

## Supplementary Materials for

### **Wireless, skin-interfaced sensors for compression therapy**

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#### **The PDF file includes:**

Figs. S1 to S15  
Tables S1 and S2  
Legends for movies S1 and S2

#### **Other Supplementary Material for this manuscript includes the following:**

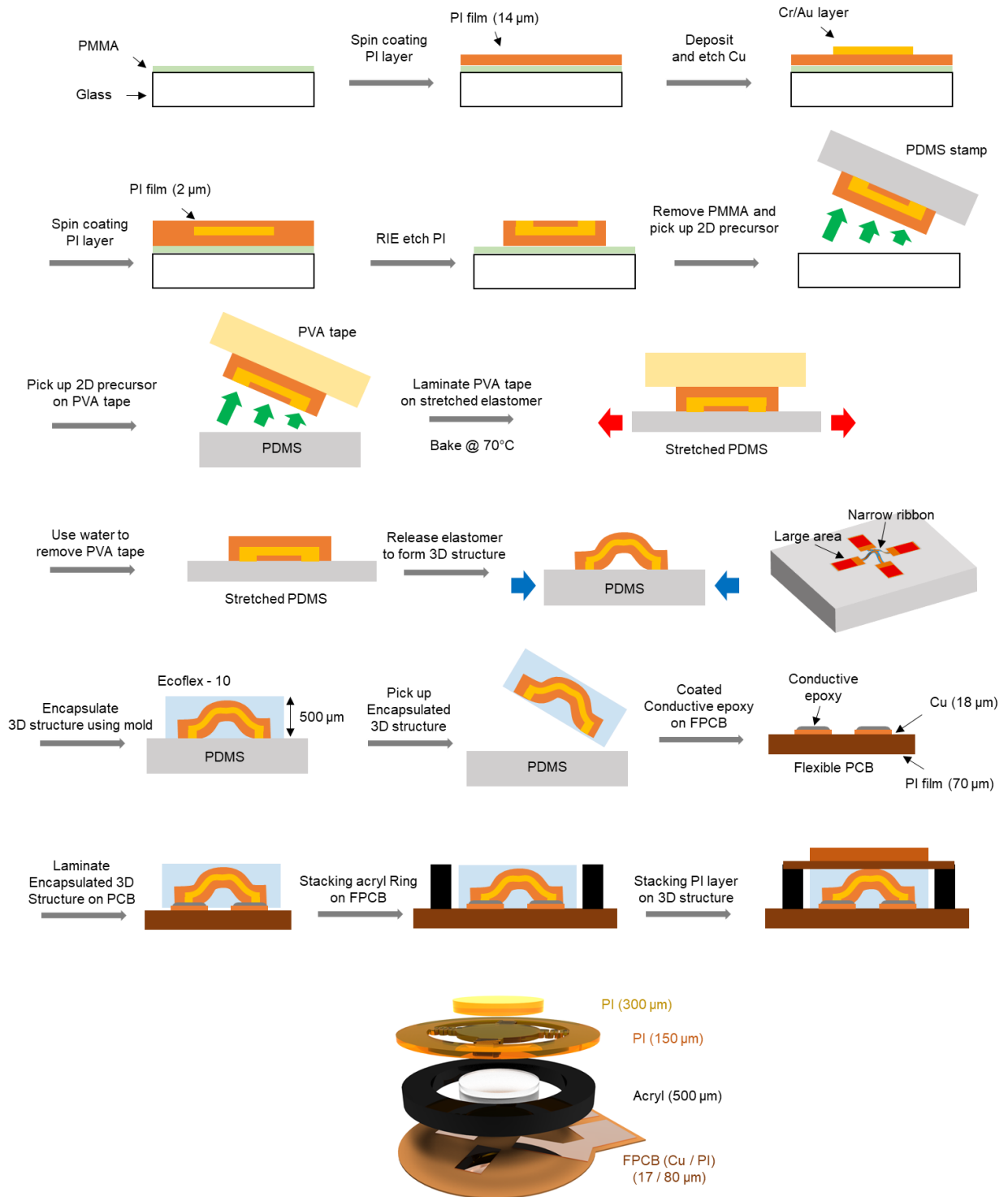
(available at [advances.sciencemag.org/cgi/content/full/6/49/eabe1655/DC1](https://advances.sciencemag.org/cgi/content/full/6/49/eabe1655/DC1))

