Supporting Information

All-fabric Ultrathin Capacitive Sensor with High Pressure Sensitivity and Broad Detection Range for Electronic Skin

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Classic capacitor theory

In our sandwiched capacitive pressure sensor, the structure is similar to the parallel-plate capacitor and capacitance can be defined as:

$$C = \frac{\varepsilon_0 \varepsilon_r A}{d} \#(1)$$

where ε_0 is the vacuum permittivity, ε_r is the permittivity of dielectric layer, A is the relative area, and d is the distance between two electrode plates.

Mathematical derivations for the initial thickness-to-capacitive sensitivity

The relative capacitance response $\Delta C / C_0$ can be expressed as

$$\frac{\Delta C}{C_0} = \frac{C - C_0}{C_0} = \frac{\varepsilon'_r A' d_0}{\varepsilon_r A_0 d'} - 1 \#(2)$$

where thickness corresponding factor is d_0/d', so the thickness-sensitivity relationship can be transferred to the function of thickness as

$$f\ (d_0) = \frac{d_0}{d'} = \frac{d_0}{d_0 - \Delta d} \#(3)$$

In an ideal case that Δd would be constant under same pressure, and we replace d_0 with the symbol x, replace Δd with the symbol C. Thus, the derivative of the function becomes

$$f'(d_0) = f'(x) = \frac{f(x + dx) - f(x)}{dx} = \frac{-Cdx}{(x - C)(x + dx - C)dx} \#(4)$$

as the constant C could not be a negative constant under pressure, the $f'(d_0) < 0$, which means that the smaller initial thickness is, the larger sensitivity would be.

Supplementary Figures

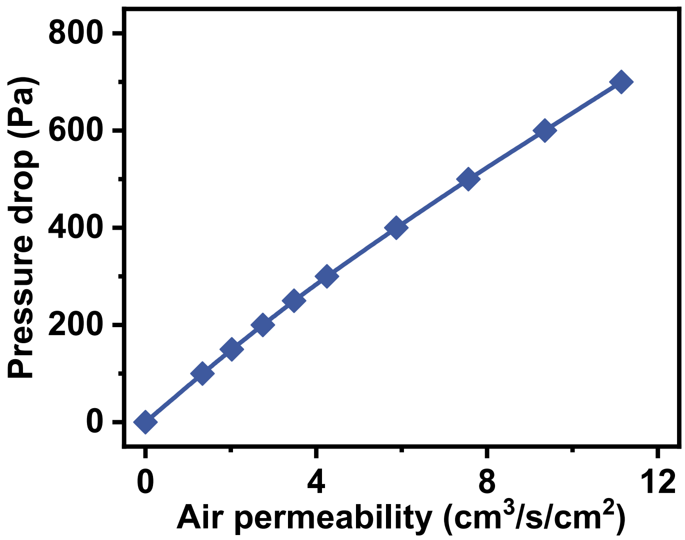

Figure S1. Air permeability at different pressure drop.

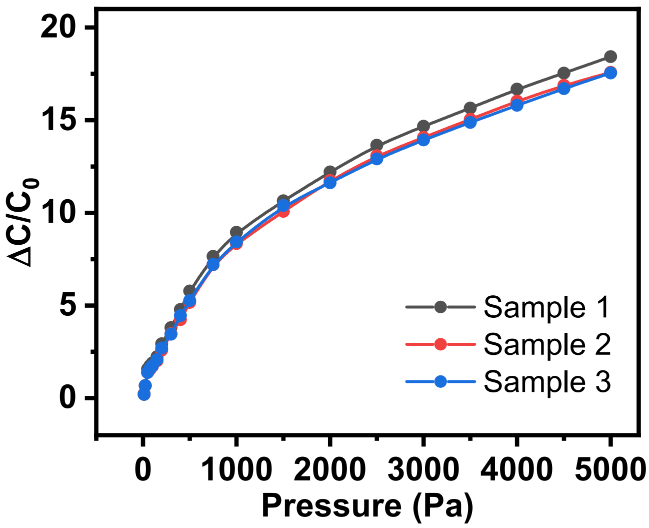

Figure S2. Reproducibility test for the sensitivity of the all-fabric capacitive sensor

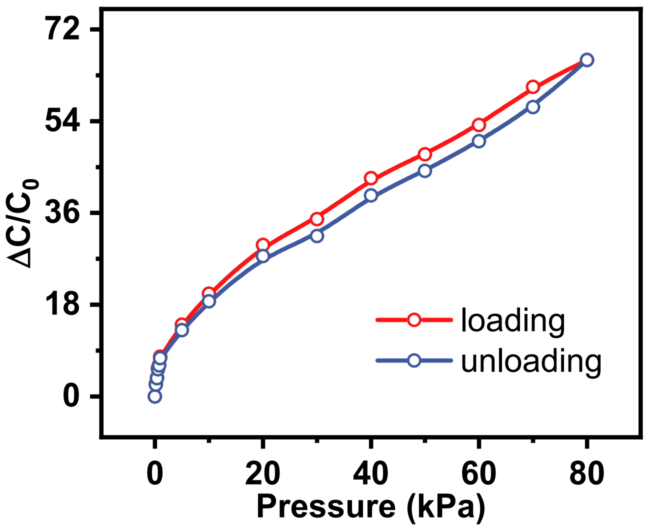

Figure S3. Hysteresis of the AFCS under loading-unloading cycle (80 kPa).

