Supporting Information

Tuning Humidity Response in 2D MOF Membranes through Nanosheet Geometry

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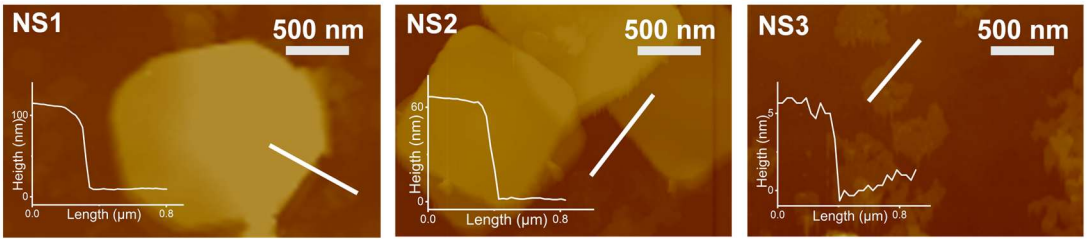

Fig. S1 AFM images of NS1, NS2, and NS3 after ultrasonic treatment.

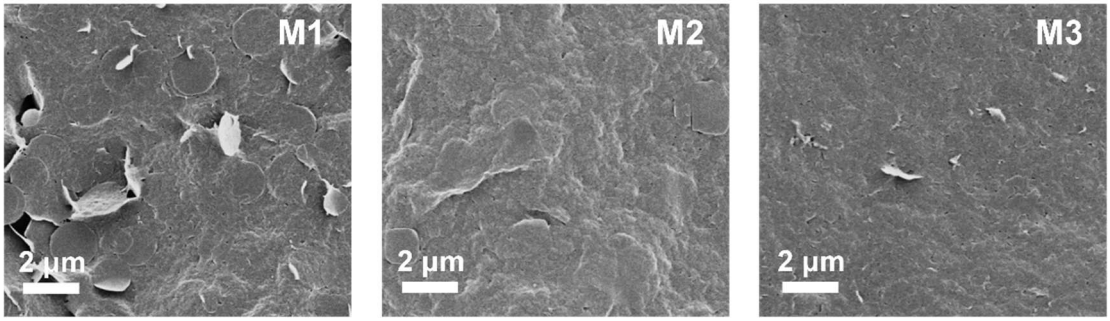

Fig. S2 Top-view SEM images of M1, M2, and M3 membranes.

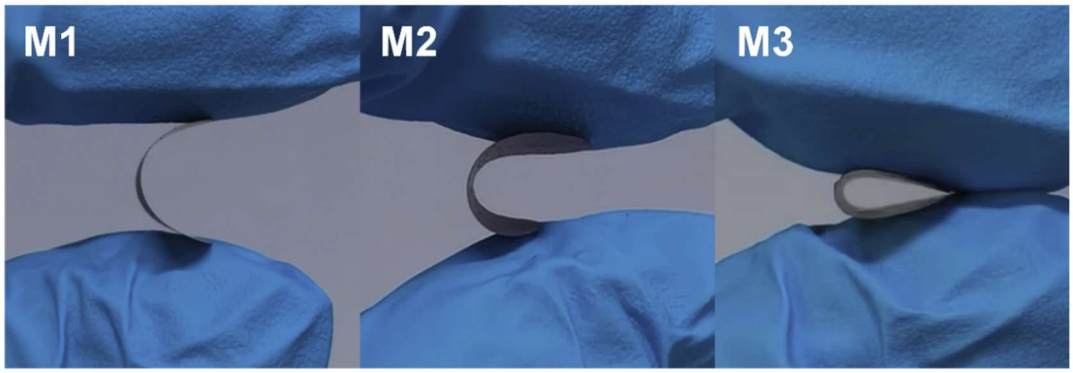

Fig. S3 Side-by-side photographs of free-standing CuTCPP membranes M1-M3 under progressively increased bending deformation, illustrating the different mechanical tolerance limits prior to fracture.

