Supporting Information

A Novel Flexible Sensor for Double-Parameter Decoupling Measurement of Temperature and Pressure with High Sensitivity and Wide Range

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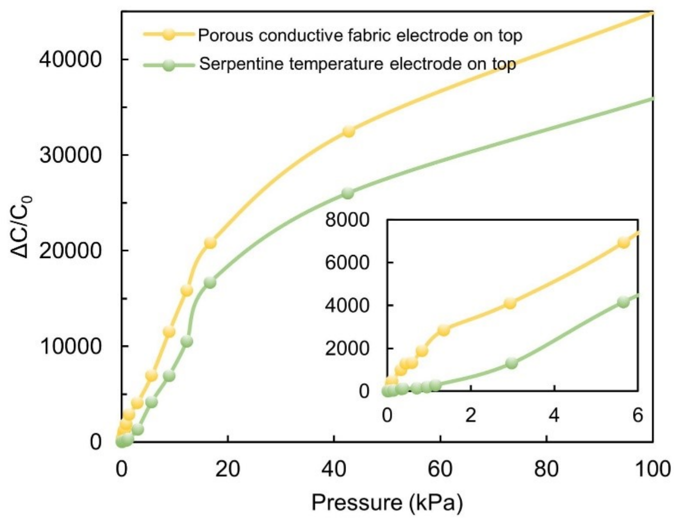

Figure S1. Relationship between pressure measurement performance and electrode distribution

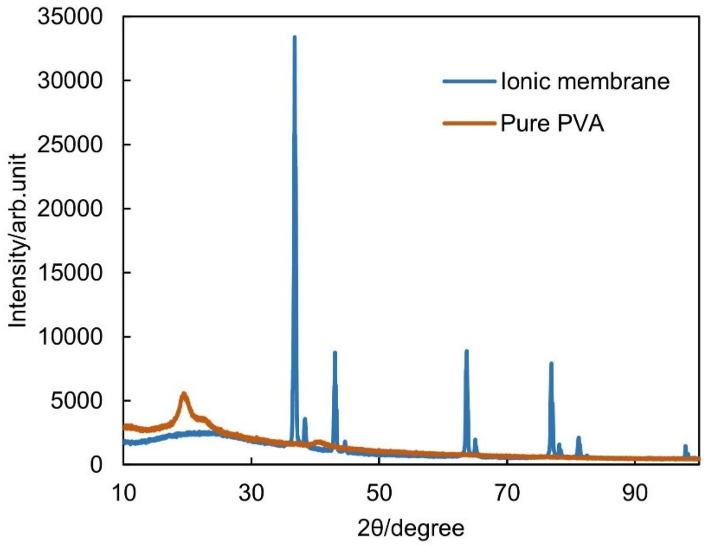

Figure S2 XRD test of ionic membrane and pure PVA

As shown in Figure S2. According to the analysis results, the composition of the ionic film is different from the phase of PVA, and a new crystal phase appears at the same time, which can confirm the formation of composite materials.

Scherrer's equation is an approximate method commonly used to predict crystal size based on the width of the X-ray diffraction peak. The equation can be used to estimate the average size of crystal particle size. The expression of the Scherrer equation is $D = k\lambda/(\beta\cos\theta)$, where k is a constant; λ is the X-ray wavelength; β is half height and width of diffraction peak; θ is the diffraction angle. In the calculation of grain size, low angle diffraction lines are generally used.

It can be seen from Figure S2, the wavelength of the X-ray is λ=0.15405 nm, β is 0.34, 2θ is 36.78°, and k is generally 0.9, which is brought into the calculation

$$D=\frac{0.9\times 0.15405}{0.34\times\frac{3.14}{180}\times\cos\left(\frac{36.78}{2}\right)}=24.634\text{nm}$$

Crystal size is an important parameter to evaluate crystal quality and crystallization properties. Smaller crystal sizes generally indicate higher crystal quality and better crystal purity. During the reaction process, the change of crystal size can reflect the degree of reaction. XRD tests are carried out on ionic membranes prepared with different proportions of PVA and phosphoric acid, as shown in Figure S3. At the same time, Scherrer equation is used to estimate the crystal size, and it can be intuitively found that when the ratio of PVA and phosphoric acid is 1:1, the diffraction angle θ is the smallest, so the crystal size D is the smallest.

