Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information

Non-contact porous composite fiber paper-based humidity sensor for wearable breathing and skin humidity monitoring

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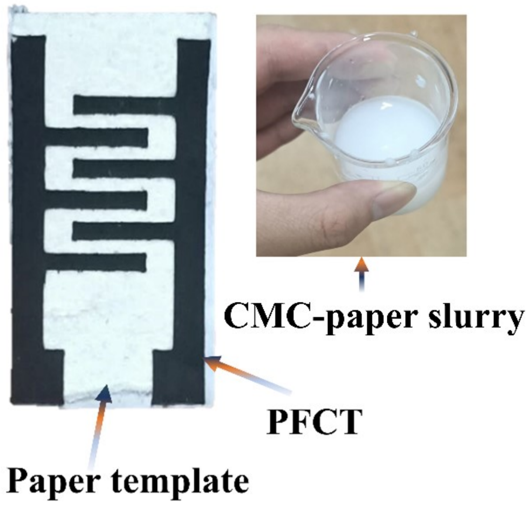

Figure S1 Paper temper and CMC-paper slurry

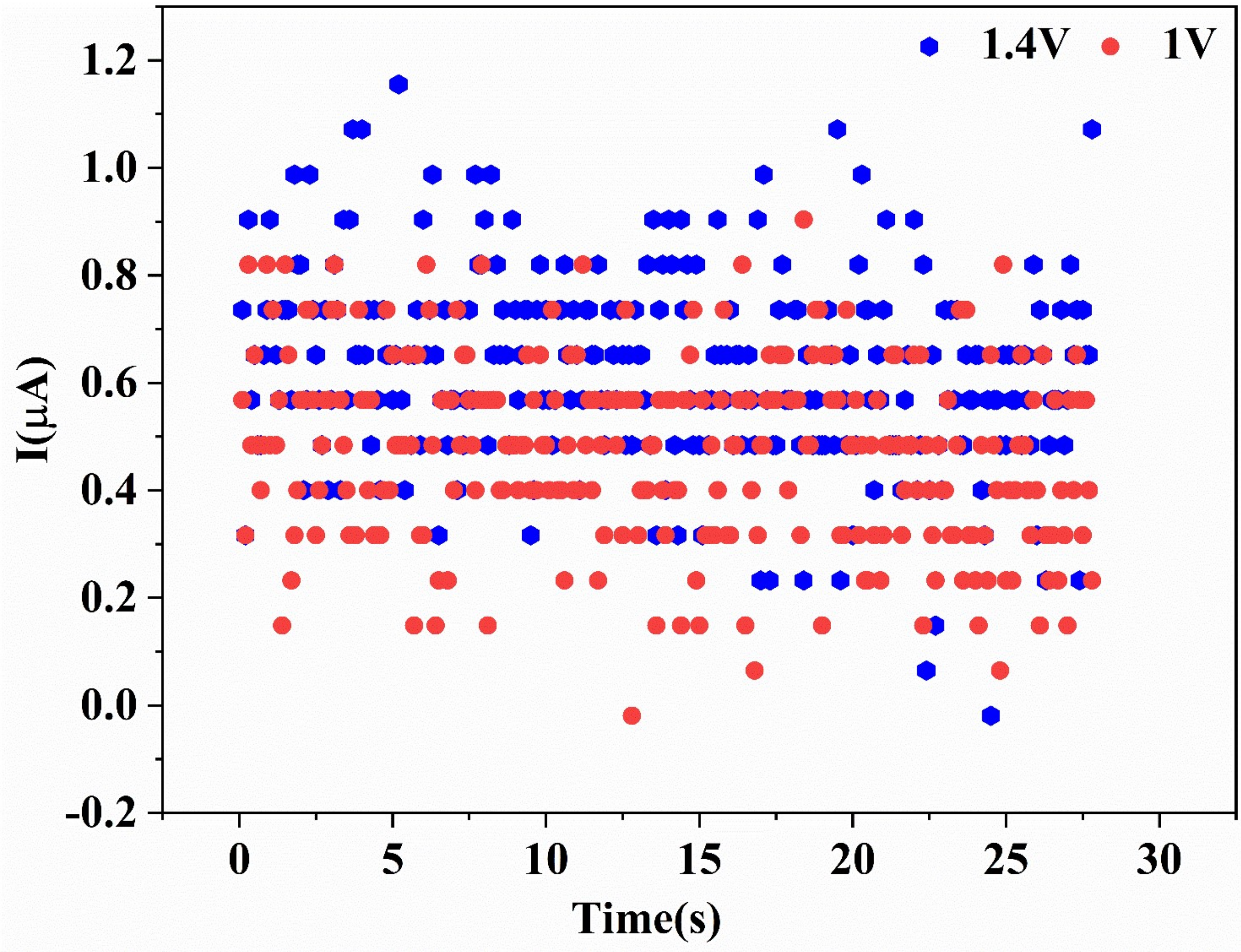

Figure S2 Current response of PLFC in the dry state changes over time

Supplementary note 1

As demonstrated by the preceding two figures, under low humidity conditions, our fabricated sensor exhibits a significantly higher resistance compared to the carbon ink-infused paper, making it nearly non-conductive and