1 **A novel electrochemical sensor based on Cu-coordinated**

2 **molecularly imprinted polymer and MoS$_2$ modified chitin-**

3 **derived carbon for selective detection of dextromethorphan**

4 Jingxia Yuan, Shulei Wang, Siying Cheng, Yiwei Liu, Faqiong Zhao, Baizhao Zeng[*]

5 *College of Chemistry and Molecular Sciences, Wuhan University, Wuhan 430072,*

6 *Hubei Province, P. R. China*

[*] Corresponding author. Tel: 86-27-68752701, Fax: 86-27-68754067.

E-mail address: bzzeng@whu.edu.cn (BZ Zeng)

Materials and reagents

Dextromethorphan cough syrup and cough tablets were purchased from local pharmacies. Healthy human serum was purchased from Fusheng Industry Co., Ltd. (Shanghai, China). Human urine samples were collected from laboratory personnel.

$CuCl_2 \cdot 2H_2O$, methanol, acetic acid, NaOH, anhydrous ethanol, potassium ferricyanide ($K_3[Fe(CN)]_6$), potassium ferrocyanide trihydrate ($K_4[Fe(CN)_6] \cdot 3H_2O$), glucose (Glu), ascorbic acid (AA), urea, uric acid (UA), NaBr and KNO_3 were obtained from China National Pharmaceutical Group Chemical Reagent Company (Shanghai, China). Hydrobromide dextromethorphan (DXM), chitin, phytic acid (50%), carbon bisulfide, ammonium tetrathiomolybdate, hydrogen peroxide (30%), anhydrous 1,10-phenanthroline, guaiacol, ketoprofen (KP) and ibuprofen (IBP) were purchased from Aladdin Chemical Reagent Co., Ltd. (Shanghai, China).

Instruments and apparatus

ZEISS field emission scanning electron microscope (SEM, Zeiss Gemini SEM 500) was used to characterize the morphology of the materials. The X-ray diffraction (XRD) measurements were performed with a Bruker D8 diffractometer (Germany) using Cu Kα radiation (40 KV, 40 mA). XRD spectra were recorded within 2θ range of 10−80° at a scan rate of $5.0° \ min^{-1}$. X-ray photoelectron spectroscopy (XPS) was obtained with ESCALAB 250Xi spectrometer (Thermo Fisher Scientific Inc, America). Survey scan spectra were recorded using a pass energy of 100 eV and a 1 eV step. Narrow scans of single regions were acquired using a pass energy of 30 eV and a 0.05 eV step. The UV–Vis spectra were collected by a UV-3600 spectrophotometer (Shimadzu Corporation, Japan). Fourier transform infrared (FT-IR) spectra were acquired on a FT-IR5700 (Thermo Fisher Scientific, USA) in the wavenumber range of 400-4000 cm^{-1}.

Electrochemical experiments were conducted on a CHI830D electrochemical workstation (Chenhua, Shanghai, China), employing a conventional three-electrode system. For electrochemical experiments, a modified GCE (diameter 3 mm), platinum

35 wire electrode, and Ag/AgCl electrode were used as the working electrode, auxiliary

36 electrode, and reference electrode.

Preparation of DXM working standard solution

38 The standard working solution of DXM (1 mM) was prepared using PBS

39 (pH=7.0). The standard working solution was stored in the dark at 4 °C, and it was

40 diluted with PBS solution before use. The working solution with the same

41 concentration was analyzed three times repeatedly for the study of linear calibration

42 curve.

High performance liquid chromatography analysis

44 Use LC-20AT with a UV-visible detector for HPLC detection, which was set at

45 280 nm for DXM analysis. In the HPLC system, chromatographic separation was

46 carried out by a mobile phase consisting of acetonitrile-water-acetic acid (100: 100: 1)

47 on Inersustain®C18 (average particle size: 5 μm, 250×4.6 mm inner diameter). The

48 flow rate was 1.0 mL min^{-1}. The injection volume was 20 μL and the column

49 temperature was kept at 30 °C.

