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A Wearable And Highly Sensitive Pressure Sensor With Ultrathin Gold Nanowires

Shu Gong1,2, Willem Schwalb3, Yongwei Wang1,2, Yi Chen1, Yue Tang1,2, Jye Si1 , Bijan Shirinzadeh3 & Wenlong Cheng1,2

1 Department of Chemical Engineering, Monash University
2 The Melbourne Centre for Nanofabrication
3 Mechanical and Aerospace Engineering, Monash University

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S.Vidhya
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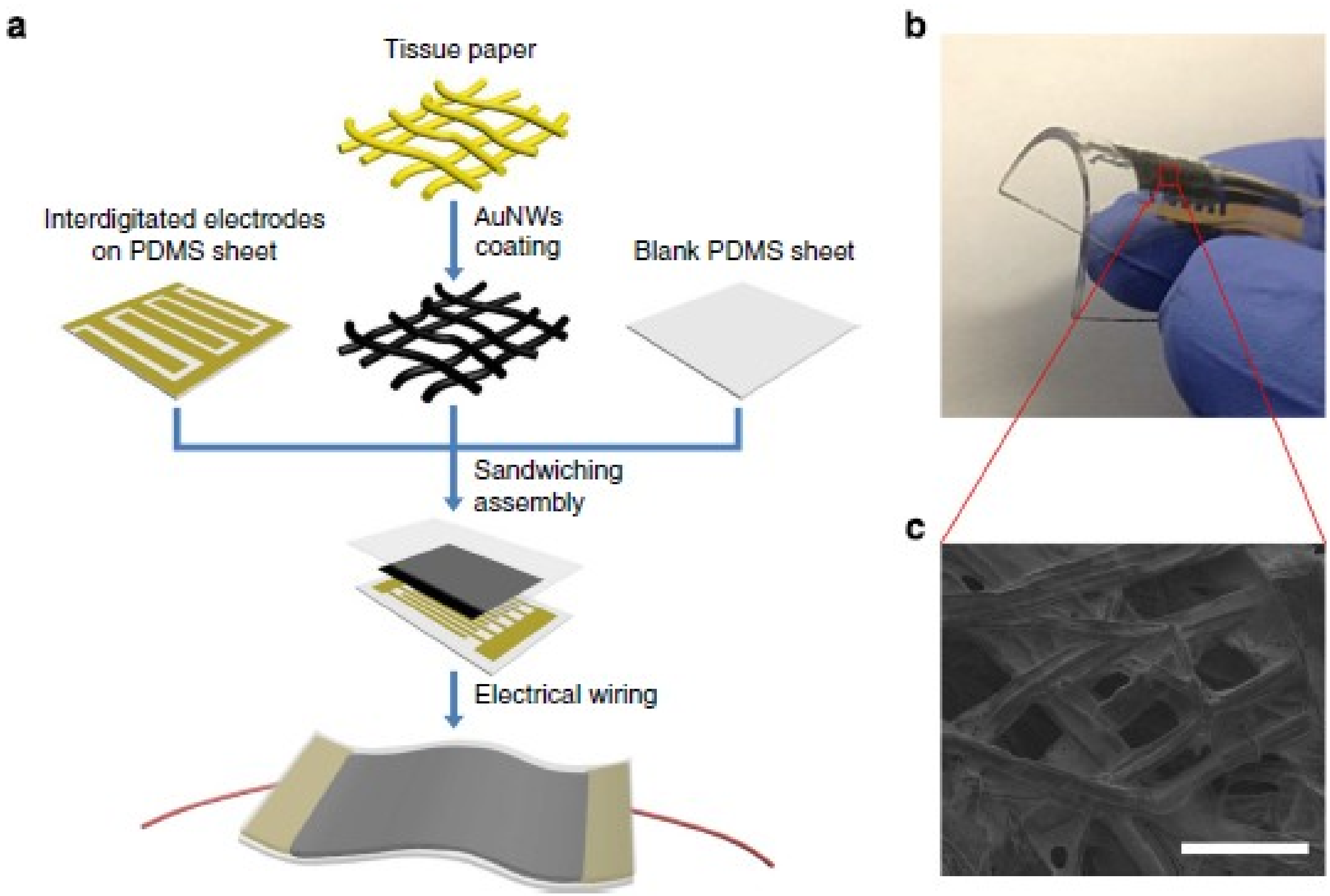
Introduction

- Wearable and lightweight pressure sensing devices are of paramount importance for various future applications, such as electronic skin, touch-on flexible displays, soft robotics and energy harvesting
- Pressure sensors are typically based on force induced changes in capacitance, piezoelectricity, triboelectricity and resistivity.
- Recently, various nanomaterials, including nanowires, carbon nanotubes,

polymer nanofiber, metal nanoparticles and graphene have been used for the design of novel flexible pressure and strain sensors.