equivalent to an open circuit when connected in an electrical circuit. However, upon the introduction of small volumes of gas with varying humidity levels, the sensor promptly generates corresponding electrical signals. In future research endeavors, by analyzing the amplitude, waveform, and other pertinent information of these electrical signals, we can not only accurately quantify the water content within equivalent volumes of gas but also gauge the flow rates of gases with differing humidity levels.

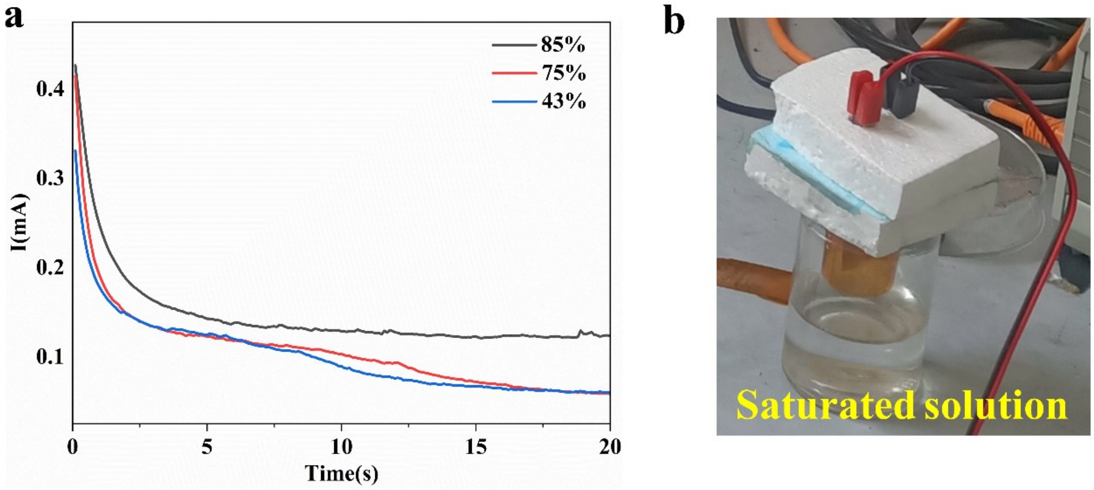

Figure S3 (a) The response of air with different humidity (b) Simulate the experimental environment with a specific humidity

