Electronic Supplementary Material (ESI) for Lab on a Chip.

Supporting Information

Wearable microfluidic pressure sensors based on deformation mechanics

Joo Chuan Yeo[1,2,3], Jiahao Yu[1], Zhao Ming Koh[1], Zhiping Wang[2], Chwee Teck Lim[1,3,*]

[1]Department of Biomedical Engineering, National University of Singapore, Singapore 117575

[2]Singapore Institute of Manufacturing Technology (SIMTech), A*STAR, Singapore 138634

[3]Mechanobiology Institute, National University of Singapore, Singapore 117411

*Correspondence: Chwee Teck Lim (ctlim@nus.edu.sg)

Calculation of deformation mechanics

The deformation behavior is expressed in relation to the electrical resistance. First, the pressure sensing region is expressed by Eq. S1,

$$R_{circle} = \int_{-r}^{r} \frac{\rho}{2h\sqrt{r^2 - x^2}} dx = \frac{\pi\rho}{2h} \tag{S1}$$

where R_{circle} is the resistance of the pressure sensing region, ρ is the electrical conductivity of eutectic Gallium Indium, h is microchannel height, and r is the radius of the pressure sensing region.

Similarly, the equivalent resistance of the parallel interconnects, R_{arc}, is expressed in Eq. S2,

$$R_{arc} = \rho \cdot \frac{\frac{1}{4}\pi d}{wh} \cdot \frac{1}{2} = \frac{\pi d \rho}{8wh} \tag{S2}$$

where d is the arc diameter and w is the microchannel width. Therefore, the initial resistance of the sensor is expressed by the sum of resistances in Eq. S3,

$$R_0 = \frac{\pi\rho}{2h} + \frac{\pi d\rho}{4wh} \tag{S3}$$

Under pressure *P*, the sensor assumes a uniform deformation to the pressure sensing region. As such, the resistance of the region is expressed as Eq. S4,

$$R'_{circle} = \frac{\rho}{2(h-\Delta h)} \int_{-r}^{r} \frac{1}{\sqrt{r^2 - x^2}} dx = \frac{\rho\pi}{2(h-\Delta h)} \tag{S4}$$

where Δh is the deformed height. The compression load could be assumed in the linear elastic region, and is expressed as Eq. S5.

$$\Delta h = \frac{Ph}{E_C} \tag{S5}$$

where E_c is the compression modulus of silicone rubber (i.e., 209 kPa). Substituting S5 into the Eq. S3 and S4, the normalized resistance is expressed in Eq. S6.

$$\frac{\Delta R}{R_0} = \frac{R'_{circle} - R_{circle}}{R_{circle} + 2 \cdot R_{arc}} = \frac{\frac{\pi\rho}{2(h-\Delta h)} - \frac{\pi\rho}{2h}}{\frac{\pi\rho}{2h} + \frac{\pi d\rho}{4wh}} = \frac{2Pw}{(2w+d)(E_c - P)} \tag{S6}$$