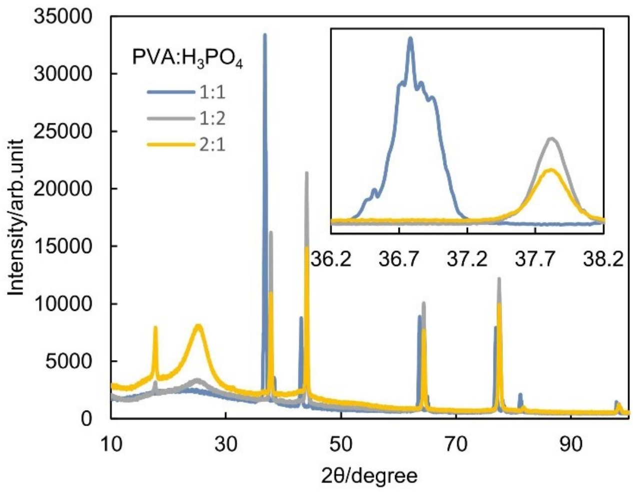

Figure S3 XRD test of ionic membranes prepared with different proportions of materials

Experimental system figures

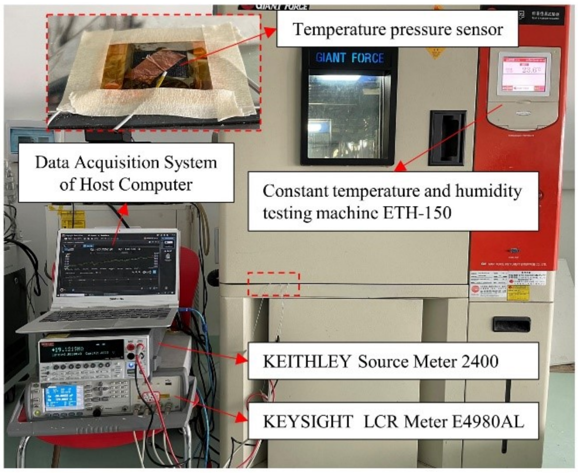

Figure S4. Experimental system to characterize the correlation between sensor resistance and capacitance dual parameters with temperature.

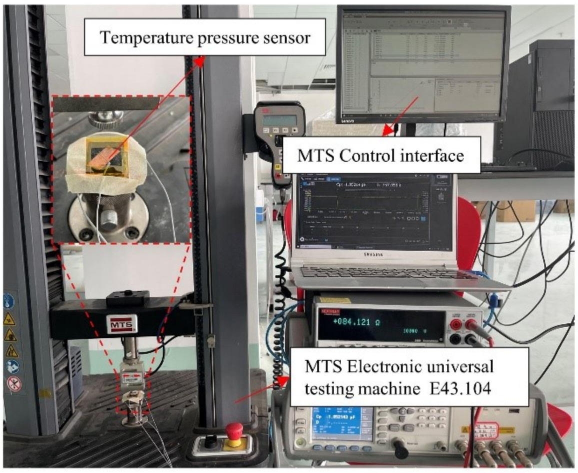

Figure S5. Experimental system to characterize the correlation between sensor resistance and capacitance dual parameters with pressure.

Table S1 Comparison of temperature and pressure sensors in various catalyst

	Material ratio (PEDOT:PSS/MWCNTs)	Sensitivity (15-80 ℃)
Temperature measurement	1:0	-0.0083 $℃^{-1}$(15-80 ℃)
	3:1	-0.013 $℃^{-1}$(15-42 ℃) -0.0068 $℃^{-1}$(42-80 ℃)
	2:1	-0.025 $℃^{-1}$(15-45 ℃) -0.0082 $℃^{-1}$(45-80 ℃)
	1:1	-0.032 $℃^{-1}$(15-50 ℃) -0.004 $℃^{-1}$(50-80 ℃)
	1:2	-0.02 $℃^{-1}$(15-47 ℃) -0.011 $℃^{-1}$(47-80 ℃)
Pressure measurement	Material ratio (PVA/H_3PO_4)	Sensitivity (0-40 kPa)
	1:0	0.06 kPa^{-1} (0-5 kPa) / (5-40 kPa)
	2:1	80.86 kPa^{-1}(0-10 kPa) 10.57 kPa^{-1}(10-40 kPa)
	1:1	1249.34 kPa^{-1} (0-10 kPa) 169.27 kPa^{-1}(10-40 kPa)
	1:2	1672.19 kPa^{-1} (0-10 kPa) 132.75 kPa^{-1}(10-40 kPa)