Electronic Supplementary Material (ESI) for Nanoscale.

MOF-derived Electrochemical Catalyst Cu-N/C for the Enhancement of the Amperometric Oxygen Detecting

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Characterizations of ionic liquid [Bmmim][TFSI].

FTIR: In Fig. S1, the peak observed at 3152 cm^{-1} was assigned to C–H stretching vibration of the imidazole ring, and the additional peaks at 2968 cm^{-1} and 2880 cm^{-1} corresponded to the saturated C–H bonds of the aliphatic chain. Besides, the peaks located at 1591 cm^{-1} and 1541 cm^{-1} were related to the stretching vibrations of C=C bond and C=N bond on the imidazole skeleton. Adsorptions peak at 1467 cm^{-1} was attributed to the bending vibration of N–CH_3. Peaks at 1351 cm^{-1}, 1192 cm^{-1} and 1058 cm^{-1} derived from the S=O and SNS in the [TFSI], while the peaks around 1140 cm^{-1} and 741 cm^{-1} could be assigned to the vibrations of CF_3. Peaks at lower wavenumber region (790 cm^{-1}, 656 cm^{-1}) were indexed to the bending vibrations from C–H of imidazole ring.

^{1}H NMR: Fig. S2 gave the 1H NMR spectra of [Bmmim][TFSI], in which the characteristic chemical shifts (δ) were provided. The chemical shifts at 7.61, 7.58 were assigned to the hydrogen of carbon 1 and 2 from the imidazole ring. The chemical shifts at 4.06~4.10 were attributed to the hydrogen atoms of methylene on carbon 3. The hydrogen atoms of methyl on carbon 4 were corresponded to the chemical shift at 3.72, while the hydrogen atoms of carbon 5 corresponded to the chemical shift at 2.56. The chemical shift intervals of 1.70~1.63, 1.22~1.31, 0.87~0.90 were ascribed to methylene on carbon 6, 7 and methyl on carbon 8, respectively.

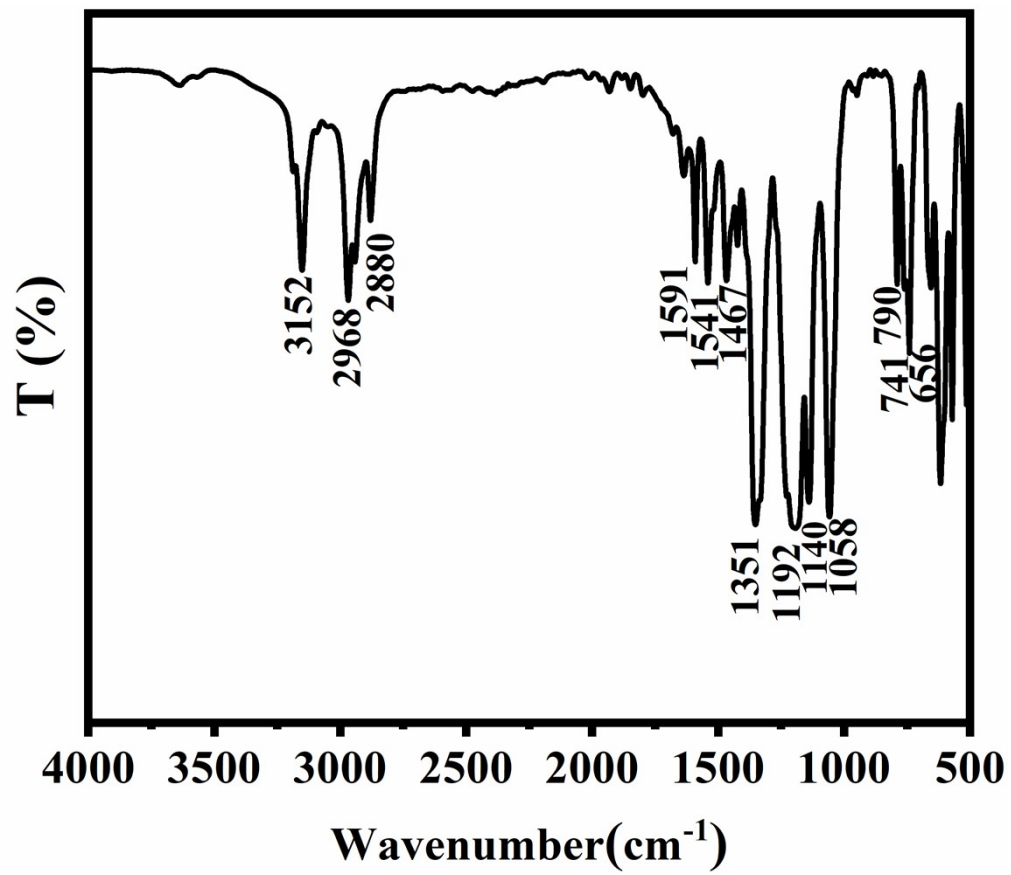

Fig. S1 FT-IR spectra of [Bmmim][TFSI].