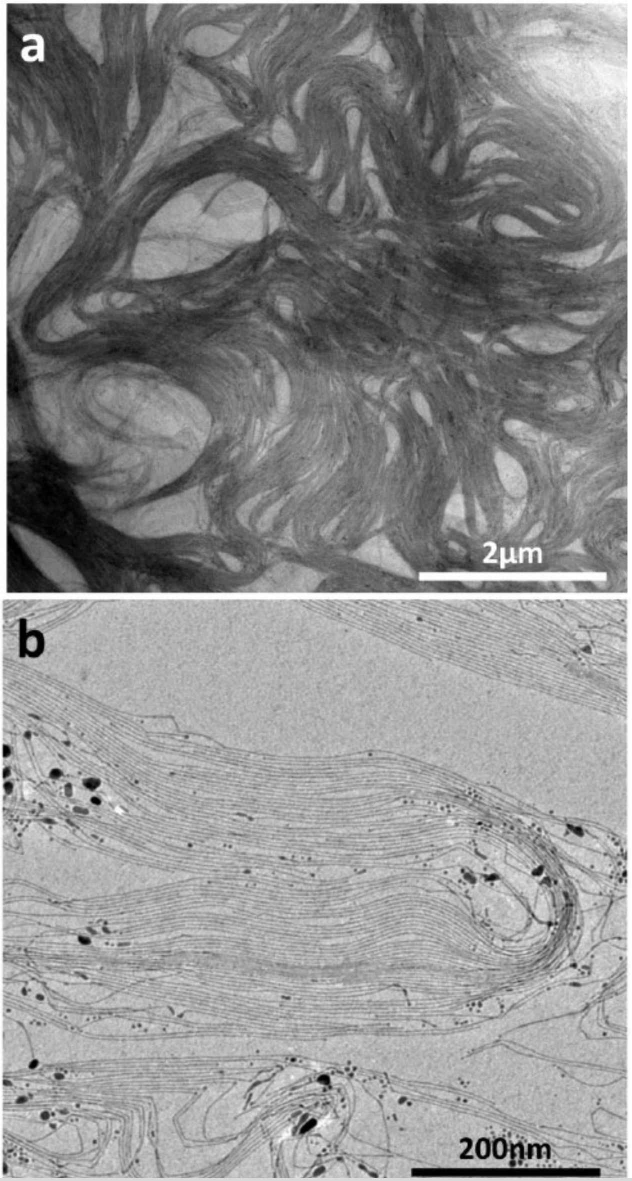
- The majority of these nanomaterials based pressure sensors are based on capacitance or piezoelectricity.
- The advantage of resistive pressure sensors lies at simplicity