Movies S1 and S2

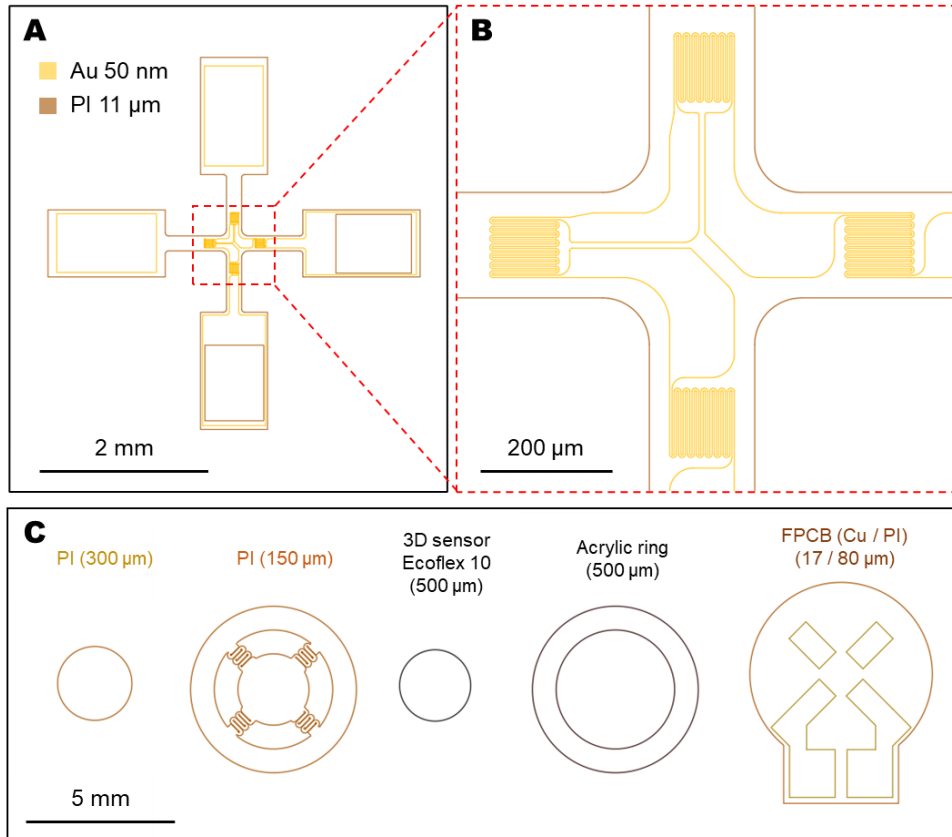
**Movie S1. Wirelessly recorded pressure.** Fractional changes of pressure by finger

**Movie 2. Wirelessly monitored interface pressure using a bandage.** The change in applied pressure with the number of inelastic bandages wrapping on the arm.

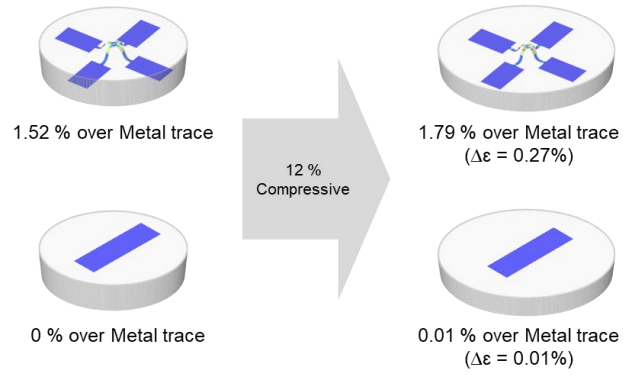
**Fig. S1 Procedure for fabricating a 3D pressure sensor.** Schematic illustration of the steps.