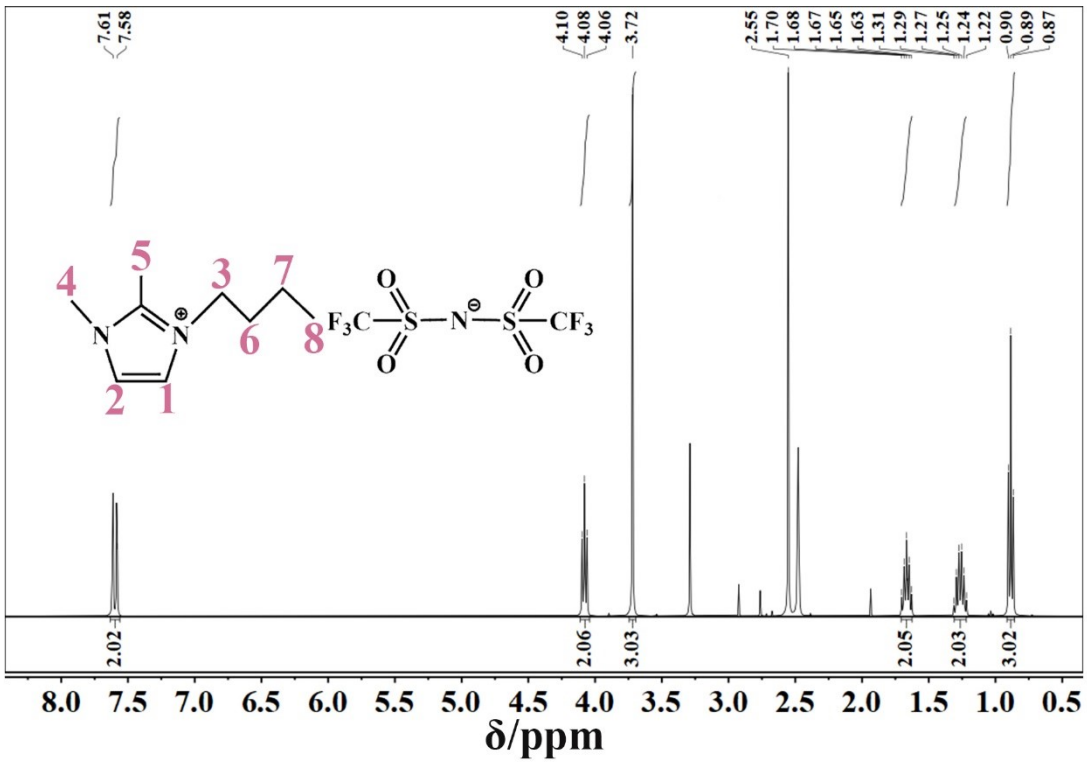

Fig. S2 ^{1}H NMR spectra of [Bmmim][TFSI].