Estimation of electroactive surface areas

51 The effective surface area of each electrode was calculated using the Randles-

52 Sevcik equation[1]:

53 $$I_p = 2.69 \times 10^5 n^{3/2} A C D^{1/2} v^{1/2}$$ **(Eq. S1)**
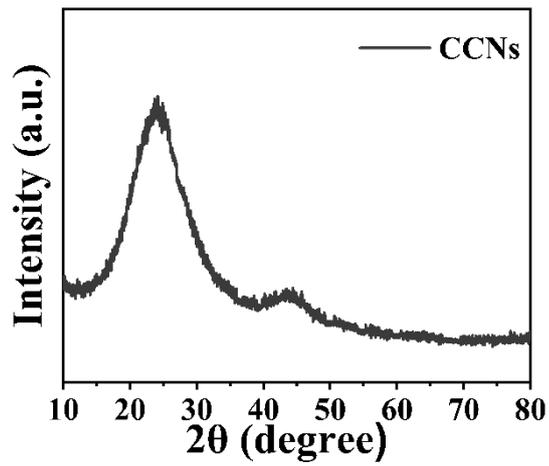
54 Where:

55 I_p is the peak current.

56 n is the number of electrons involved in the oxidation-reduction reaction（n=1）.

57 A is the active surface area of the electrode.

58 D is the diffusion coefficient of $K_3Fe(CN)_6$ (6.73×10^{-6} cm^2 s^{-1}).

59 C is the volume concentration of $K_3Fe(CN)_6$.
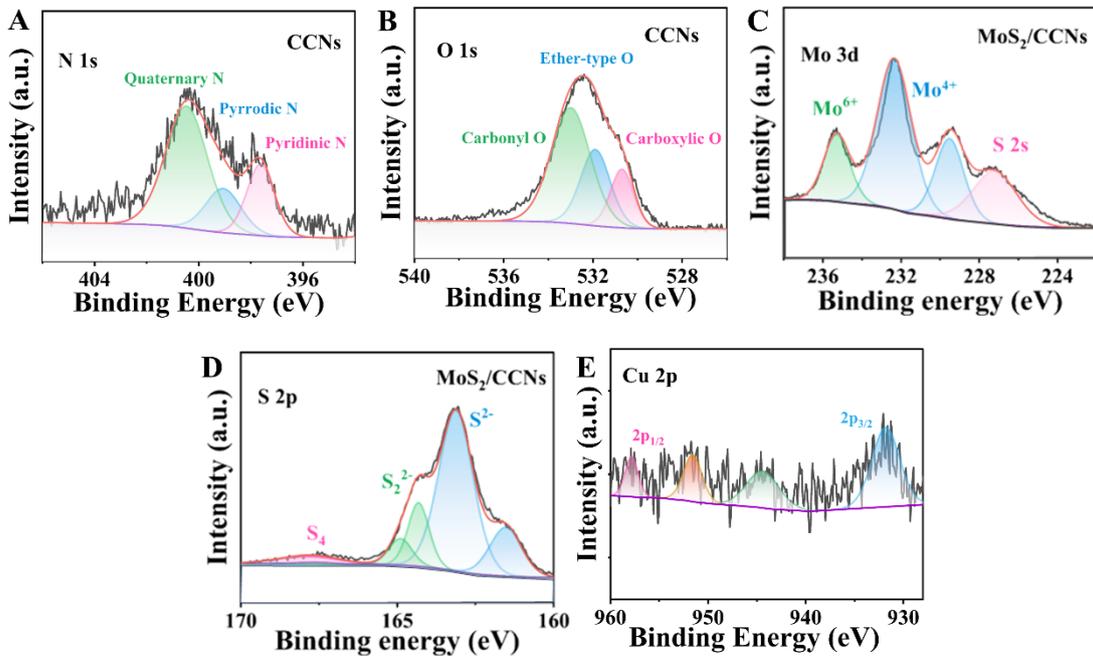
60 v is the scan rate. (100 mV s^{-1})
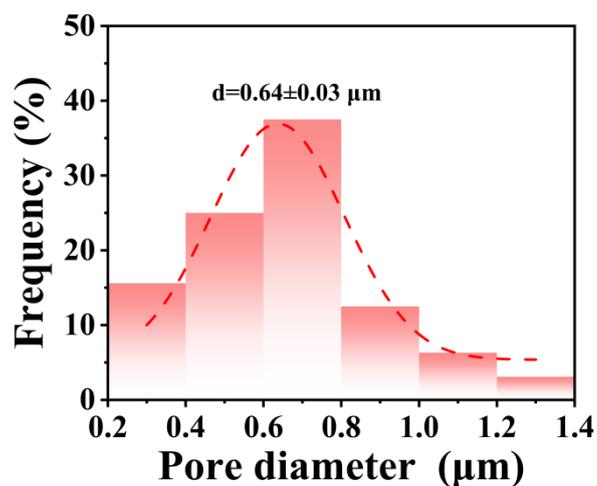
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Fig. S1. XRD pattern of CCNs.