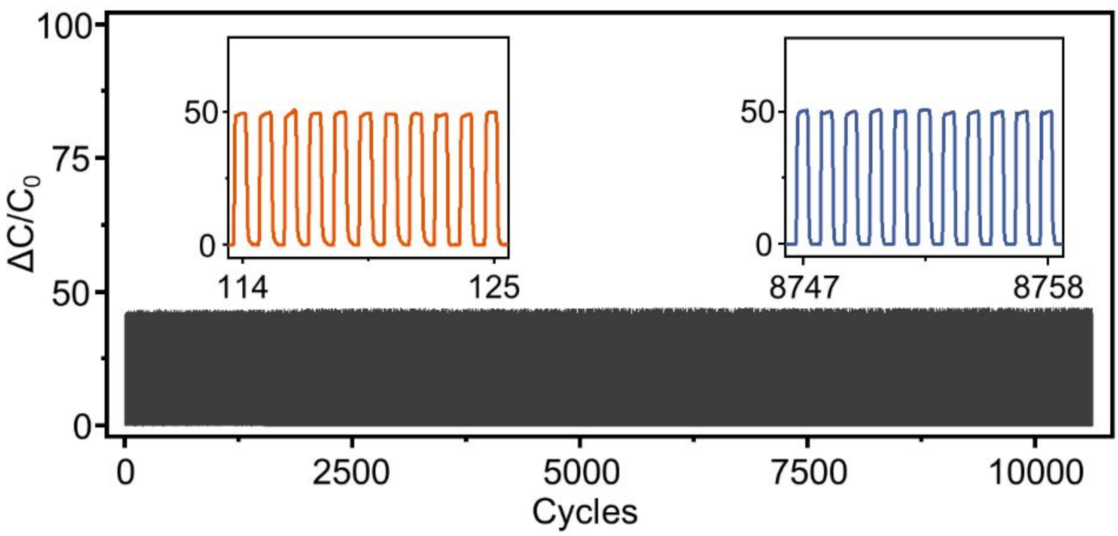

Figure S4. Durability of the AFCS response over 10 000 cycles with an external pressure of 50 kPa. The insets show the beginning and end of the test.

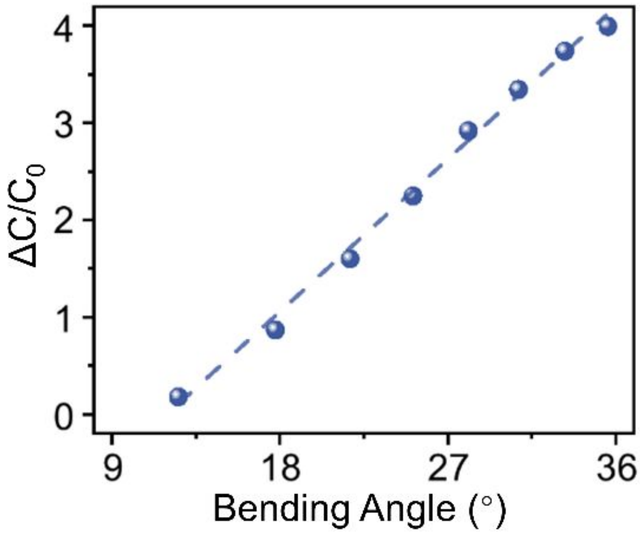

Figure S5. The linear relationship between angle and $\Delta C/C_0$ under 36°.

Supplementary Tables

Table S1. The thickness comparison among capacitive sensors.

Reference	Sensitivity	Materials of the sensor	Thickness
1	5 nF kPa^{-1}	Home-made ionic films	75 μm
2	0.33 kPa^{-1}	Graphene/PDMS electrodes + Nylon networks	> 1.3 mm
3	0.17 kPa^{-1}	PET films (Cu/Ni) electrodes + structured PDMS	~ 2 mm
4	0.601 kPa^{-1}	CNT + Ecoflex	~20 mm
5	0.73 kPa^{-1}	CNT/PDMS electrodes + CCTO@PU sponge	2mm
Our work	8.31 kPa^{-1}	AgNWs/TPU electrodes + TPU netting	36 μm

Table S2. The parameters of two copper meshes

Mesh numbers	Thickness/μm	Side length of the square holes/μm
120	87	120
200	80	75

Table S3. The performance comparison among capacitive pressure sensor

Materials	Sensitivity (Range)	Detection Limit	Reseponse Time	Reference
Nylon/PDMS /Graphene	0.33 kPa^{-1} (1 kPa)	3.3Pa	20ms	2
CNT/Ecoflex	0.601 kPa^{-1} (5 kPa)	0.16Pa	-	4
AgNWs/PU	5.54 KPa^{-1} (30 Pa)	7.5Pa	-	6
ITO/(PDMS—PS)	0.63 kPa^{-1} (1 kPa)	2.4Pa	40ms	7
rGO/PDMS	0.002 kPa^{-1} (10 kPa)	0.5kPa	<200ms	8
Au/PDMS/PS	0.815 kPa^{-1} (1.5 kPa)	17.5Pa	38ms	9
Graphite/PMDS	0.62 kPa^{-1} (2 kPa)	6Pa	200ms	10
PDMS@PVDF-HFP	0.43 kPa^{-1} (1.5 kPa)	10Pa	-	11
AgNWs/PDMS	2.04 kPa^{-1} (2 kPa)	7Pa	100ms	12
AgNWs/TPU	**8.31 kPa^{-1}** (1 kPa)	**0.5Pa**	**27.3ms**	**This work**

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