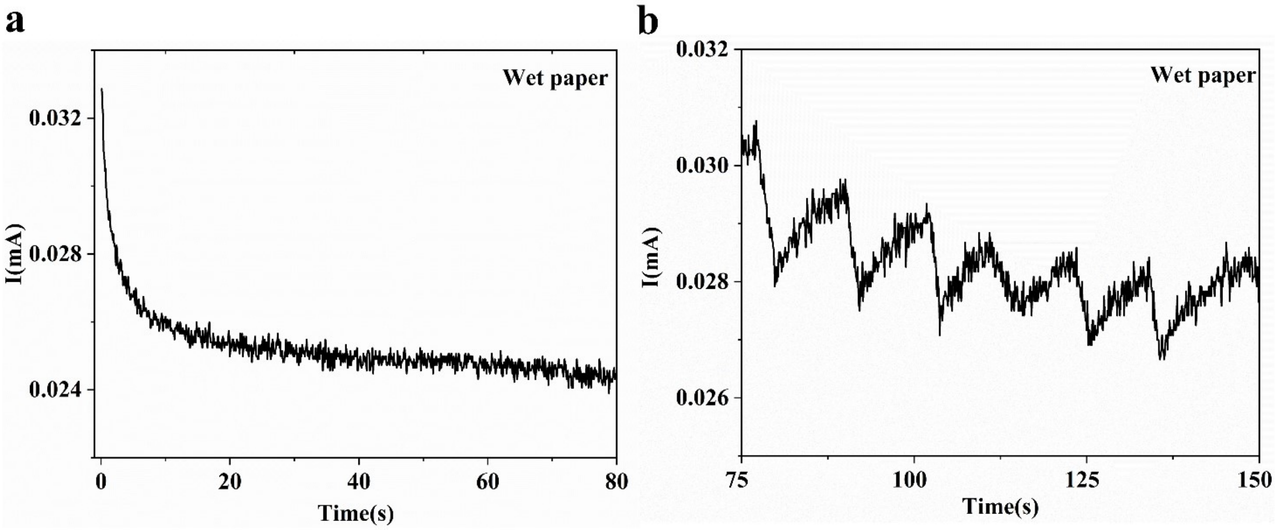

Figure S4 (a) Response of wet paper at air (b) Responds to electrical signals when blowing on wet paper