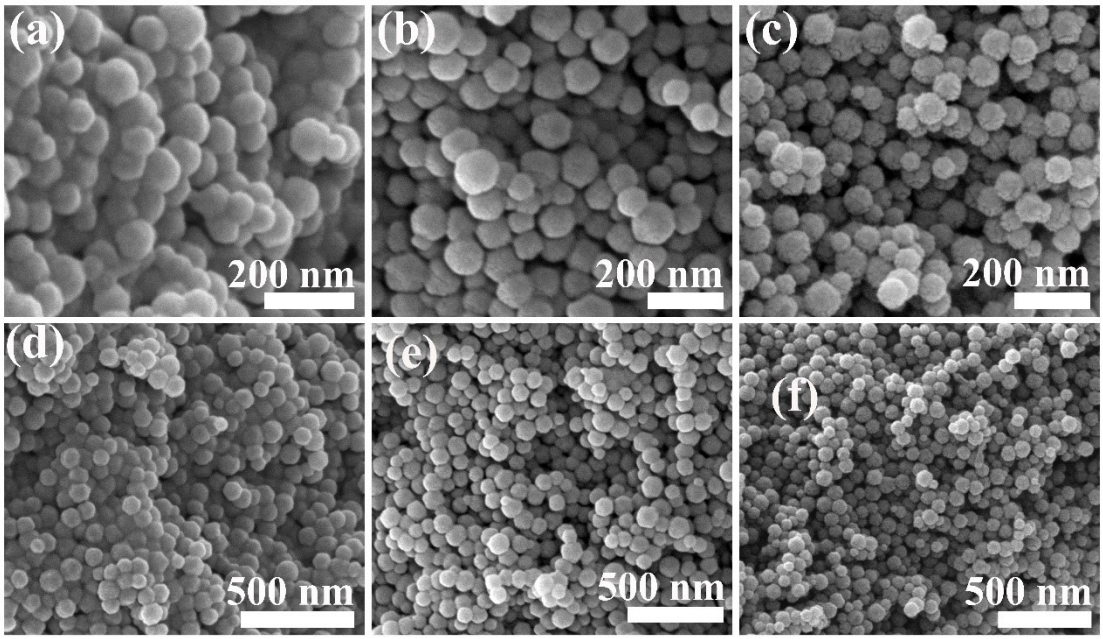

Fig. S3 Secondary electron SEM images of Cu-N/C-700 (a, d), Cu-N/C-800 (b, e) and Cu-N/C-900 (c, f).

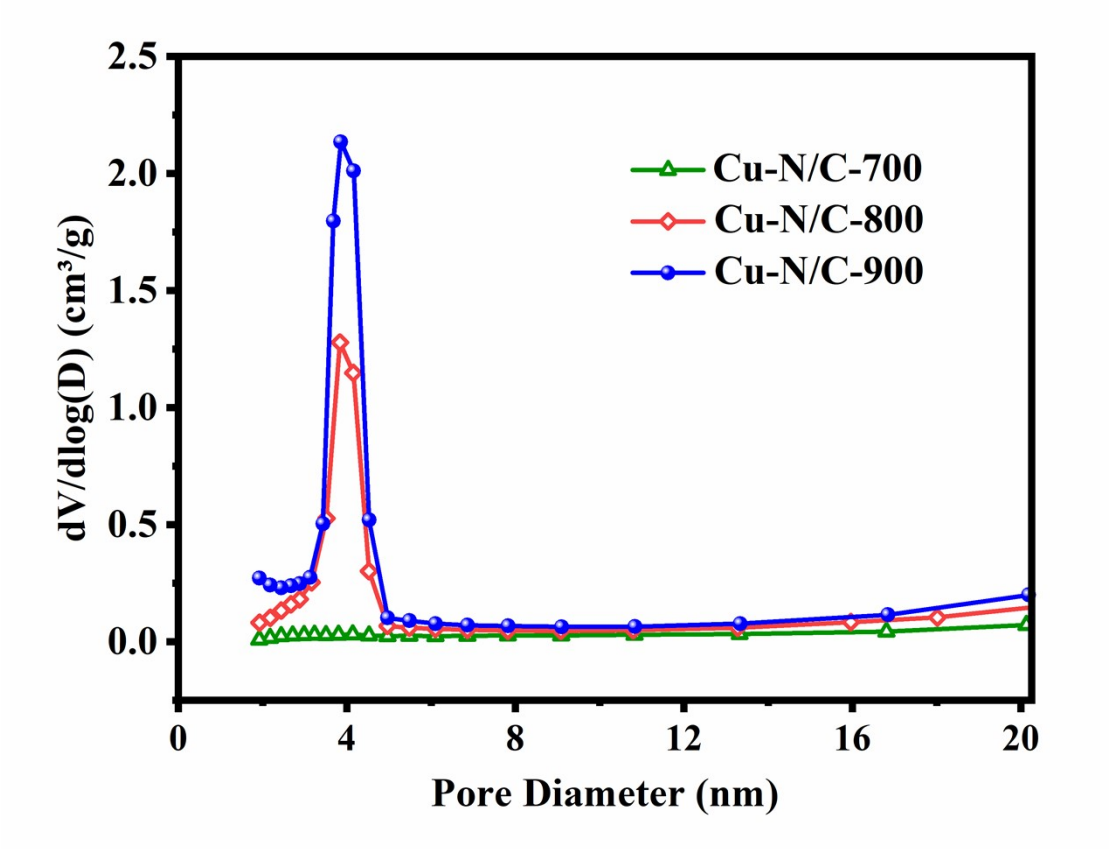

Fig. S4 Pore size distribution of Cu-N/C-700, Cu-N/C-800 and Cu-N/C-900.