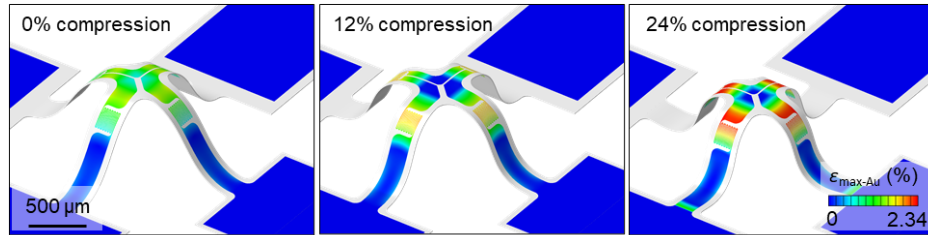
**Fig. S2. The design of a 3D pressure sensor. (A)** 2D precursor for a 3D pressure sensor. **(B)** Magnified view of four gold serpentine wires. **(C)** Layouts of polyimide, pressure sensor, acrylic ring and FPCB.



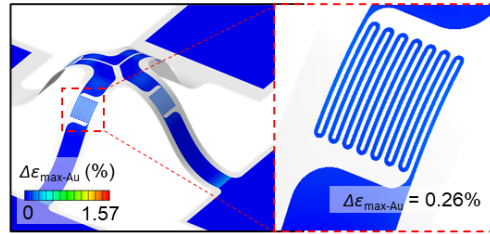
**Fig. S3. Computed strains for a metal trace under compression of 0% and 12%. The maximum principal strain ( $\epsilon_{max}$ ) over the metal trace of 3D structure and 2D structure under 0% and 12% compression.**



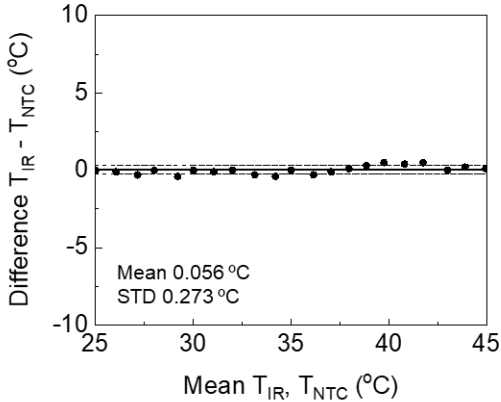
**Fig. S4. Computed strains for a metal trace under compression of 0%, 12% and 24%. The maximum principal strain ( $\epsilon_{max}$ ) over the metal trace of 3D structure under 0%, 12% and 24% compression.**



**Fig. S5. Computed change in strain for a metal trace under compression of 2.5%.** The change in maximum principal strain for a metal trace under compression of 2.5%.

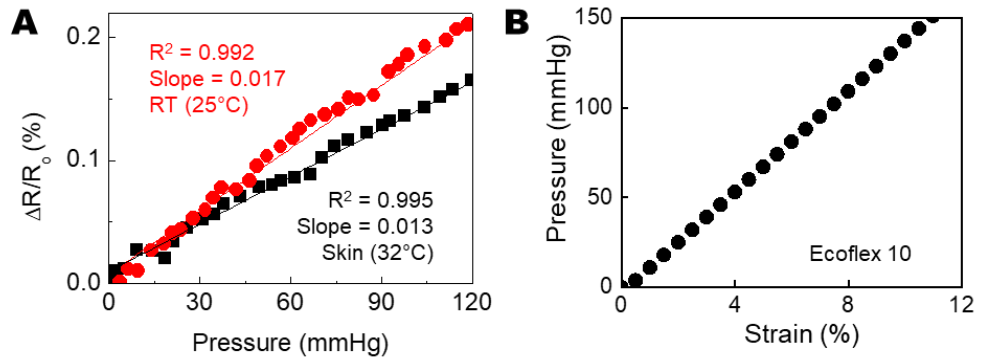


**Fig. S6. Bland-Altman plots between the two paired measurements of Fig 3D. Measurement from NTC temperature sensor of SCV and IR camera**