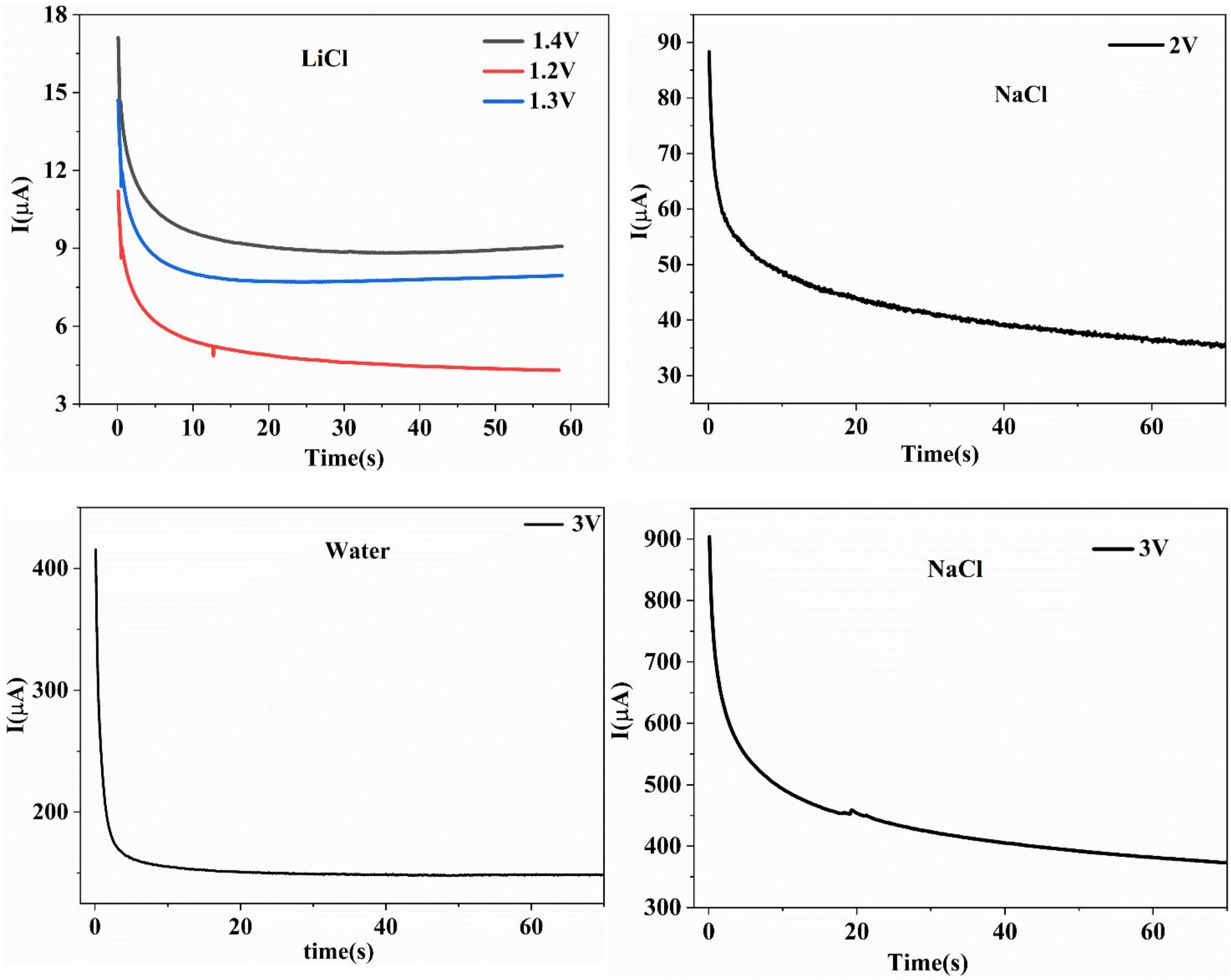

Figure S5 (a) Lithium chloride solution is electrolyzed at different voltages (c) Electrolysis of water (b) and (d) Electrolysis of aqueous sodium chloride solution at different voltages