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64

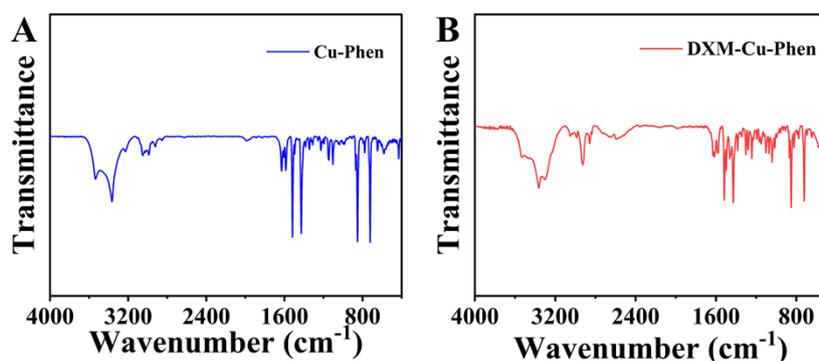**Fig. S2.** XPS high-resolution spectra of (A) N 1s, (B) O 1s in CCNs samples and (C) Mo 3d, (D) S 2p in MoS_2/CCNs samples, (E) Cu 2p in Cu-MIP after electropolymerization and elution process.
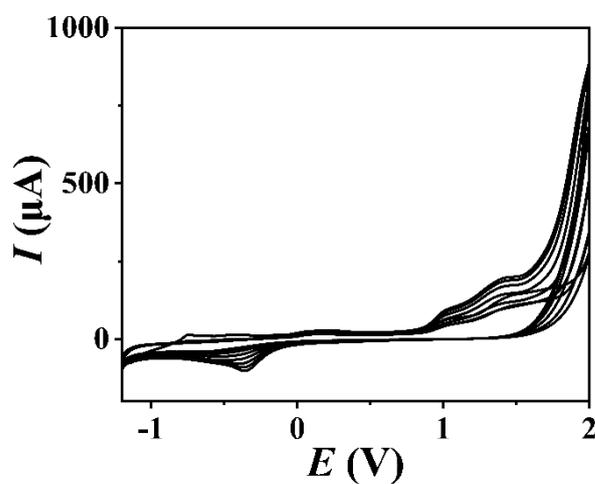
68

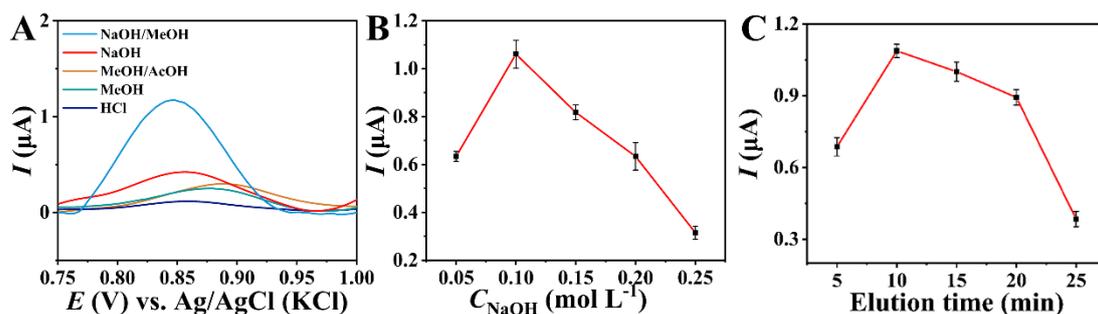**Fig. S3.** Statistical histogram of the pore size distribution derived from the cross-sections on the SEM image.

