3D geometry structured PANI/CNTs decorated polydimethylsiloxane active pressure and temperature dual-parameter sensor for man-machine interaction application

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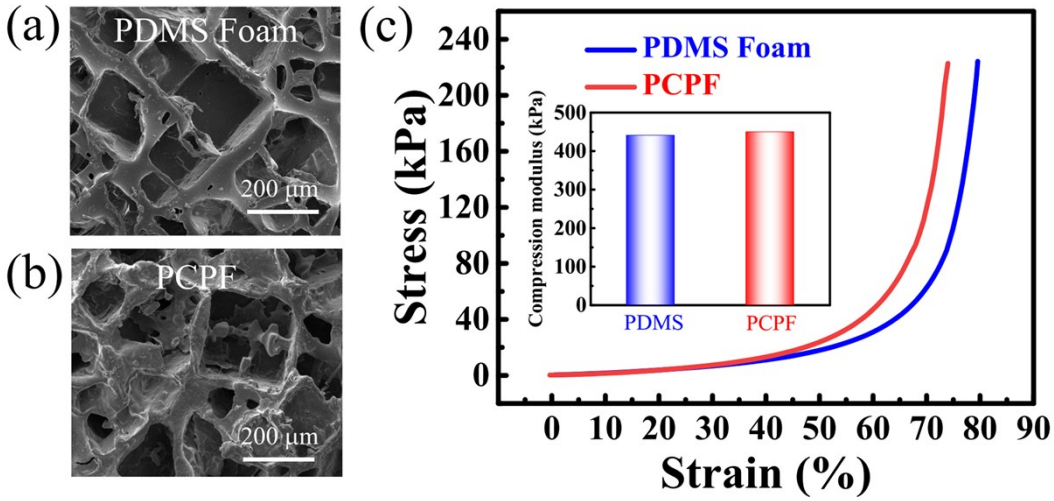

Figure S1. Comparison on porous microstructure of (a) PDMS foam and (b) PANI/CNTs decorated PDMS foam. (c) Stress–strain curves of pure PDMS foam and PCPF with the inset showing each compression modulus.

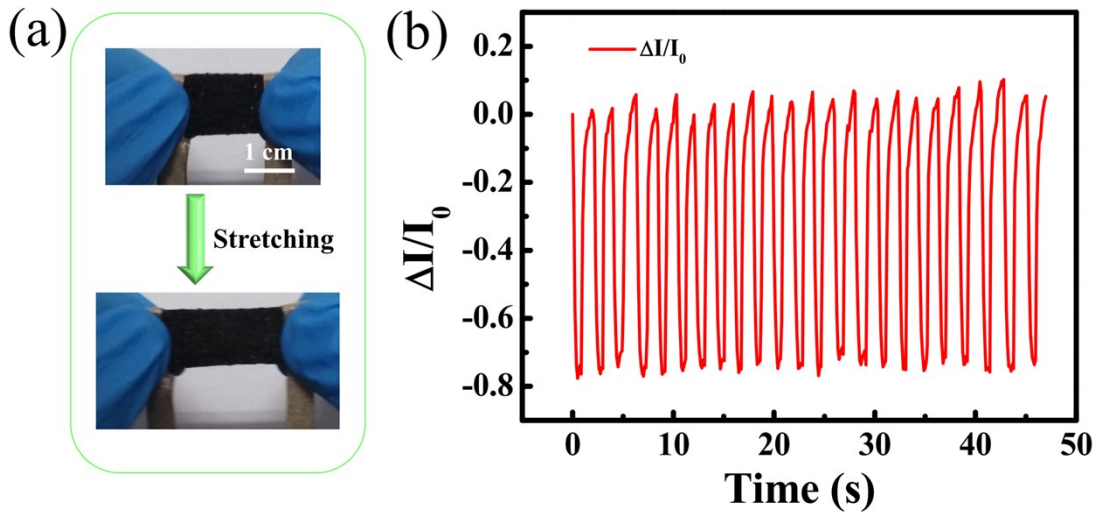

Figure S2. (a) Pictures of PCPF under 100% tensile strain (b) The corresponding current change signals under repeated tensile strain.