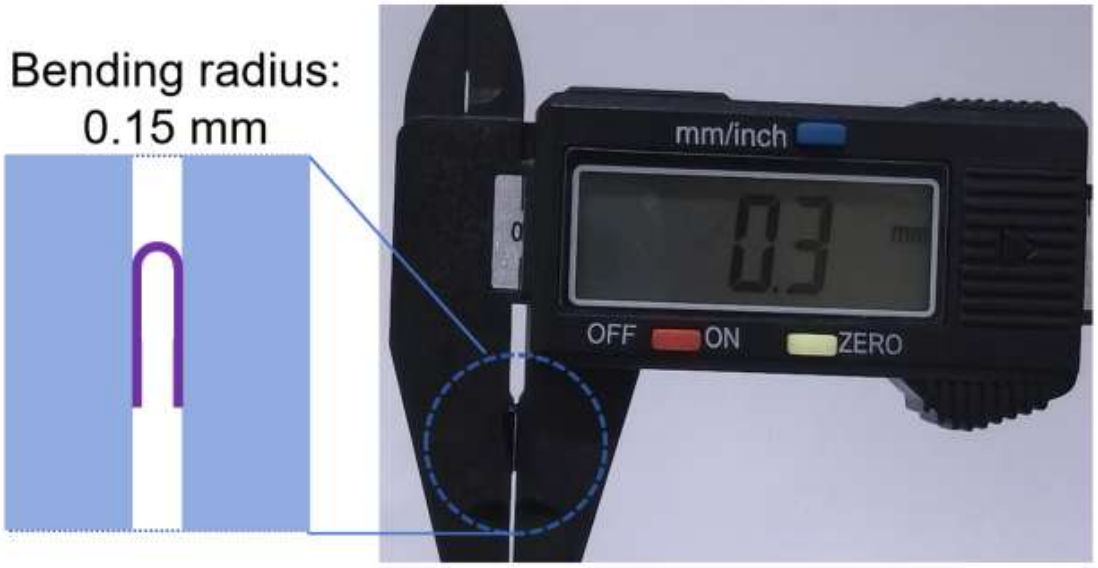

Fig. S4 Optical photograph of the free-standing M3 membrane bent to a curvature radius below 1 mm at a thickness of approximately 11 μm.

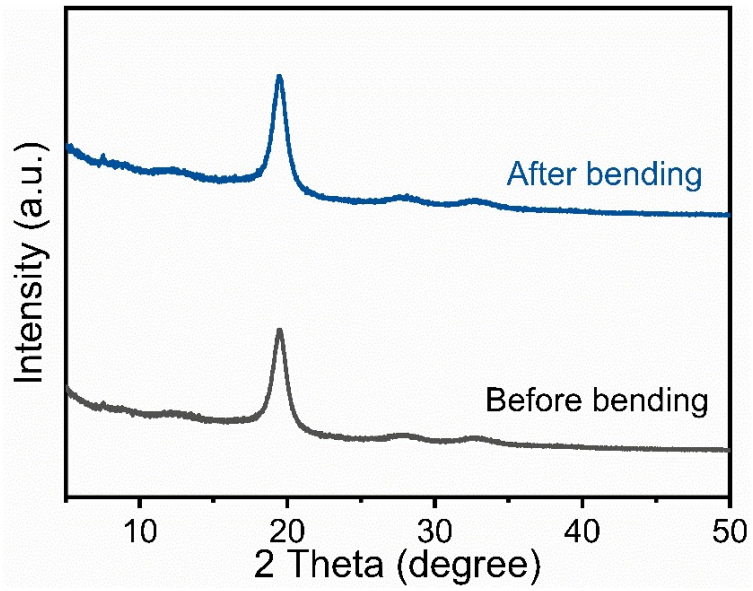

Fig. S5 XRD patterns of the CuTCPP membrane before and after bending.

Fig. S6 Optical image of CuTCPP membrane device.

