Supplementary Information (SI) for Journal of Materials Chemistry C.
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Ultrastable Fluoropolymer-Based Porous Conductive Elastomer Composites (PVDF-HFP/CB) for High-Sensitivity Pressure Sensing Applications

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Sensor Testing Platform

The testing platform for the sensors developed in this study is illustrated in Figure 1. Fig. S1(a) shows the data acquisition card (2001-TCSCAN), Fig. S1(b) depicts the digital multimeter (DMM6500), Fig. S1(c) presents the universal material testing machine (E1000), and Fig. S1(d) features the data acquisition software (Kickstart). The data acquisition card (2001-TCSCAN) is a 10-channel thermocouple relay that can simultaneously collect signals from multiple channels. The digital multimeter (DMM6500), produced by Keithley, is a multifunctional measuring instrument with testing capabilities that include capacitance, voltage, current, and resistance measurements. The universal material testing machine (E1000), manufactured by Instron, is a fully electric dynamic testing apparatus with a load measurement range of ±1000 N and a sensor accuracy of ±0.5%. Kickstart is a data acquisition software that, when connected with the data acquisition card (2001-TCSCAN) and the universal material testing machine (E1000), can display the sensor's real-time strain, stress, and resistance values.

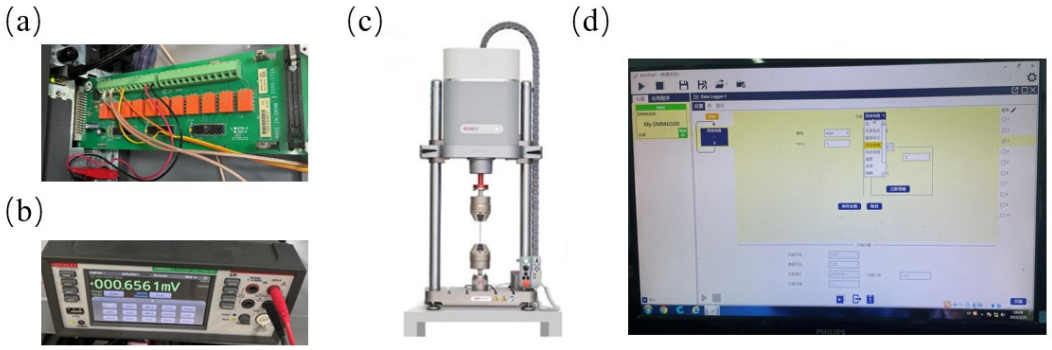

Fig. S1 (a) Data acquisition card (2001-TCSCAN); (b) Digital multimeter (DMM6500); (c) Universal material testing machine (E1000); (d) Kickstart software interface.

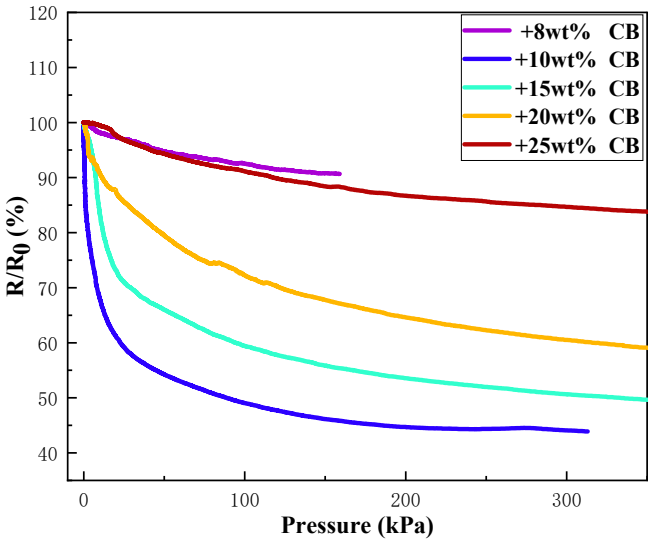

Fig. S2 Electrical performance of sensors with different mass ratios of carbon black

Our systematic investigation of CB mass ratios in PVDF-HFP/CB composite sensors revealed a critical threshold for optimal electromechanical response. As the CB content decreased from 25% to 10% mass ratio, the relative resistance change (R/R_0) under equivalent pressure conditions exhibited a huge enhancement, demonstrating improved pressure sensitivity as shown in Fig. S2. Notably, this trend reversed abruptly when CB concentration dropped below 8%, with R/R_0 values decreasing significantly. Complete loss of electrical conductivity occurred at 5% CB content, transitioning the composite to insulating behavior. This nonlinear relationship between CB concentration and sensor performance aligns with percolation theory, where 10% CB represents the optimal balance between maintaining conductive networks and achieving high strain-induced resistance variation.