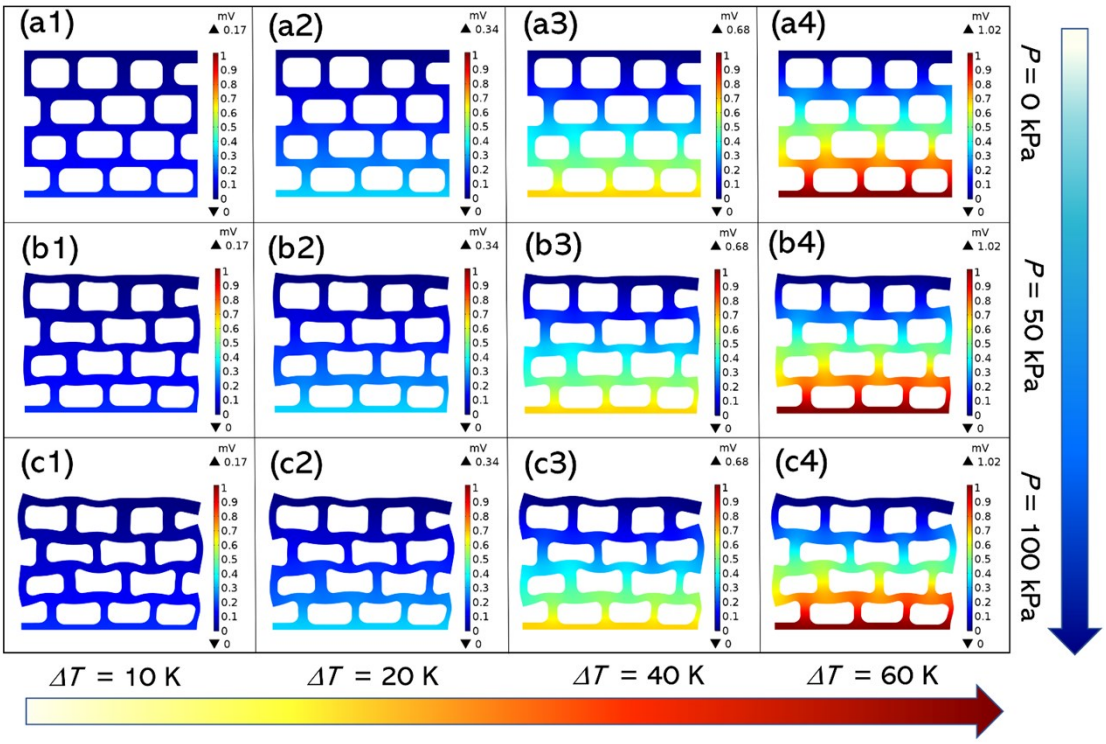

Figure S3. Simulations on the output voltages of sensors under both stimuli of pressure and temperature. (a1-a4) P = 0 kPa, (b1-b4) P = 50 kPa, (c1-c4) P = 100 kPa with temperature difference varying from 10 K, 20 K to 40 K and 60 K.

Finite element analysis

The finite element analyses of PPCF under different external stimuli have been carried out on COMSOL Multiphysics 5.3. The 3D model in size of 1.1 mm × 0.9 mm (length × height) was built according to the microstructure observed from SEM. Default values on Young's modulus, mass density, and Poisson's ratios of the materials were used from COMSOL 5.3 package, while electrical conductivity (10000 S/m), dielectric constant (2.75), Seebeck coefficient (17 μV/K), and thermal conductivity (0.5 W/m·K) were experimentally measured values.

The "Solid Mechanics (*solid*)" module was used to study the stress distribution. The

boundary condition of bottom boundary was set as “fixed constraint” and the top boundary was set as “boundary load” with 100 kPa. The other boundary were set as “free”. For current distribution of PCPF under pressure, both the “Solid Mechanics” and “Electric Currents (*ec*)” modules were used. For “*solid*” module, the boundary condition of bottom boundary was set as “fixed constraint” and the top boundary was set as “boundary load” with 10 kPa. The other boundary were set as “free”. For “*ec*” module, the boundary condition of bottom boundary was set as “grounded” and the top boundary was set as “electric potential” with 1 V. The other boundary were set as “electric insulation”. For potential distribution of PCPF under temperature gradient, the “Thermoelectric Effect” module was added, with “Heat Transfer in Solids (*st*)” and “*ec*” two modules. For “*st*” module, the boundary condition of bottom boundary was set 293 K and the top boundary was 353 K. The other boundaries had heat loss due to convection with air (ambient temperature was set at 293 K) and the air convection coefficient was set as 1 $W/m^2 \cdot K$. For “*ec*” module, the boundary condition of top boundary was set as “grounded” and the other boundary were set as “electric insulation”.