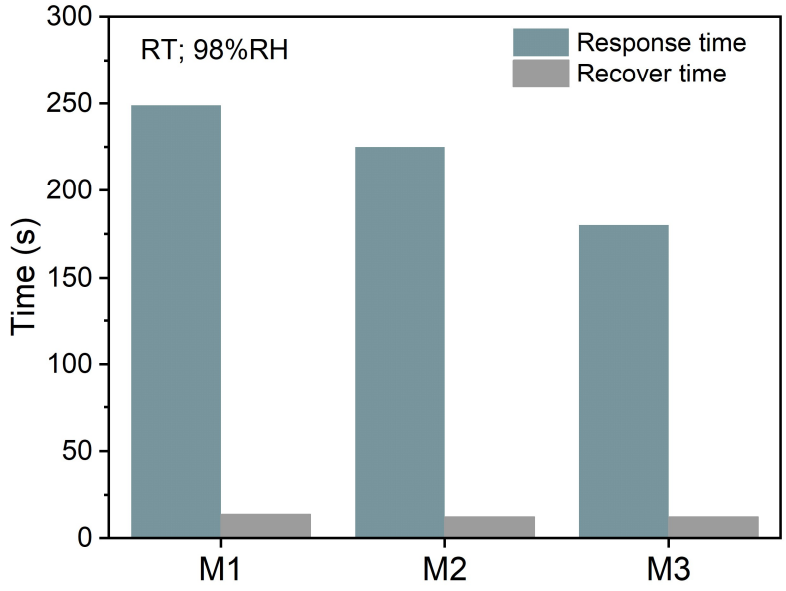

Fig. S7 Response and recovery times of M1, M2, and M3 at 98% RH.

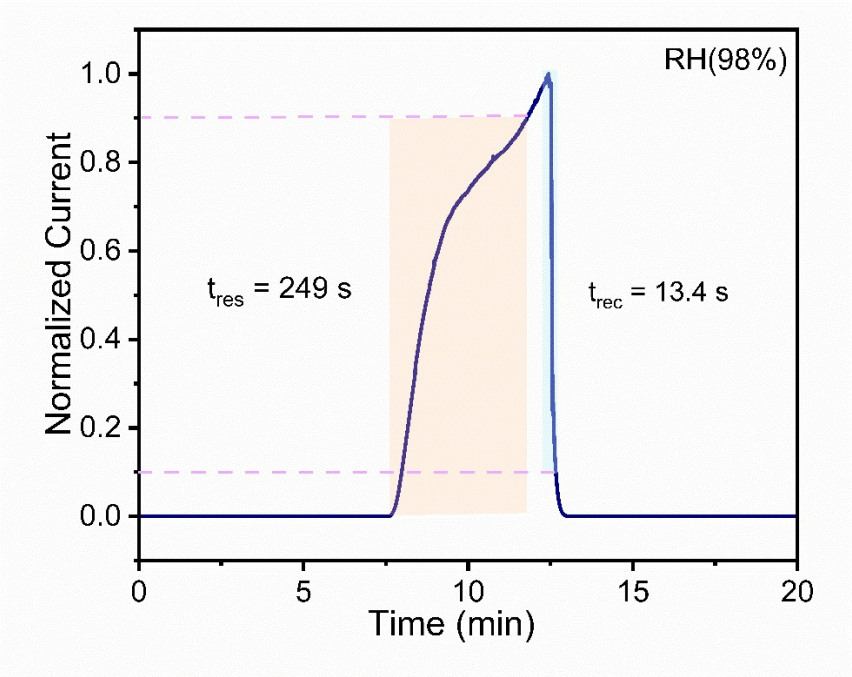

Fig. S8 Response and recovery times of M1 measured at 98% RH.

