Electronic Supplementary Material (ESI) for Nanoscale.

Supplementary Information

Digital Strain Sensor Accomplished by Engineering Polydimethylsiloxane (PDMS) Bridge Structure

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SU-8 photolithography parameters:

	Spin speed (rpm)	Soft bake 1 (mins)	Soft bake 2 (mins)	Exposure dose (mJ/cm^2)	PEB 1 (mins)	PEB 2 (mins)	Develop-ment time
58µm	3000	3	10	230	1	7	5
90µm	2000	3	10	275	2	8	7
124µm	1200	7	45	375	1	12	10

Table S1 Parameters for SU-8 lithography.

SEM images of PDMS bridge structures:

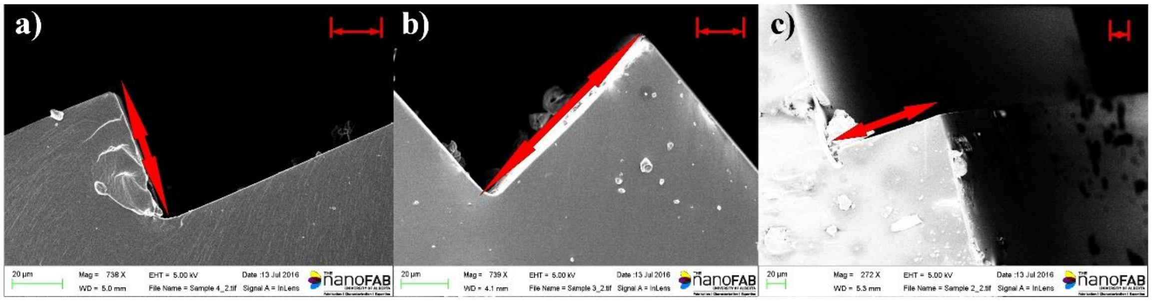

Figure S2 SEM images for bridges with different heights. a), b) and c) show 54 µm, 90 µm and 128 µm bridges, respectively. (Red arrows are showing heights for bridges while red legend represent 20 µm.)

Strain calculation:

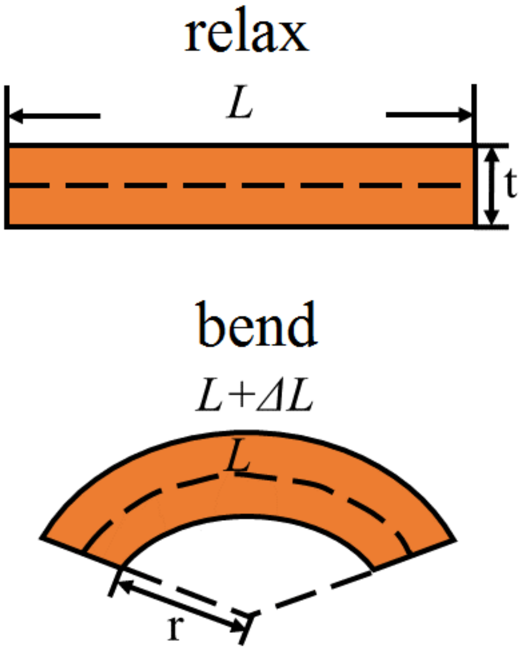

Figure S2. Illustration of bending strain calculation

In our testing measurement, we used steel block to apply strain on the device. We used the strain on the top side of the Kapton film to quantify it. According to the previous report[1,2], the strain on a bended substrate with the bending radius r can be calculated as shown in Fig. S2. At relax condition, the length of the substrate can be expressed as L while the thickness is t. After being bent on a stainless steel block with a radius of r, the condition of the substrate is shown as the bottom graph in Fig. S2.

It is common to assume that the centre of the substrate will not be stretched or compressed. The length of the central line is still L. However, the top is stretched and the bottom is compressed. The top of the substrate is stretched to $L+\Delta L$. The top and bottom of the substrate are bended to radius of $r+t/2$ and $r+t$. Thus we can get equations as below:

$$\frac{L}{r+t/2}=\frac{L+\Delta L}{r+t}$$

It is derived to get:

$$\frac{t/2}{r+t/2}=\frac{\Delta L}{L}$$

$$\varepsilon=\frac{t/2}{r+t/2}$$

Where ε represents the strain of the top.

Measurement testing setup illustration:

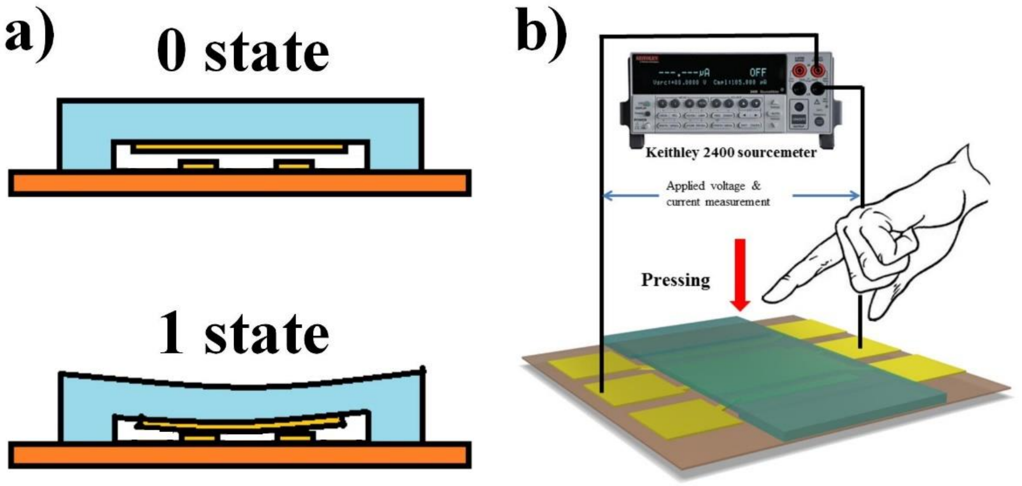

Figure S3 a) Schematics of the digital MEM sensor at ‘0’ and ‘1’ states. b) Measurement testing setup illustration.

Reproducibility test:

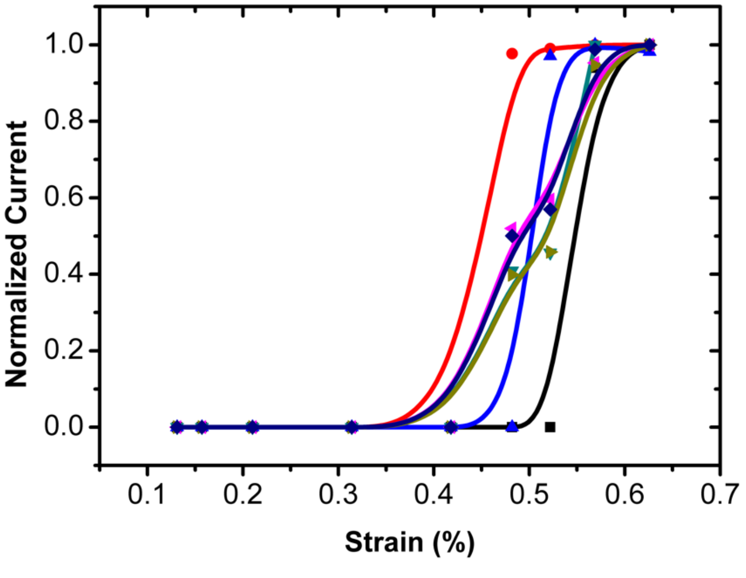

Figure S4 Normalized current vs. strain curves of 7 digital MEM sensors that all have 124 µm pier height. Curves of different colors represent different devices with the same design and fabrication method.

Atomic force microscopy (AFM) images of PDMS surfaces:

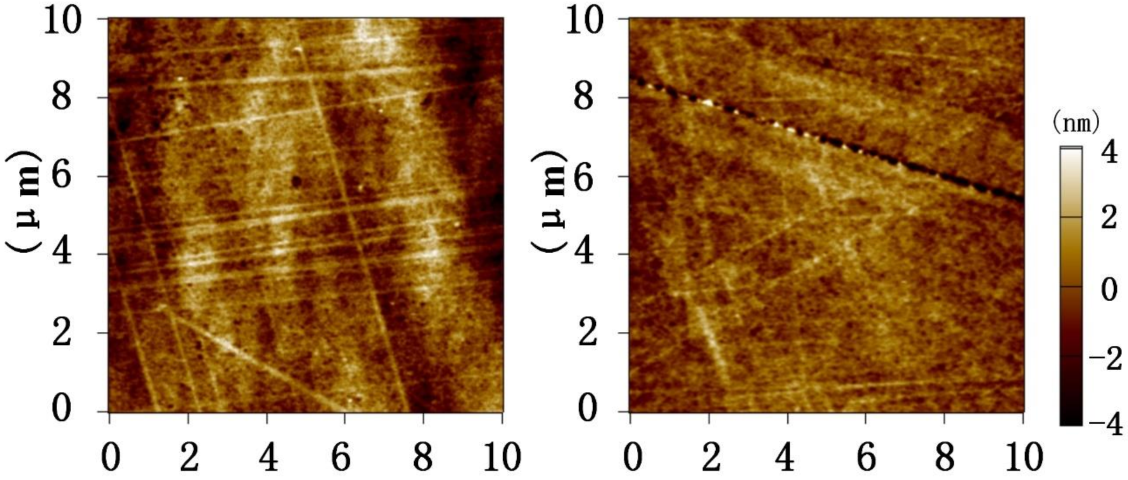

Figure S5 AFM images of PDMS bridge surfaces: the left one is the area which contacts silicon wafer while the right one is the area contacting SU-8 patterns.

References:

1 J. Yin, P. Hu, J. Luo, L. Wang, M. F. Cohen and C. J. Zhong, *ACS Nano*, 2011, **5**, 6516–6526.

2 L. Meng, S. M. Mahpeykar, Q. Xiong, B. Ahvazi and X. Wang, *RSC Adv.*, 2016, **6**, 85427–85433.