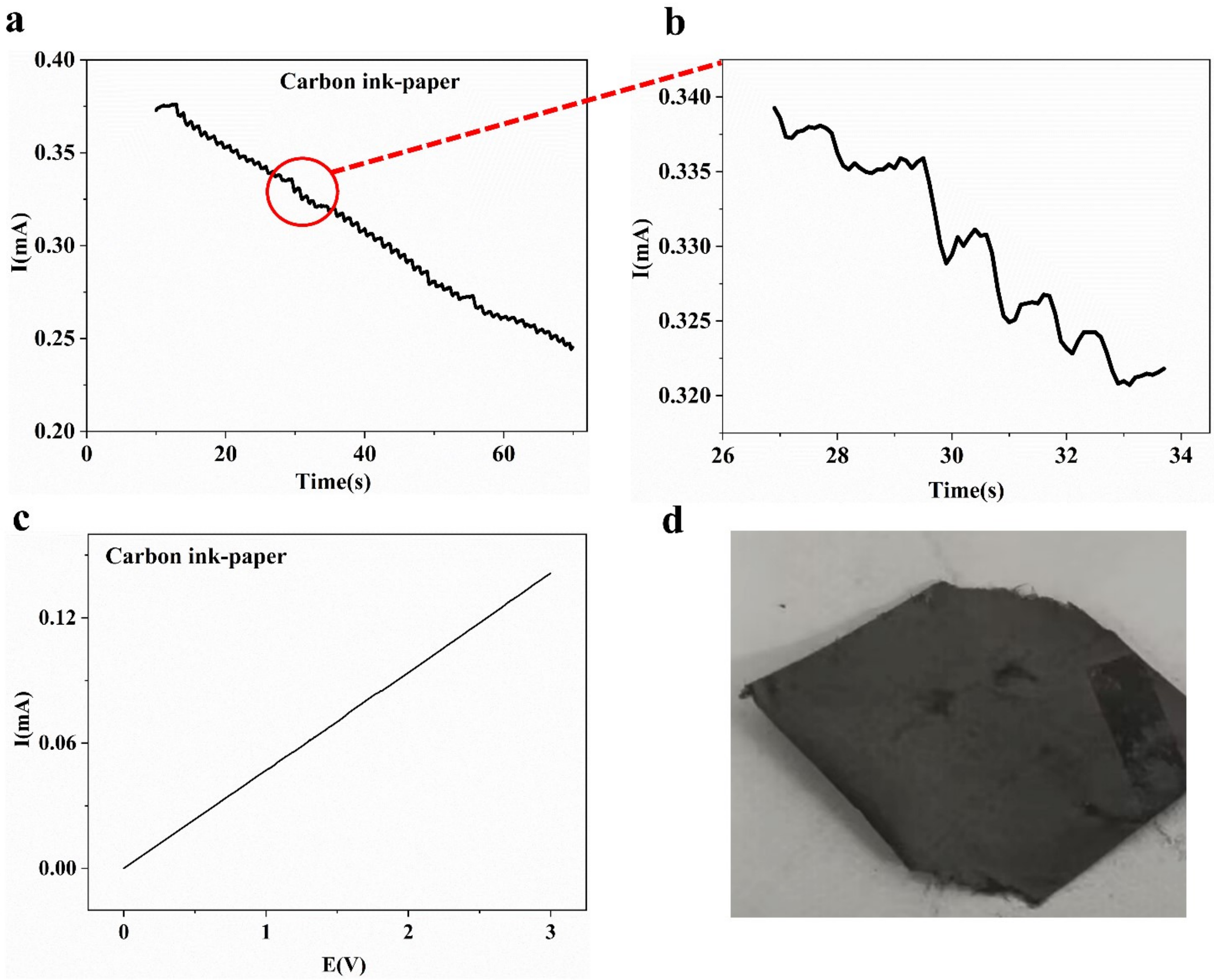

Figure S6 (a) and (b) Respiratory response curve on carbon ink paper (c) Volt-ampere characteristic curve of carbon ink paper (d) carbon ink paper display

Supplementary note 2

Upon an in-depth examination of the current variations post the permeation of carbon ink into paper, we observed that the effective embedding of carbon nanoparticles within the paper fiber matrix significantly expanded the electron transport pathways, resulting in an enhancement of electrical conductivity compared to the pristine, untreated paper. Notably, in a humid environment, water molecules acted as a solvent medium, fostering an increase in the number of freely mobile ions within the paper fiber network, further bolstering the conductive performance of carbon ink-treated paper, thereby forming an efficient and intricate conductive network structure.Distinct from PLFC, our experiments revealed that the application of air blowing on carbon ink-treated paper altered its surface aerodynamic properties, accelerating the evaporation process of moisture. This led to a drastic reduction in the number of conductive media (encompassing free ions and water molecules) within and on the surface of the paper, subsequently triggering a notable decline in current intensity. Upon cessation of air blowing, a reverse trend emerged; however, the relatively sluggish dynamics of water molecules re-adsorbing onto the paper surface, coupled with environmental humidity constraints, prevented the current from fully recovering to its pre-blowing saturation level. Consequently, the overall current-time response curve exhibited a unique staircase-like fluctuation pattern.