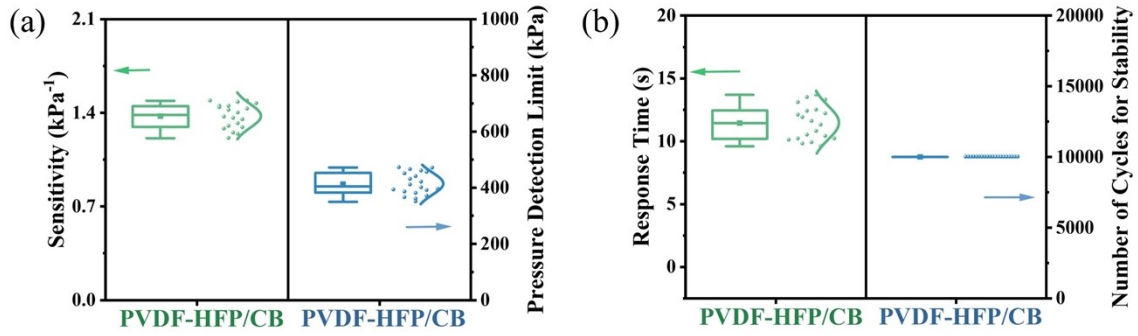

Fig. S3 Statistical sensitivity, detection range range, response time, and cycle stability times of sensor w/ PVDF-HFP/CB.

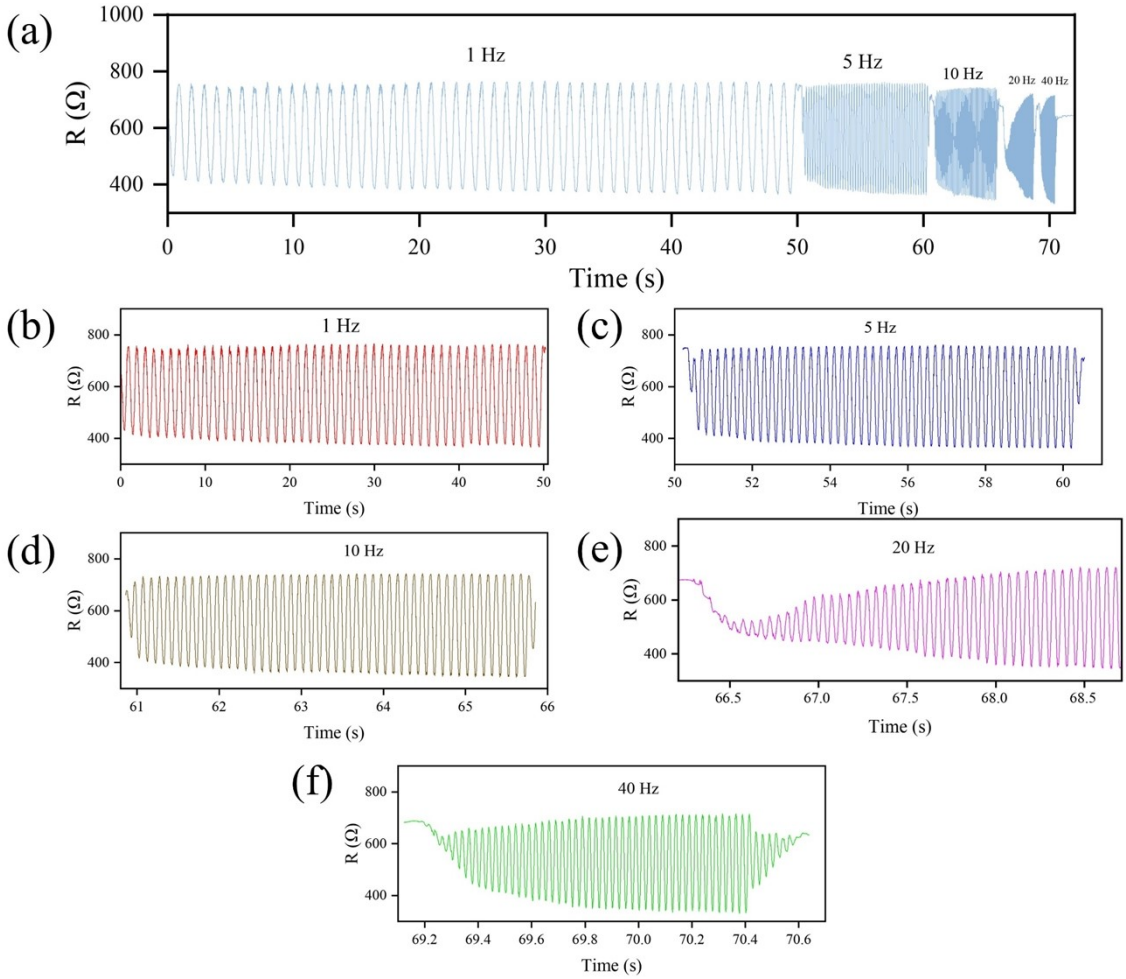

Fig. S4 Dynamic response tests at different frequencies (a) Continuous testing process of the sensor at different frequencies (b) 1Hz (c) 5Hz (d) 10 Hz (e) 20Hz (f) 40Hz