S1: Analytical instruments

Fourier transform infrared (FT-IR) spectra of the samples, before and after CPA detection, were recorded using a Bruker Vertex 70 spectrometer in the spectral range of 375–4000 cm^{-1}, with a resolution step of 4 cm^{-1}. Powder X-ray diffraction (PXRD) patterns were acquired on a Bruker D8 DISCOVER diffractometer, equipped with a Co Kα radiation source (λ = 1.79026 Å) and an Eiger 2R 500 K area detector, over a 2θ range of 0–60°. The morphological characteristics of the Fe3O4@Mxene@Fe-BDC/SPCE were examined using a field-emission scanning electron microscope (FE-SEM, FEI Magellan 400), operating at accelerating voltages between 1 and 30 keV, and capable of sub-nanometer resolution. X-ray photoelectron spectroscopy (XPS) analyses were performed using a PHI Quantera II Scanning XPS Microprobe. Survey scans were collected over a 300 × 700 µm analysis area with a pass energy of 224 eV, while high-resolution spectra were acquired at a pass energy of 20 eV. All spectra were charge-corrected by referencing the

main C 1s peak of organic carbon to 285.0 eV and were processed using CasaXPS software (version 2.3.14). The electrochemical analyses were carried out using a mono-potentiostat PalmSens4 with the PSTrace 5-Palm-Sens software.

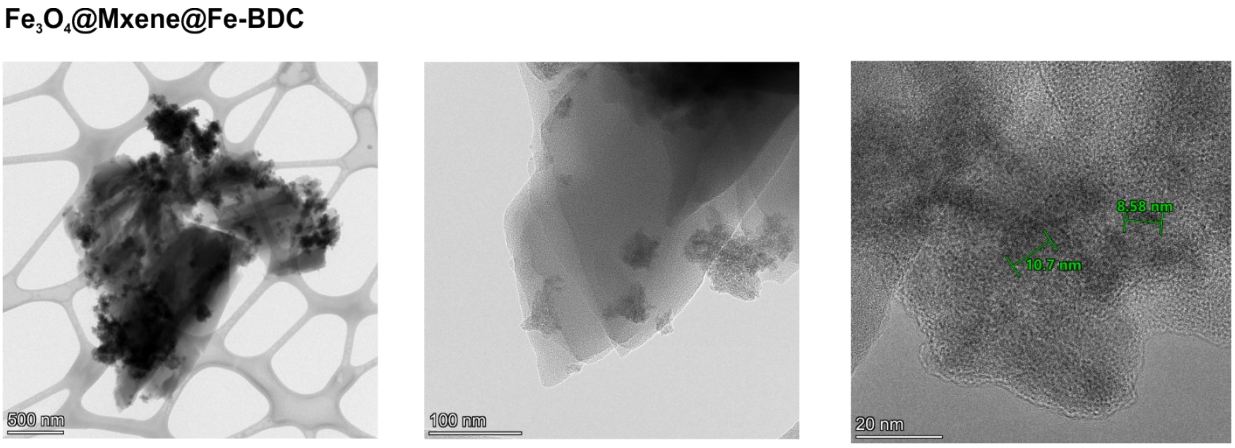

Figure S1. TEM micrographs of Fe_3O_4@Mxene@Fe-BDC.

The TEM micrograph of Fe_3O_4@Mxene@Fe-BDC shows a non-uniform distribution of Fe_3O_4 nanoparticles over the Mxene-Fe-BDC composite, which was the result of the physical mixing method used for the preparation of the final composite.