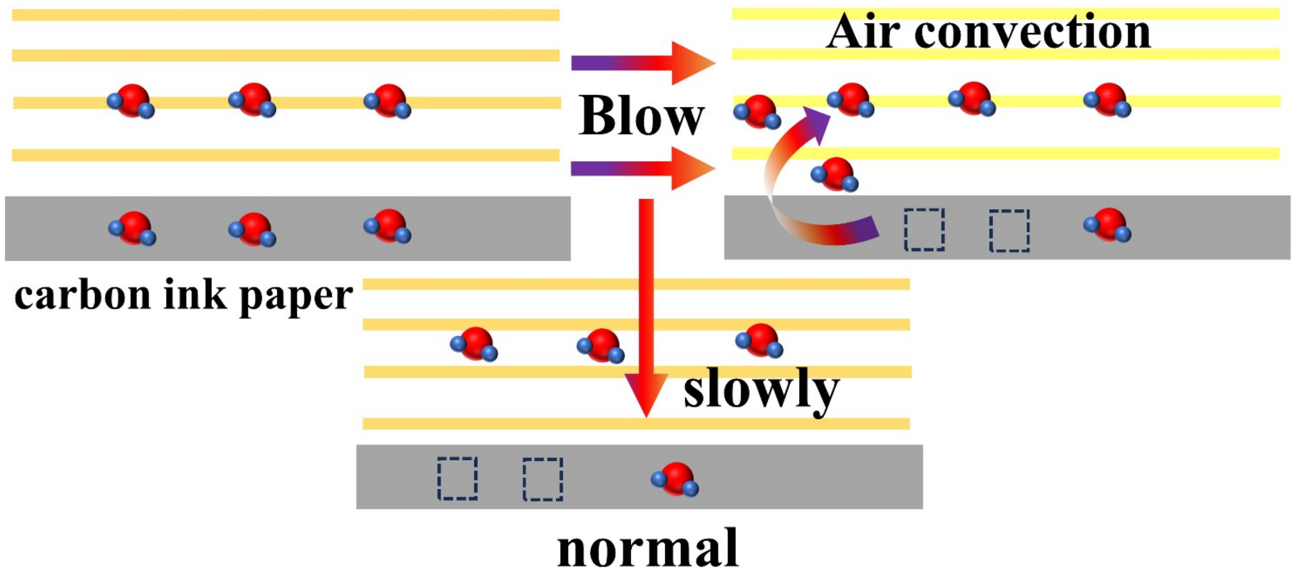

Figure S7 **Humidity sensing schematic**

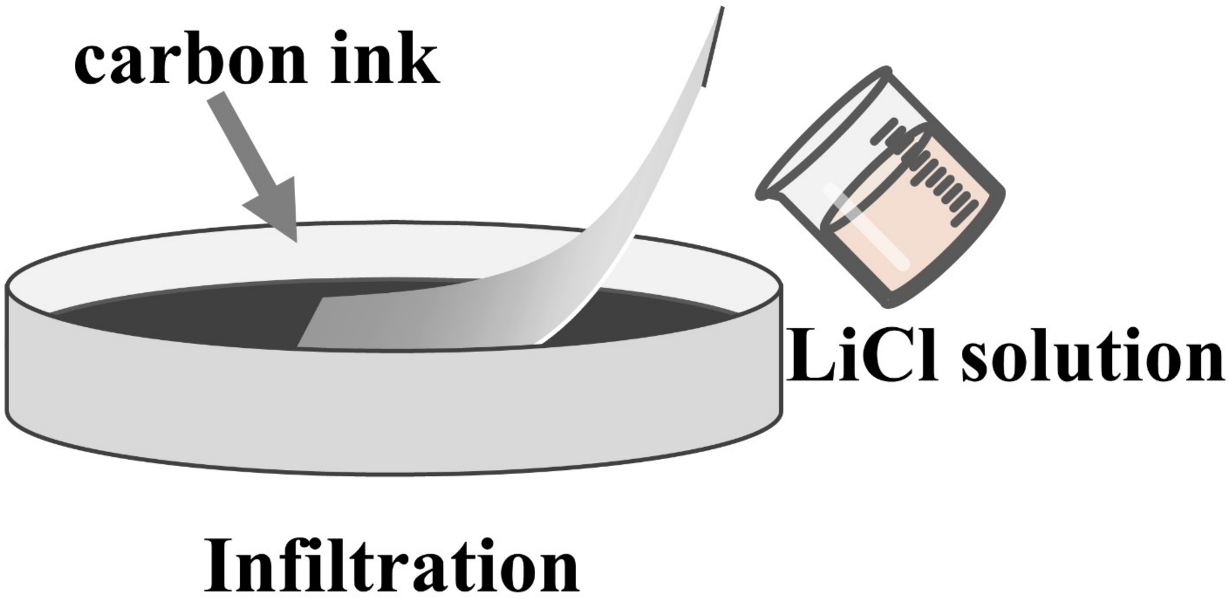

Figure S8 Carbon ink-LiCl paper

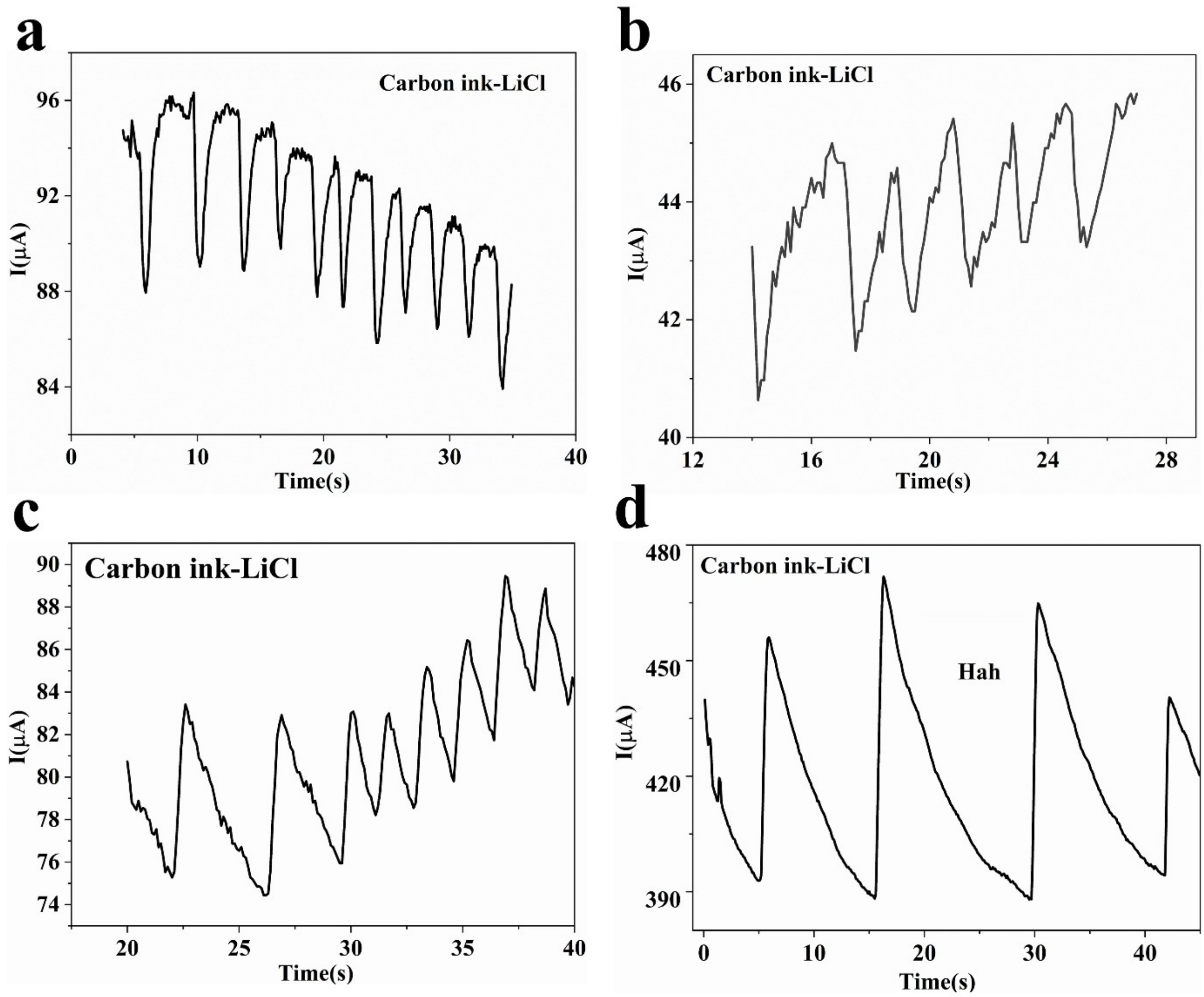

Figure S9 （a）Breathe lightly on carbon ink-LiCl paper (c)and(b) Breathe normally on carbon ink-LiCl paper (d) Hah on carbon ink-LiCl paper

Supplementary note 3

After doping LiCl into carbon ink, the respiratory curve waveform exhibits an increase in burrs and a slower recovery rate, without enhancing the overall performance. This phenomenon could be attributed to the mutual hindrance between carbon particles and ionic particles within the paper fibers. The main constituent of carbon ink, carbon black, possesses hydrophilicity compared to carbon nanotubes. When carbon black fills the fibers, it blocks the exchange channels for water molecules. Although carbon enhances conductive pathways, it obstructs the movement of ions and water within the fiber pores, thereby failing to improve performance.