In this paper

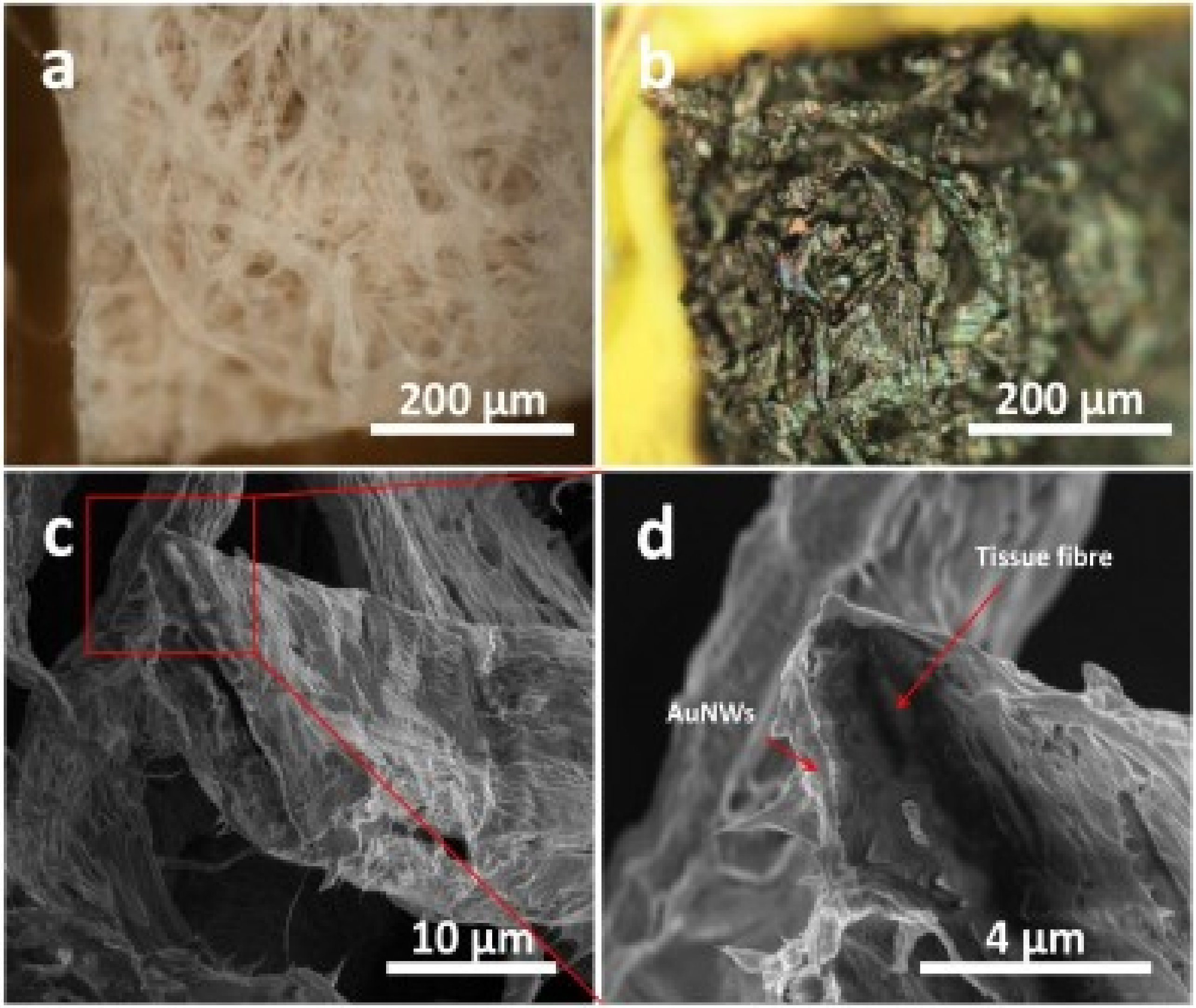


Pressure Sensor Based On The Au NWs Coated Tissue Paper(a) Schematic illustration of the fabrication of a flexible sensor. (b) Photograph showing the bendability of the sensor. (c) Scanning electron microscopy image of the morphology of gold nanowires coated tissue fibres (scale bar, 100 mm).

Experimental

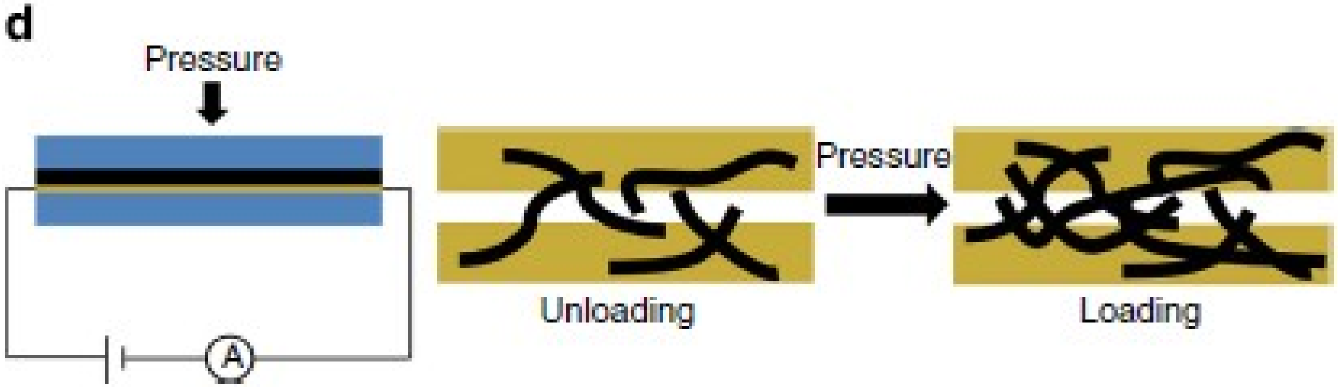


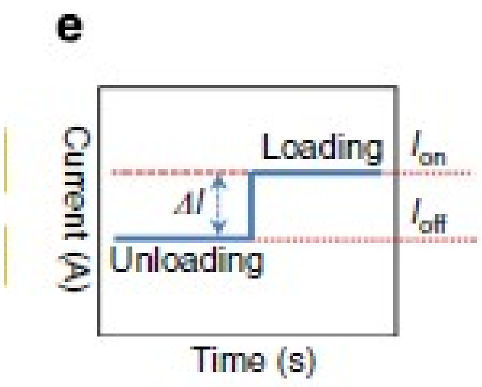
(a) and (b) are TEM images of ultrathin Au nanowires under