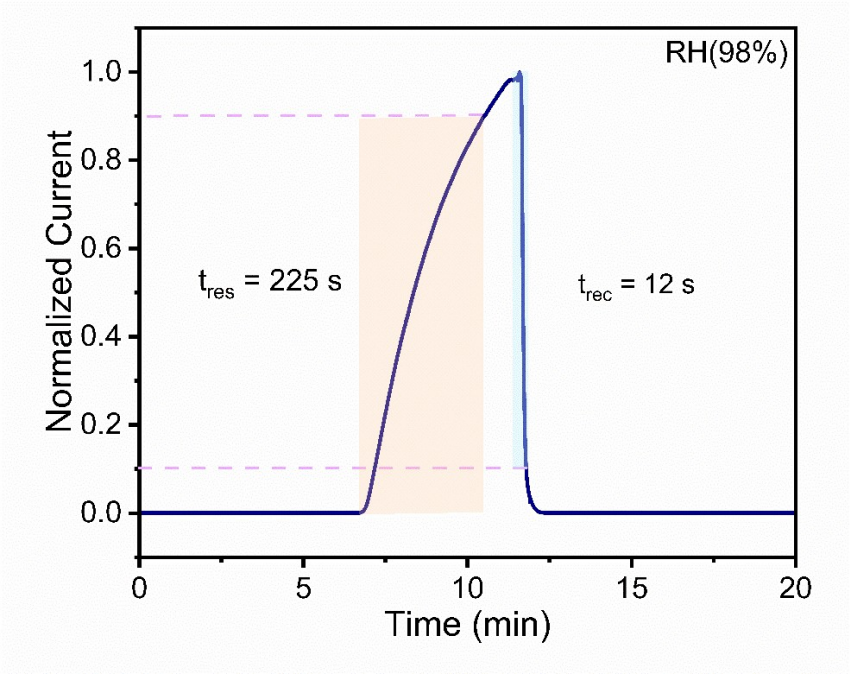

Fig. S9 Response and recovery times of M2 measured at 98% RH.

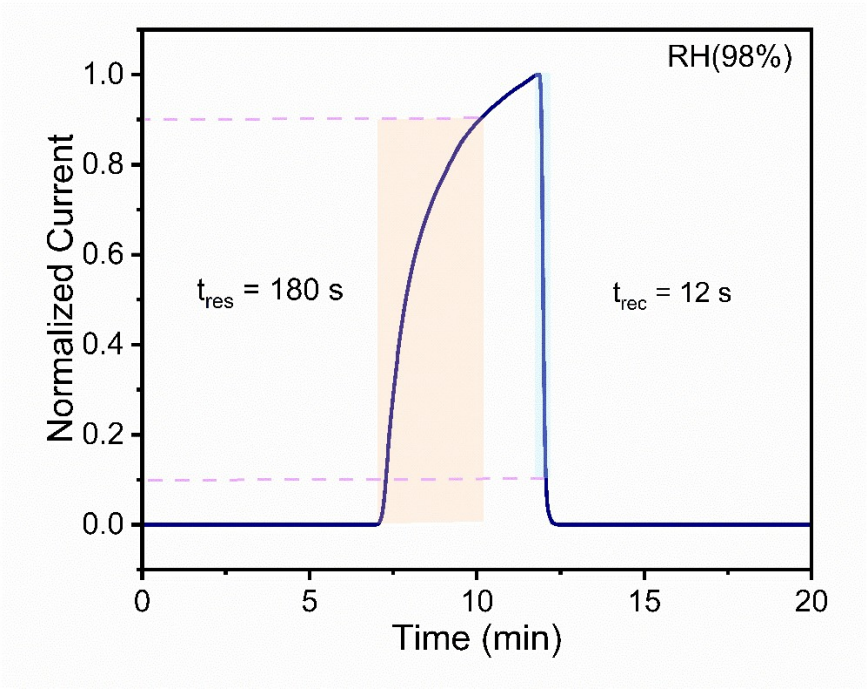

Fig. S10 Response and recovery times of M3 measured at 98% RH.