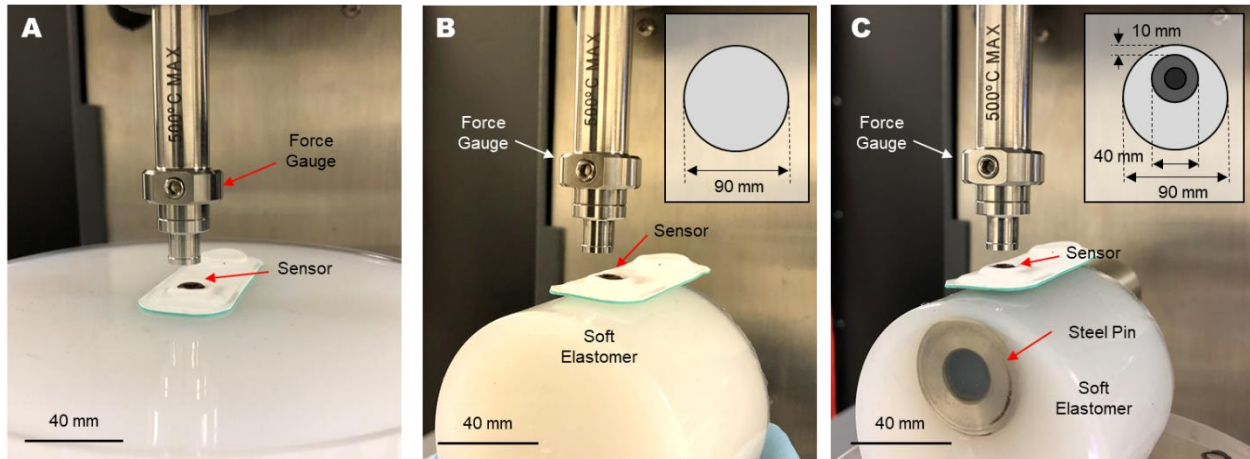




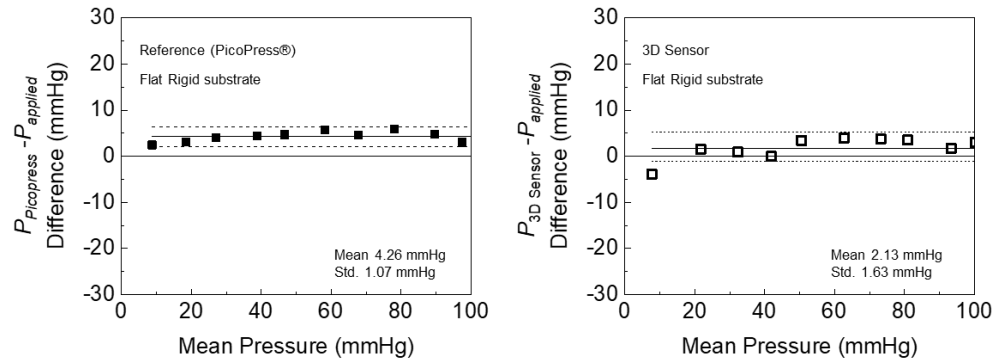
**Fig. S7. Temperature dependent changes in resistance of the SCV and deformation - pressure relation of Ecoflex 10.** (A) Change in resistance of the SCV as a function of temperature variation (room temperature 25 °C and skin temperature 32 °C). (B) Relation between deformation and pressure of Ecoflex 10.



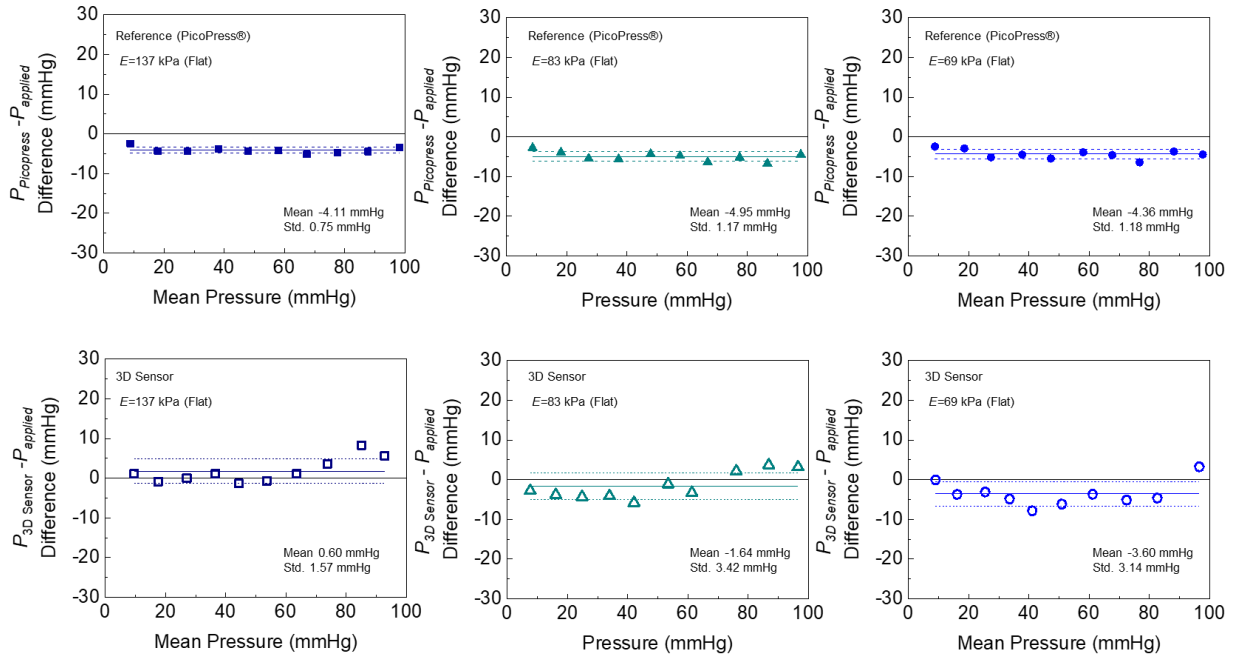
**Fig. S8. Experimental set up for testing feasibility of 3D pressure sensor and reference device using universal testing machine (UTM)** Optical microscopic image shows 3D sensor placing on (A) flat substrate, (B) curved substrate and (C) curved substrate with steel pin. Photo credit: Yoonseok Park, Northwestern University.