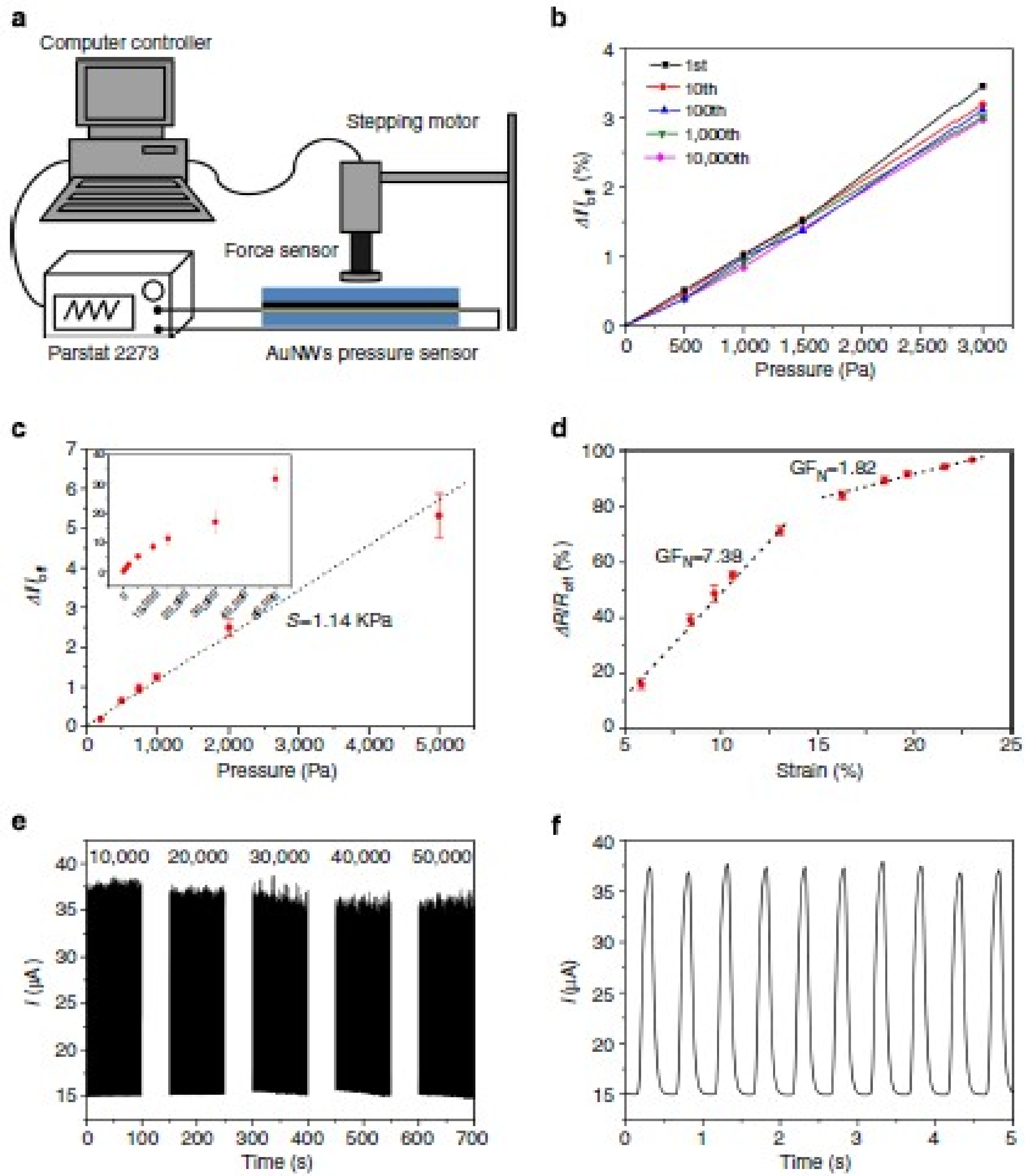
(a) and (b) are the optical images of tissue paper before and after 10 dip-coating cycles in nanowire solutions, respectively. (c) and (d) are the cross-sectional SEM image of nanowire-impregnated tissue fibres. The dark area inside

Schematic of Sensing Mechanism





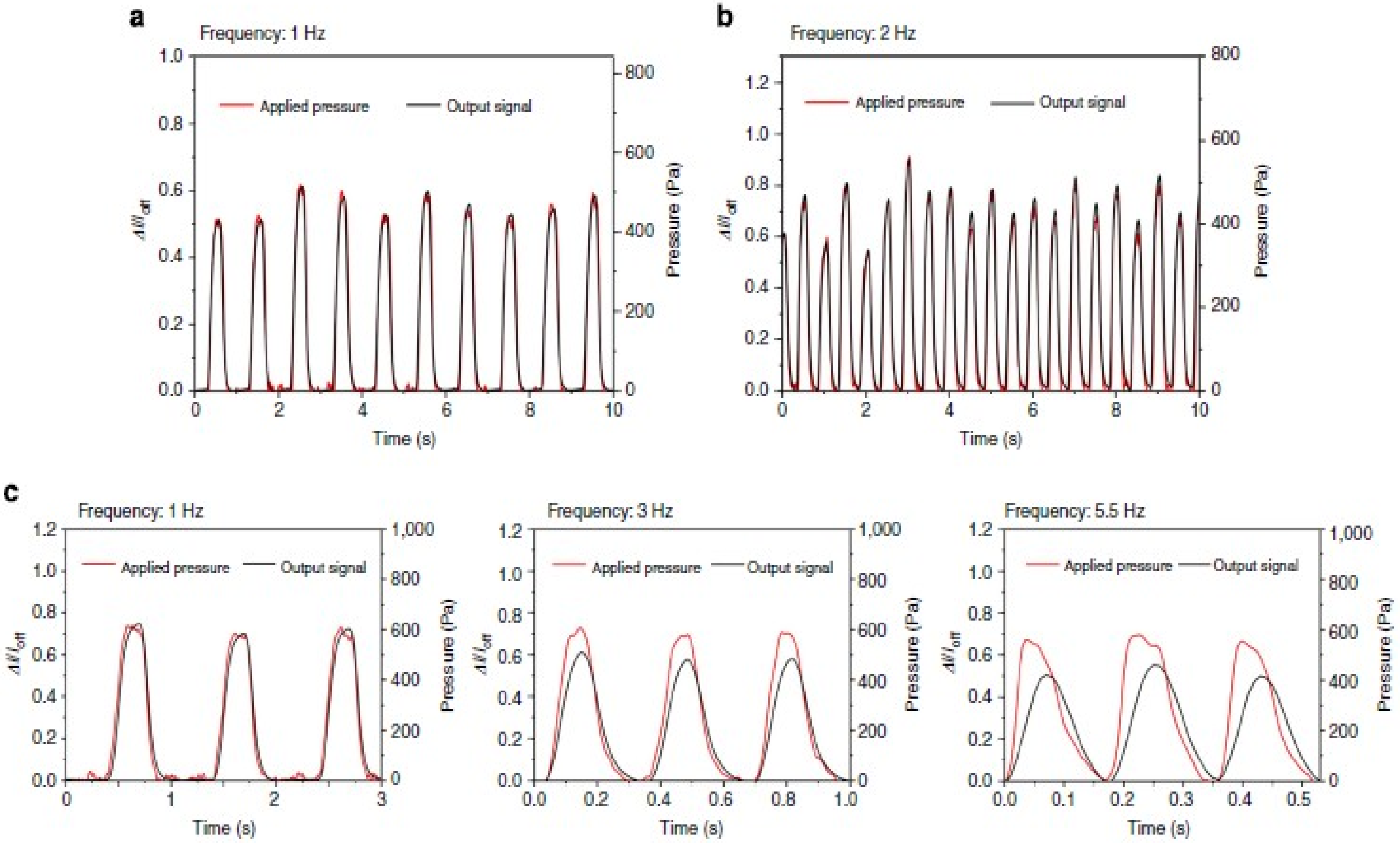
(d) Schematic illustration of the sensing mechanism. (e) Current changes in responses to loading and unloading (Ioff: unloading, Ion: loading).