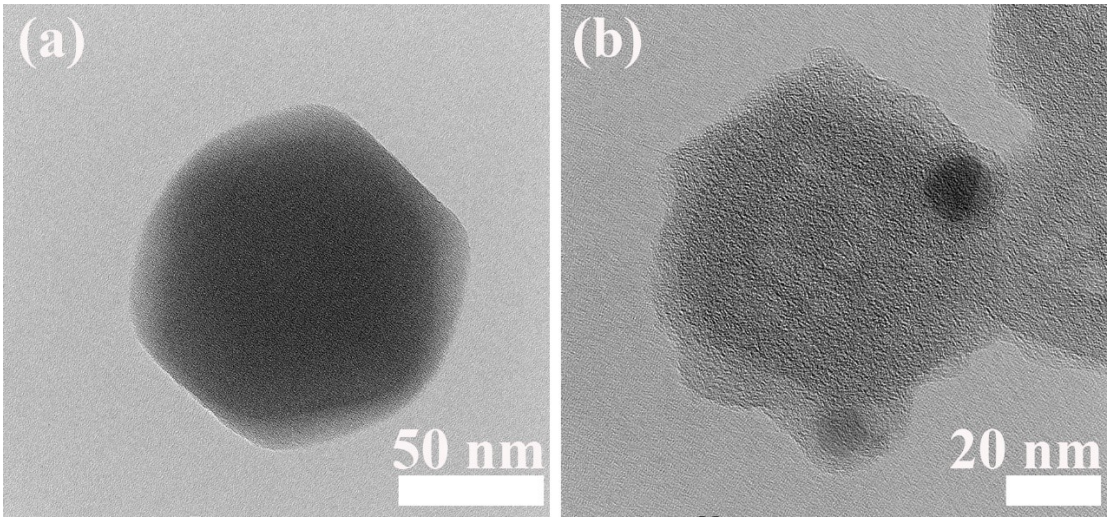

Fig. S5 Bright field TEM images of an individual particle of Cu-ZIF-8 and Cu-N/C-900.

Tab. S1 The percentage (%) for each element of Cu-ZIF-8, Cu-N/C-700, Cu-N/C-800 and Cu-N/C-900 from XPS.

Elements	Cu-N/C-900	Cu-N/C-800	Cu-N/C-700	Cu-ZIF-8
Zn	-	3	4.19	11.73
Cu	0.8	0.57	0.6	0.56
N	6.41	14.86	20.92	16.82
O	12.13	10.94	9.29	16.16
C	80.66	70.63	65	54.72

Tab. S2 Zn content (wt%) in different samples from ICP analysis

Sample	Zn content (wt%)
Cu-N/C-700	8.29
Cu-N/C-800	4.66
Cu-N/C-900	0.10

Tab. S3 Comparison of the sensing performance of the as-assembled sensor unit and O_2 sensor reported in literatures.

Sensors (IL adopted)	Target sensing gas	Concentration range (v/v%)	Sensitivity	LOD	reference
Porous polyethylene membrane ($EMIBF_4$)	O_2	0~100 % (v/v%)	0.0067 μA/O_2%	unprovided	[1]
Planar permeable membrane [C_4mpy][NTf_2]	O_2	0~21 % (v/v%)	0.48 μA/%	0.08 vol %	[2]
Microdisc electrode [$P_{6,6,6,14}$][FAP]	O_2	0.77~1.00 bar	9.8 nA/bar^{-1}	unprovided	[3]
[BMIM][NTf_2]	O_2	200~10^6 ppm v/v	660 μA ppm^{-1} v/v	140 ppm v/v	[4]
IL-$NiCo_2O_4$/rGO composite electrolyte [BMIM][PF_6]	O_2	0~100 % (v/v%)	0.1087 μA/O_2% (v/v)	unprovided	[5]
Double-layer ionic liquid film [BMIM][BF_4]	O_2	0~100 % (v/v%)	0.077 μA/O_2%	unprovided	[6]
This work	O_2	0~100 % (v/v%)	0.1678 μA/O_2%	0.42 vol %	**This work**

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Tab. S4 The fitted EIS parameters from the equivalent circuits for the pure ionic liquid, and composites electrolytes (with different Cu-N/C content).

Electrolyte	R_{ct} (Ω)	W (Ω)
[Bmmim][TFSI]	485.0	1.45*10^5
[Bmmim][TFSI]-2 % Cu-N/C	427.6	1.32*10^{-8}
[Bmmim][TFSI]-4 % Cu-N/C	420.3	8.30*10^{-17}
[Bmmim][TFSI]-6 % Cu-N/C	404.7	3.02*10^{-8}
[Bmmim][TFSI]-8 % Cu-N/C	778.1	1.45*10^5