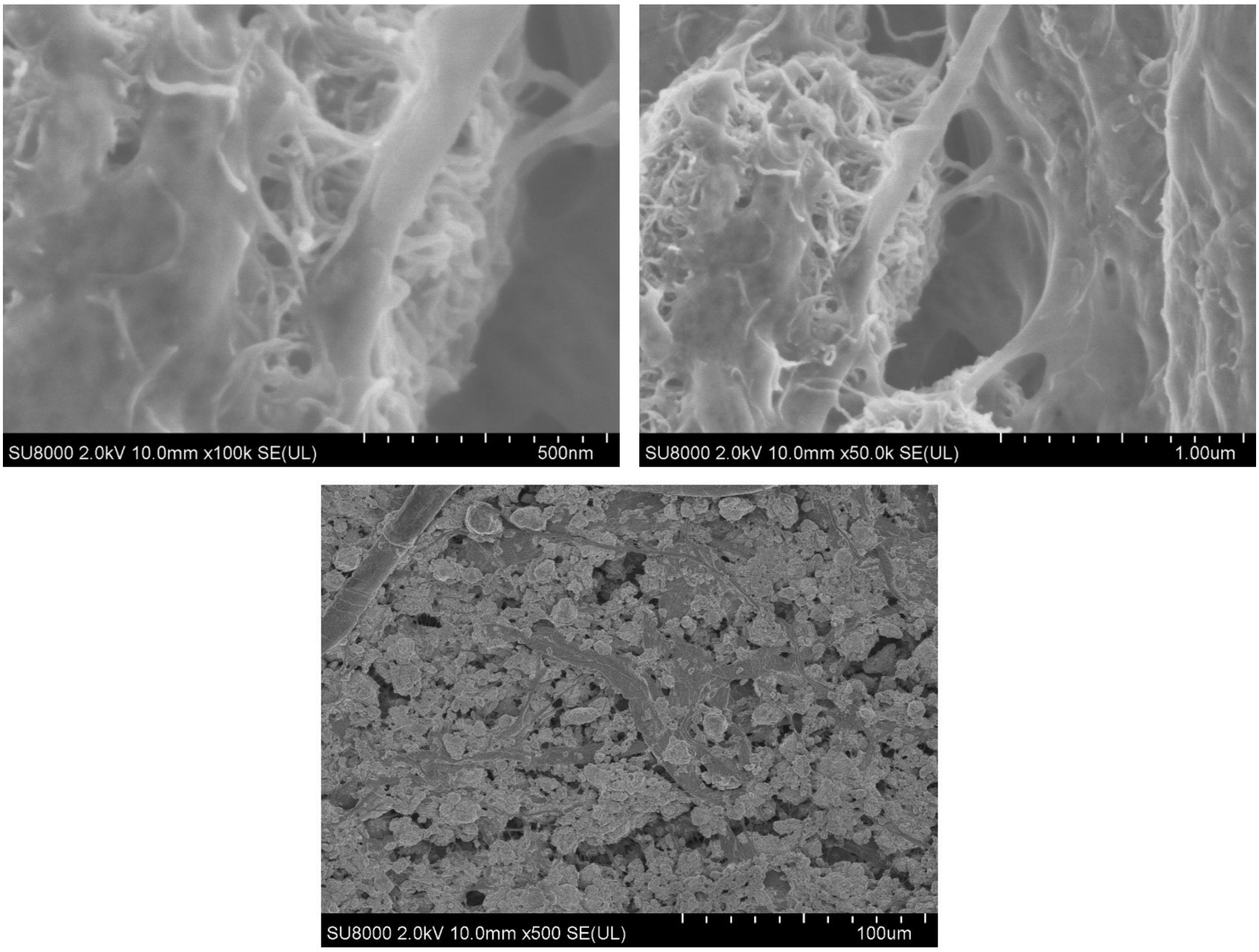

Figure S10 SEM-PFCTe