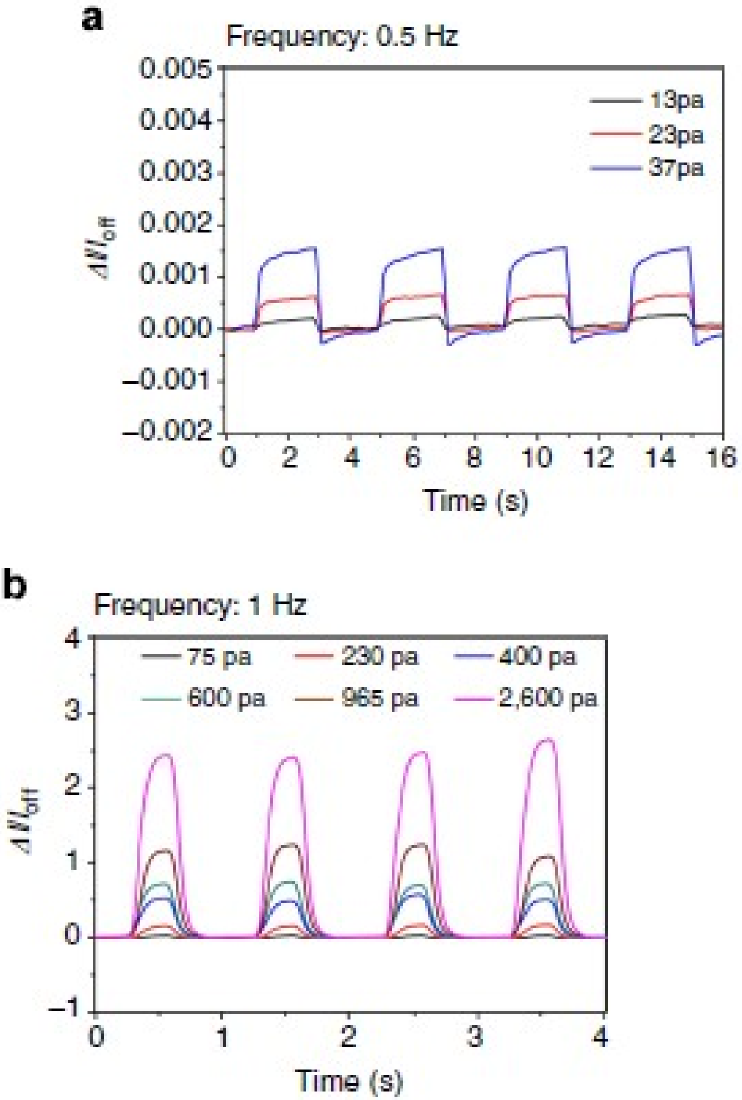
Evaluation Of Sensing Performances

(a) Schematic illustration of the experimental setup.
(b) Sensitivity after repeated loading–unloading cycles at a frequency of 3 Hz.
(c) Current response to various pressures. Dot line is a linear regression giving a sensitivity of ~1.14 kPa.
(d) Electrical resistance changes under various strains. Gauge factor, GFN could be derived by linear fitting.
(e) The durability test under a pressure of 2,500 Pa at a frequency at 2 Hz. The current change curves were recorded after each 10,000 cycles and 200 cycles of data were presented in each recording.
(f) Enlarged view of the part