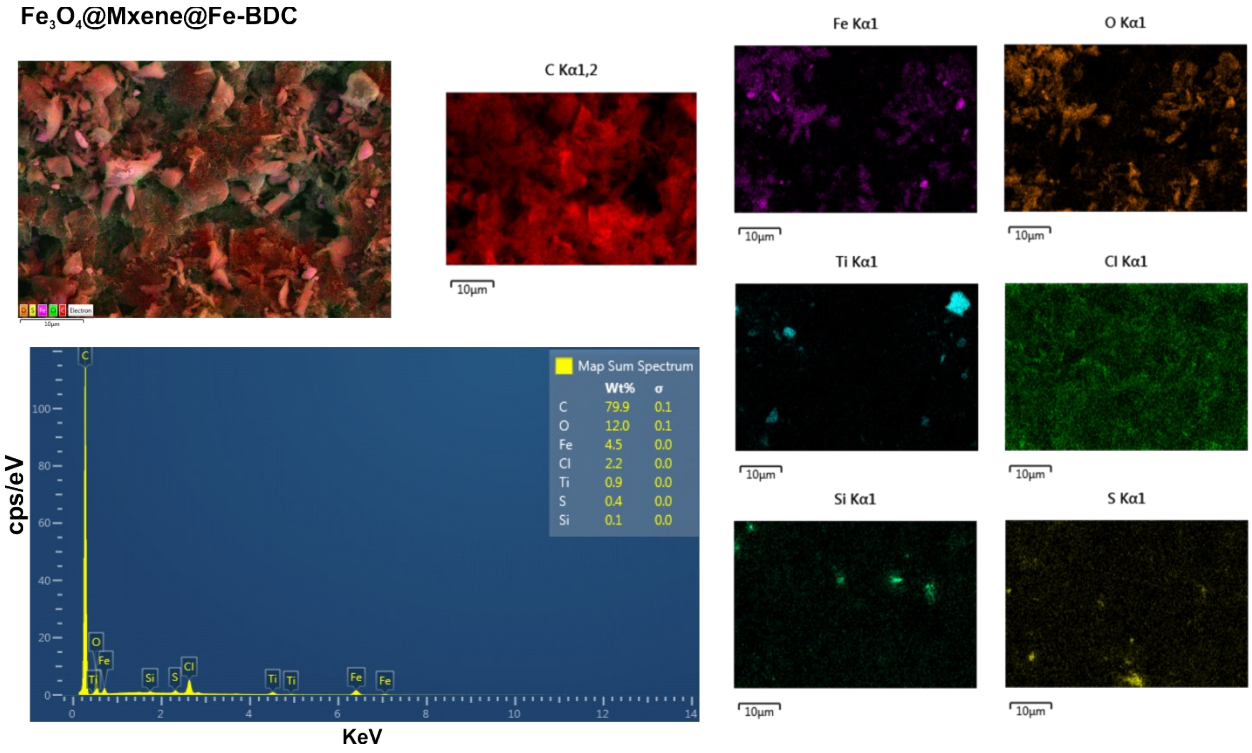

Figure S2. EDS mapping of Fe_3O_4@Mxene@Fe-BDC/SPCE.

Table S1. XPS survey data (atomic percentage) for the most concentrated elements in the materials.

Samples	Elements (At. %)								
	C 1s	O 1s	Fe 2p	Ti 2p	F 1s	N 1s	Cl 2p	S 2p	Na 1s
Fe_3O_4	4.5	53.0	42.5	-	-	-	-	-	-
MXene	47.6	21.1	-	13.7	17.7	-	-	-	-
Fe-BDC	64.2	28.9	6.9	-	-	-	-	-	-
P (Pristine Electrode)	87.3	11.9	-	-	-	0.8	-	-	-
Fe_3O_4@Mxene@Fe-BDC@Z*	65.8	24.0	3.4	1.1	0.8	-	3.9	1.0	-
Fe_3O_4@Mxene@Fe-BDC@Z + CPA**	54.3	28.9	3.4	0.3	0.6	0.7	6.8	0.4	4.5

***Zensor electrode modified with Fe_3O_4@Mxene@MIL 53 composite**
****Washing the electrode with water and then letting it dry at room temperature**

Table S2. The peak-fitting results of the C 1s high-resolution signal of materials.

Sample	Assignment	E_B (eV)	FWHM (eV)	At. %
P (Pristine Electrode)	C1s $_{C=C\ aromatic}$	284.4	0.8	20.5
	C1s $_{C-C,\ C-H}$	285.0	1.3	43.1
	C1s $_{COH,\ C-O-C,\ C-Cl}$	286.3	1.4	32.5
	C1s $_{O-C=O}$	288.3	1.8	3.8
Fe_3O_4@Mxene@Fe-BDC@Z	C1s $_{C=C\ aromatic}$	284.4	1.0	22.1
	C1s $_{C-C,\ C-H}$	285.0	1.3	53.4
	C1s $_{COH,\ C-O-C,\ C-Cl}$	286.4	1.3	12.4
	C1s $_{O-C=O}$	288.8	1.5	12.1
Fe_3O_4@Mxene@ Fe-BDC@Z + CPA	C1s $_{C=C\ aromatic}$	284.3	0.9	20.3
	C1s $_{C-C,\ C-H}$	285.0	1.3	57.2
	C1s $_{COH,\ C-O-C,\ C-Cl}$	286.3	1.3	13.2
	C1s $_{O-C=O}$	288.7	1.5	9.3

Table S3. The peak-fitting results of the O 1s high-resolution signal of materials.

Sample	Assignment	E_B (eV)	FWHM (eV)	At. %
Fe-BDC	**O1s** $_{C=O}$	532.2	1.8	55.4
	O1s $_{O^*-(C=O)-C,\ C-O\ aromatic}$	533.6	1.8	44.6
Fe_3O_4@Mxene@Fe-BDC@Z	**O1s** $_{O-Fe}$	530.0	1.4	12.7
	O1s $_{O=C-O}$	531.7	1.6	72.0
	O1s $_{C-OH}$	533.0	1.8	15.3
Fe_3O_4@Mxene@Fe-BDC@Z + CPA	**O1s** $_{O-Fe}$	530.5	1.4	12.9
	O1s $_{O=C-O}$	531.6	1.5	58.8
	O1s $_{C-OH}$	533.0	1.7	18.7
	O1s $_{Na\ Auger}$	536.2	2.3	9.6

Table S4. The peak-fitting results of the Cl 2p3/2 high-resolution signal of materials.

Sample	Assignment	E_B (eV)	FWHM (eV)	At. %
Fe_3O_4@Mxene@Fe-BDC@Z + CPA	Cl $2p_{3/2\ M-Cl}$	199.0	1.4	20.4
	Cl $2p_{1/2\ CxCl}$	200.6	1.4	-
	Cl $2p_{3/2\ CxCl}$	200.2	1.5	79.6
	Cl $2p_{1/2\ CxCl}$	201.8	1.5	-

Table S5. The peak-fitting results of the N 1s high-resolution signal of materials.

Sample	Assignment	E_B (eV)	FWHM (eV)	At. %
Fe_3O_4@Mxene@Fe-BDC@Z + CPA	N 1s $_{-N=}$	399.8	1.6	64.1
	N 1s $_{N+}$	401.8	1.9	35.9