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Fig. S4. FT-IR spectra of (A) Cu-Phen and (B) DXM-Cu-Phen.
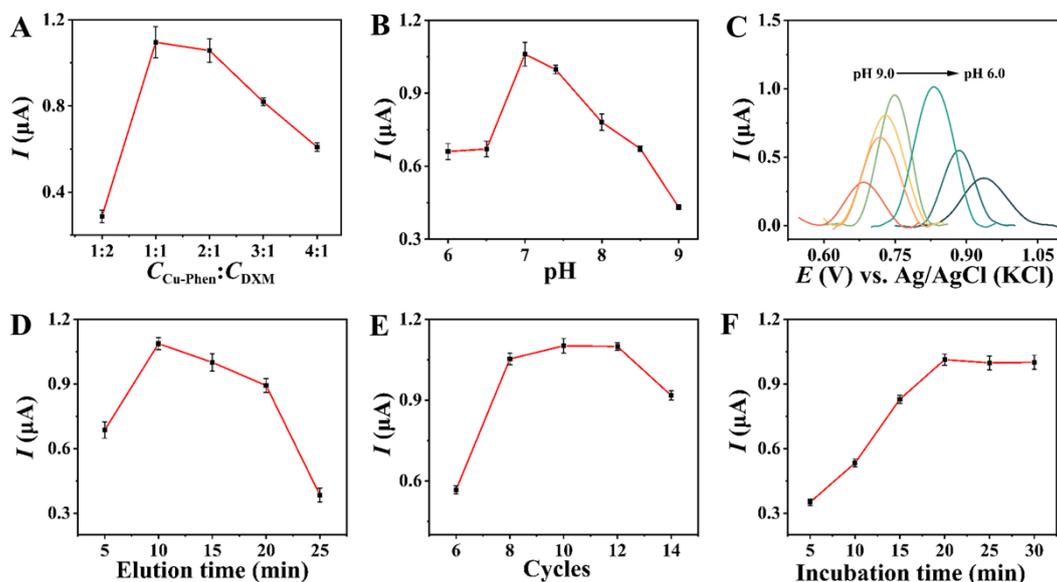

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Fig. S5. CV curves of MoS_2/CCNs/GCE in PBS (pH=7.0) containing 1.0 mM DXM-Cu-Phen.

76

77 **Fig. S6.** (A) DPV curves of 10 μM DXM at the Cu-MIP/MoS$_2$/CCNs/GCE by using

78 different eluents. Effect of (B) C_{NaOH}; (C) elution time on the peak current of 10 μM

79 DXM at the resulting Cu-MIP/MoS$_2$/CCNs/GCE.

80

81 **Fig. S7.** Effect of (A) the ratio of Cu-Phen to DXM; (B) pH of phosphate buffered

82 solution. (C) Influence of solution pH on DPV response of 10 μM DXM at Cu-

83 MIP/MoS$_2$/CCNs/GCE. pH values: 6.0, 6.5, 7.0, 7.5, 8, 8.5 and 9.0. Effect of (D)

84 electropolymerization scanning rate; (E) number of electropolymerization cycles; (F)

85 incubation time on the peak current of 10 μM DXM at the resulting Cu-

86 MIP/MoS$_2$/CCNs/GCE.
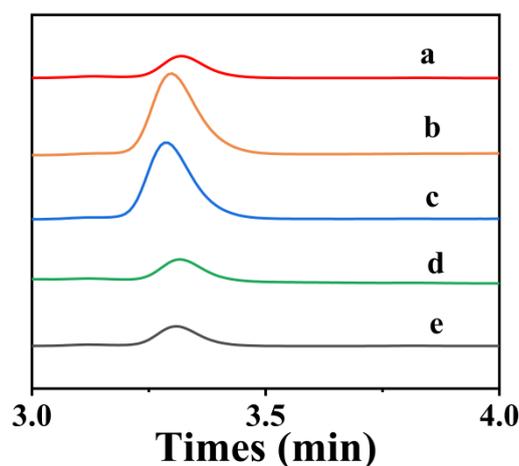
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88 **Fig. S8.** Chromatographic diagram of (a) 10 μM standard solution of DXM, (b) syrup

89 simple solution, (c) table simple solution, (d) spiked serum (spiked 10 μM DXM

90 standard solution), (e) spiked urine (spiked 10 μM DXM standard solution).

91

92 **Table S1.** Comparison of Cu-MIP/MoS$_2$/CCNs/GCE with some reported

93 electrochemical sensors for DXM detection.

Modified electrodes	Method	Linear range (μM)	LOD (μM)	Reference
PDDA/MWCNT/CD/PGE[a]	DPV	2.0−600	0.2	2
CNP/CPE[b]	DPV	8.0–800	2.9	3
SPCE[c]	Potentiometry	10.0–10^4	6	4
ITO-IL-CME[d]	DPV	0.97–620	0.047	5
β-CD-CWE[e]	Potentiometry	0.1–10^4	0.07	6
MIP/PVCE[f]	Potentiometry	2.8−10^3	1	7
Cu-MIP/MoS$_2$/CCNs/GCE	DPV	0.1-100	0.02	This work

94 [a] PGE: pencil graphite electrode.

95 [b] CPE, [d] CWE: carbon paste electrode.

96　^{c} SCPE: disposable screen-printed carbon electrodes.

97　^{e} CWE: silver coated wire electrode.

98　^{f} PVCE: Polyvinyl chloride membrane electrode.

99　Reference

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