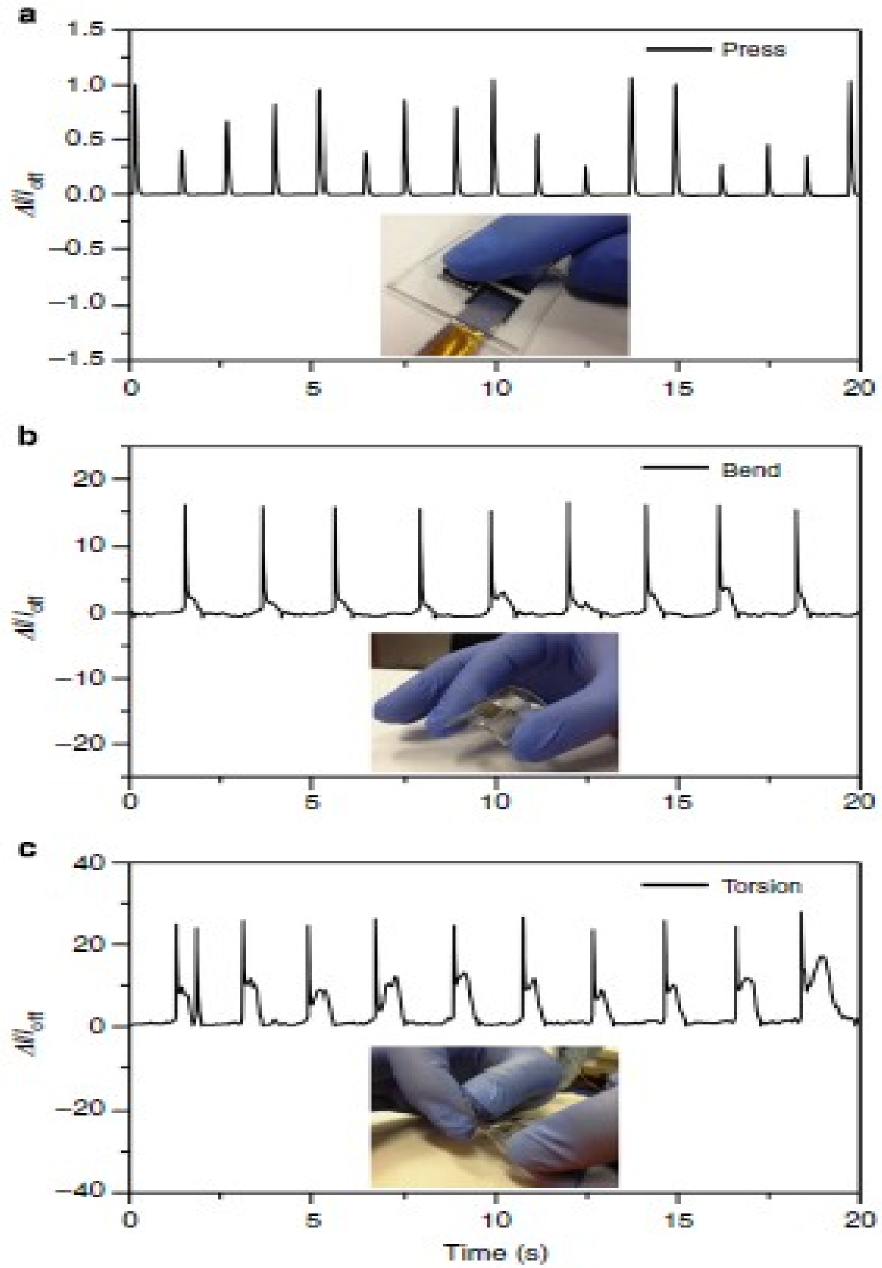
Pressure-resolved and time-resolved responses