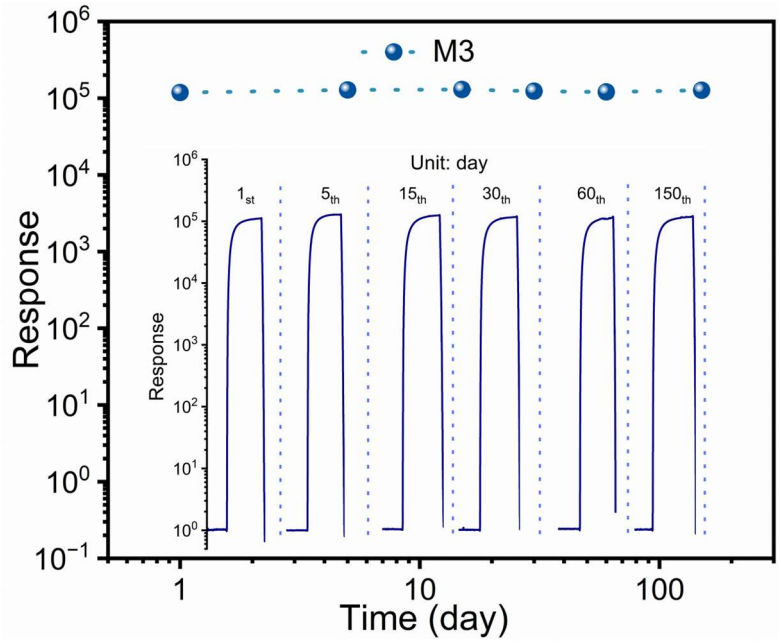

Fig. S11 Long-term stability of M3 membrane under 98% RH.

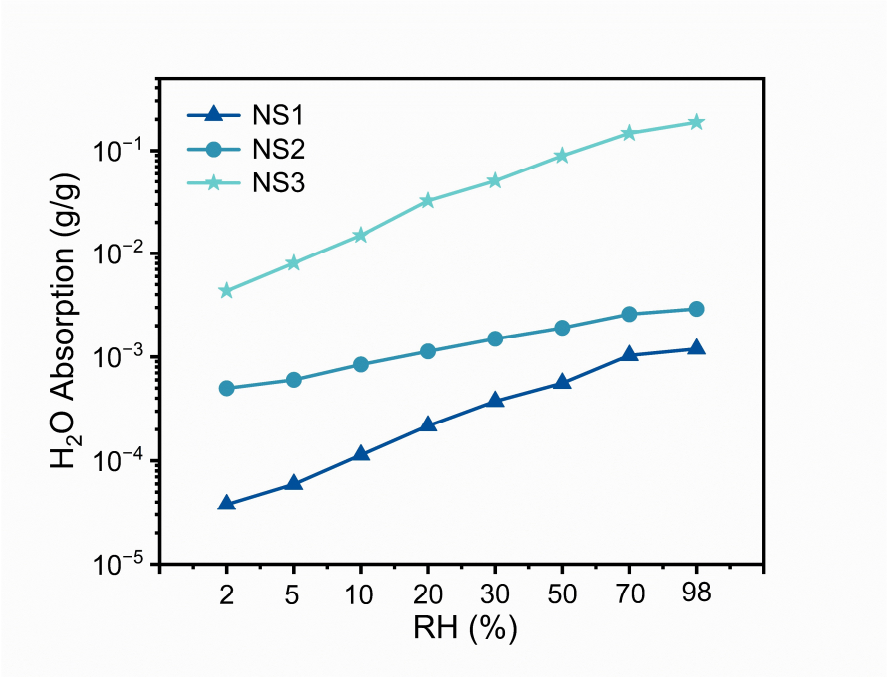

Fig. S12 Dynamic response adsorption curve of CuTCPP nanosheets to water vapor under continuous relative humidity.