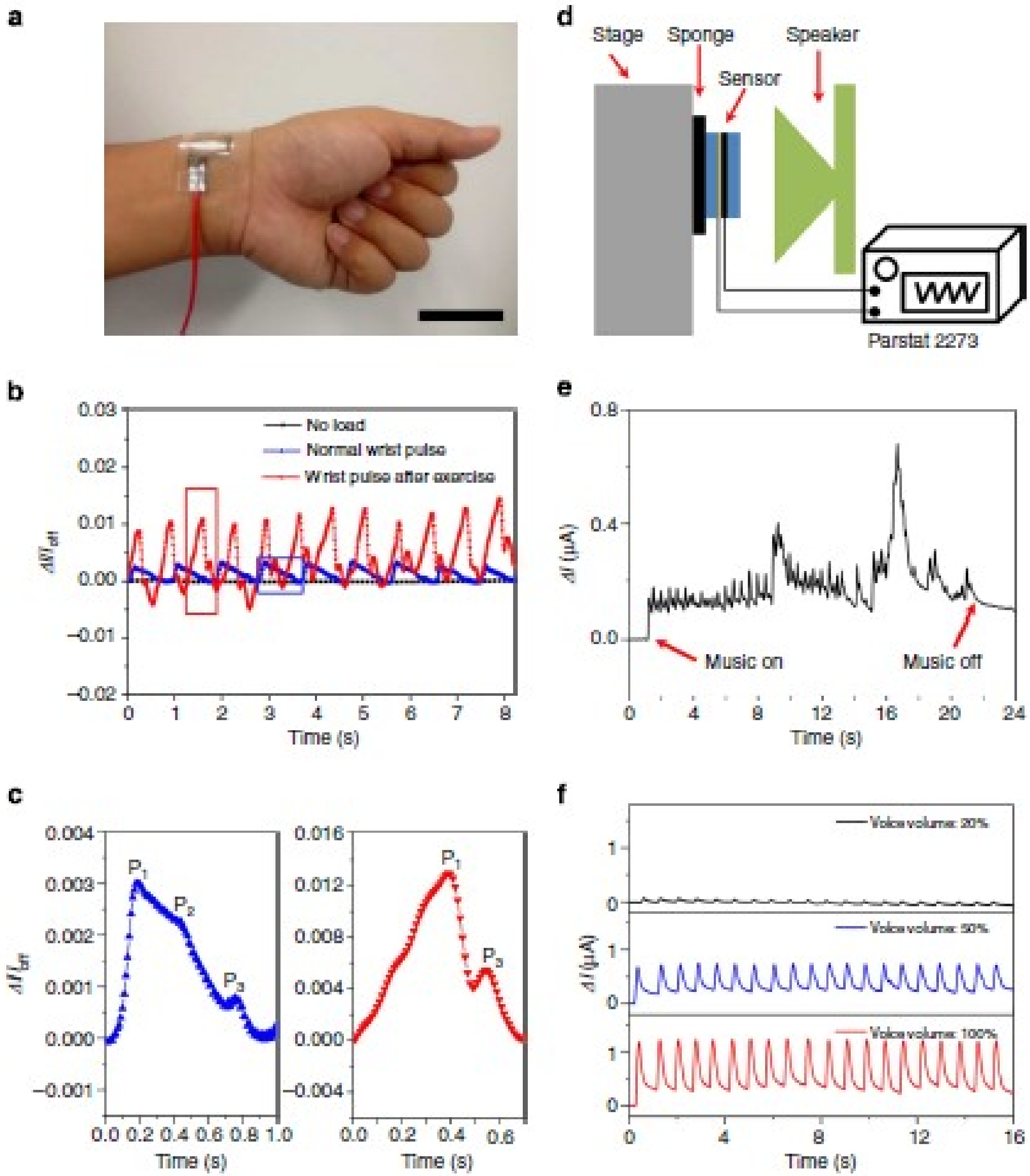
(a, b) Pressure-resolved measurements of the output signal as the function of applied pressure in the range of 400–550 Pa at the frequency of 1Hz and 2 Hz, respectively.
(c) Plots showing frequency responses at the dynamic pressure of 600 Pa: pressure input frequency of 1, 3 and 5.5 Hz.



Dynamic pressure response at low and high pressure range. (a) Plot of current response as a function of time (pressure input frequency: 0.5 Hz) for three applied pressures (13, 23 and 37 Pa). (b) Plot of current response of the sensor as a function of time (pressure input frequency: 1 Hz) for the applied pressures in the range of 75–2,600 Pa



Detection of other types of mechanical forces. (a–c) Plots showing the current responses to dynamic loading and unloading cycles: (a)



Real-time and in-situ artery wrist pulses and acoustic vibrations.

the skin-attachable sensor directly above the artery of the wrist (scale bar, 3 cm).

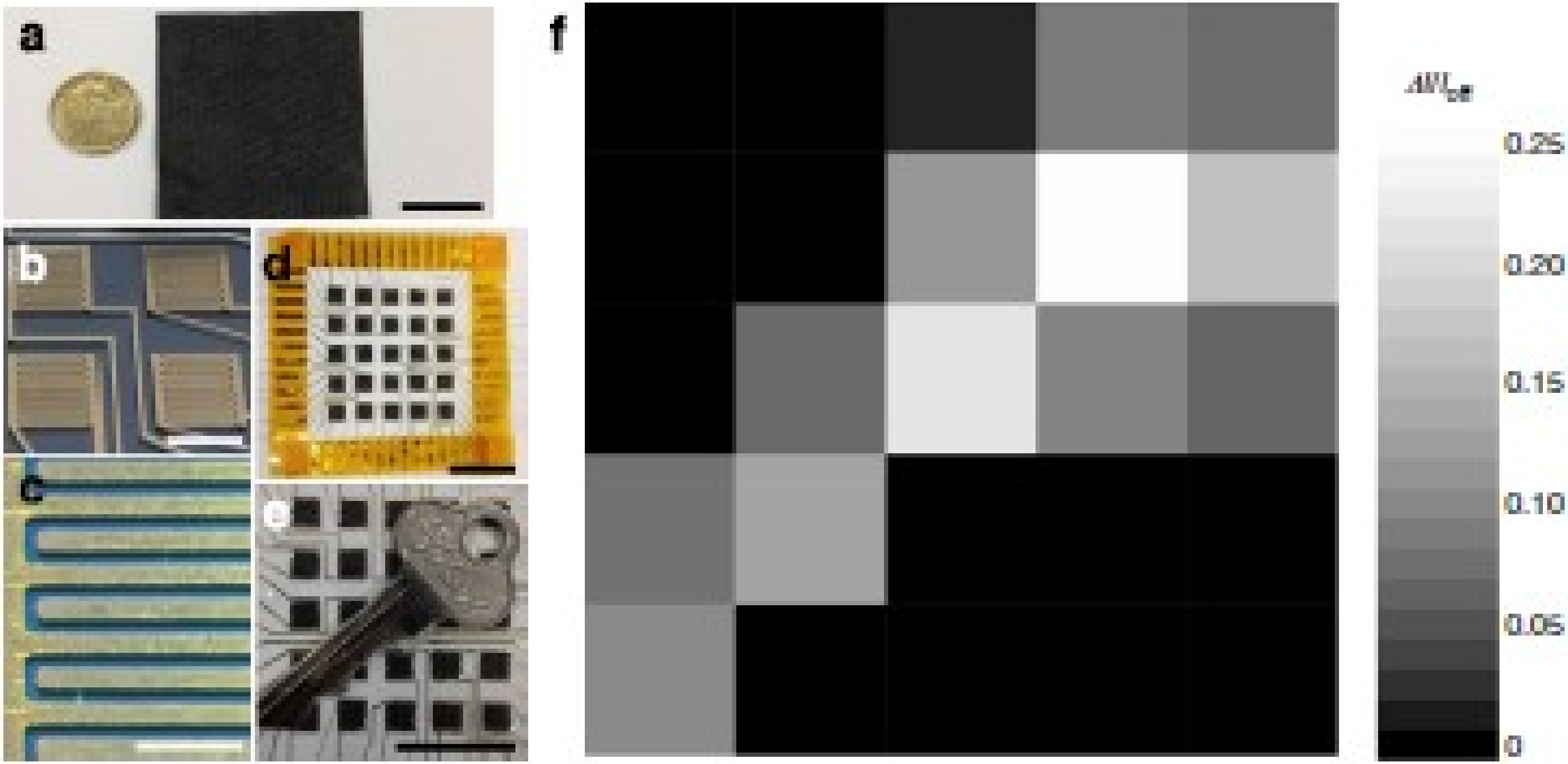
(b, c) Measurement of the physical force of a heartbeat under normal (66 beats per minute) and exercise conditions (88 beats per minute).

(d) Schematic illustration of the setup for acoustic vibration sensing.

(e) The current responses to the acoustic vibrations from a piece of music.

(f) The current responses to the acoustic vibrations from regularly clicking mouse. Note that three

Large-area integration and patterning



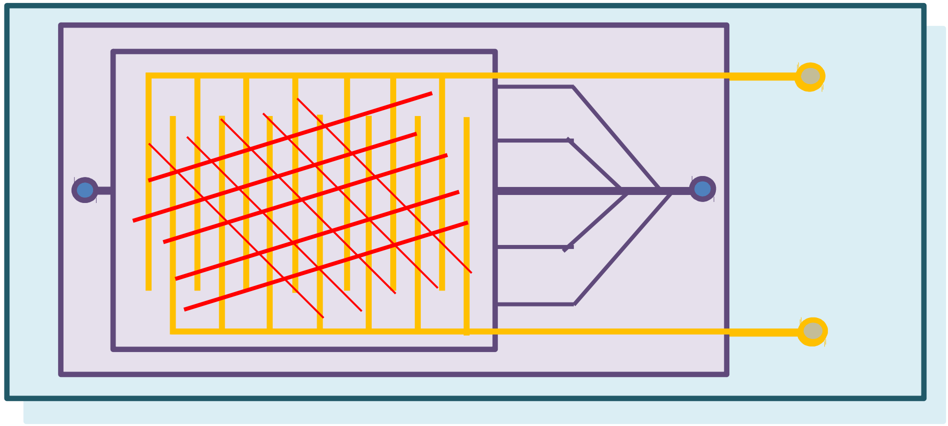
(a) Photograph of a 55 cm2 gold nanowires-impregnated tissue paper (scale bar, 2 cm).
(b) Photograph of interdigitated Ti-Au electrode arrays on PDMS substrate (scale bar, 5 mm).
(c) Optical microscope image of one pixel electrode (scale bar, 1 mm).
(d) Photograph of a large-area pressure sensor with 55 pixels (scale bar, 2 cm).
(e) Top view of a key (6.6 g) lays on the surface of the 55 pixel-pressure sensor (scale bar,

Summary

- They have developed a simple yet efficient, low-cost, bottom-up approach to fabricate a wearable and highly sensitive pressure sensor using ultrathin, high-aspect-ratio Au NWs.
- This new sensor featured a sensitivity of > 1.14 kPa-1, a fast response time of < 17 ms, high stability over > 50,000 cycles and a low power consumption of < 30 mW when operated under a battery voltage of 1.5 V.
- This new sensor could detect dynamic forces in a wide pressure range (13 ~ 50,000 Pa) with the ability of resolving various complex forces including pressing, bending, torsion and acoustic vibrations.
- These attributes enabled them to monitor in real-time and in-situ the real-world force signals from radial artery blood pulses and acoustic vibrations.
- Notably, the entire device fabrication process is scalable without the need of complex and expensive equipment.
- These methodologies open a new route to low-cost pressure sensors with potential facile integration into future wearable electronics such as flexible

Prospectives

Nanofibers / Nanowires based Impedance sensor for pathogen detection.



Thank you...