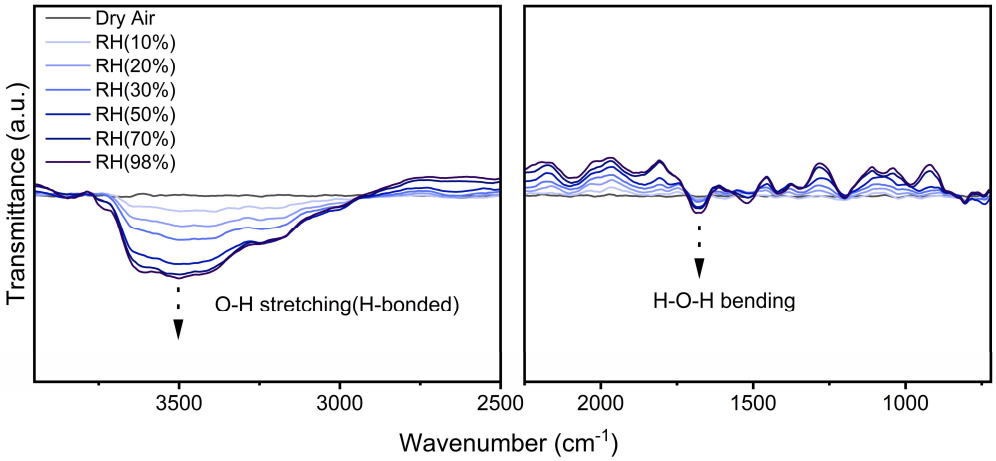

Fig. S13 In situ FTIR spectra of Cu-TCPP M3 membrane under humidity variation.

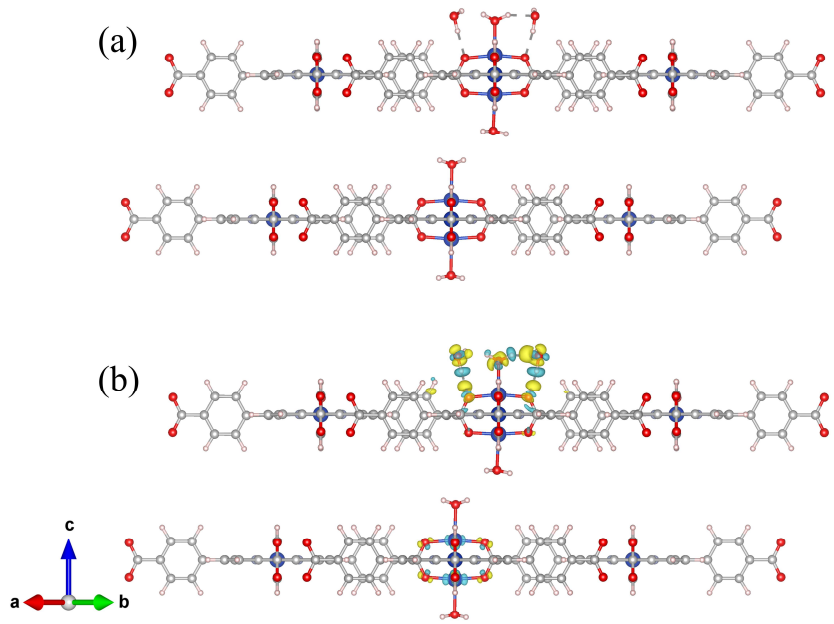

Fig. S14 (a) The model of CuTCPP molecule that absorbs H_2O molecules; (b) Differential charge density plots of H_2O molecule absorbed on CuTCPP. The yellow and green isosurfaces represent electron accumulation and depletion. The isosurface value was set to 0.002e/bohr^3 for H_2O adsorption.

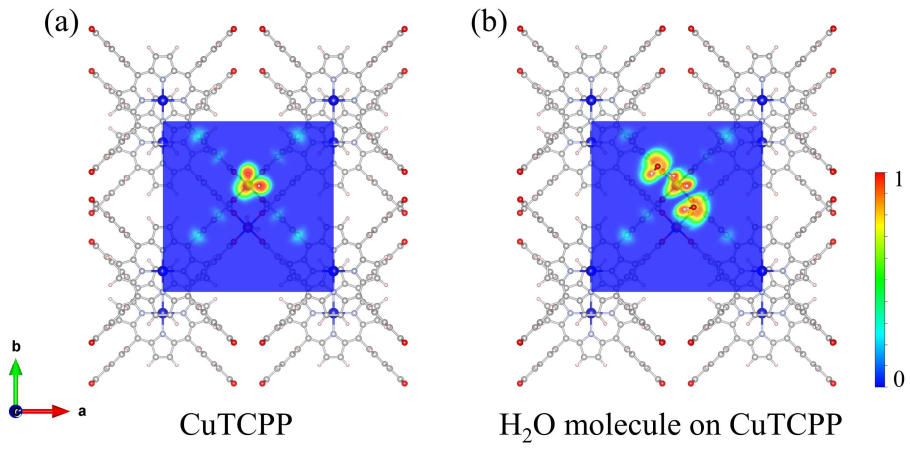

Fig. S15 (a) Slice cutting through O atoms along c-axis of CuTCPP molecule model. (b) Slice cutting through O atoms along c-axis of H_2O molecule absorbed on CuTCPP molecule model. Iso-value increases from blue to red, and the maximum electron localization function (ELF) value is scaled to 1.

Table S1 Thickness, mass, volume, and calculated average density of CuTCPP membranes.

NO.	Thickness	Diameter	Volume	Weight	Density	Average density
M1-1	19.7 μm	1.5 cm	3.48×10^{-3} cm^3	1.8 mg	0.517 $g \cdot cm^{-3}$	0.515 $g \cdot cm^{-3}$
M1-2	20.0 μm	1.5 cm	3.54×10^{-3} cm^3	1.9 mg	0.537 $g \cdot cm^{-3}$	
M1-3	20.7 μm	1.5 cm	3.67×10^{-2} cm^3	1.8 mg	0.492 $g \cdot cm^{-3}$	
M2-1	17.7 μm	1.5 cm	3.12×10^{-3} cm^3	2.3 mg	0.735 $g \cdot cm^{-3}$	0.773 $g \cdot cm^{-3}$
M2-2	18.7 μm	1.5 cm	3.30×10^{-3} cm^3	2.2 mg	0.666 $g \cdot cm^{-3}$	
M2-3	16.3 μm	1.5 cm	2.90×10^{-3} cm^3	2.3 mg	0.795 $g \cdot cm^{-3}$	
M3-1	10.7 μm	1.5 cm	1.89×10^{-3} cm^3	2.0 mg	1.059 $g \cdot cm^{-3}$	1.029 $g \cdot cm^{-3}$
M3-2	11.7 μm	1.5 cm	2.06×10^{-3} cm^3	2.0 mg	0.968 $g \cdot cm^{-3}$	
M3-3	10.7 μm	1.5 cm	1.89×10^{-3} cm^3	2.0 mg	1.059 $g \cdot cm^{-3}$	

Table S2 State-of-the-art 2D sensing materials for chemiresistive humidity sensor at RT.

Sensing materials	Response range (RH)	Response%/RH%	Ref.
Cu-TCPP	2-98	1.3×10^7/98	This work
Graphene	8-95	110/88	1
GNCP	10-97	2.0×10^6/97	2
GQD	8-97	1.4×10^5/97	3
Defect graphene	3-30	330/30	4
Borophene–Graphene	11-85	4.2×10^3/85	5
α′-4H borophene	67-85	1.5×10^4/85	5
Graphene/Ag	12-97	35/97	6
Borophene–MoS_2	11-97	1.6×10^4/97	7
GO	10-80	1×10^3/80	8
RGO	4.3-75.7	6/75.7	9
rGO/MoS_2	5-85	2.5×10^3/85	10
g-C_3N_4	11-97	3.5×10^5/97	11
CuCl2-MOF-303	33-95	5.6×10^4/95	12
CMC-Na/MOF-801/PPY	7-85	1.24×10^5/85	13
CoTCPP@PA	23-95	2×10^5/95	14
HTT–Pb	5-100	6×10^6/90	15
MoS_2	5-35	6×10^6/35	16
Ti_3C_2Tx	11-98	6.0×10^3/95	17
BP	10-85	1.0×10^6/85	18

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