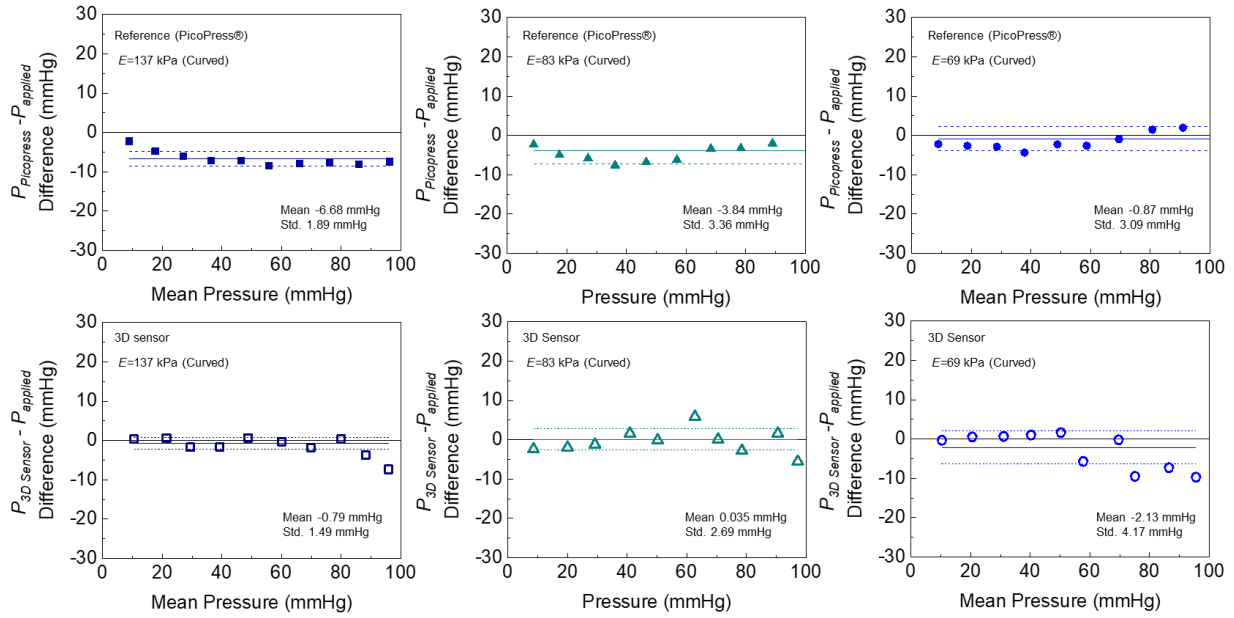
**Fig. S9. Bland-Altman plots between the two paired measurements of Fig 4B.** Measurement from (left) reference sensor and applied pressure from UTM and (right) 3D pressure sensor and applied pressure on flat rigid substrates.



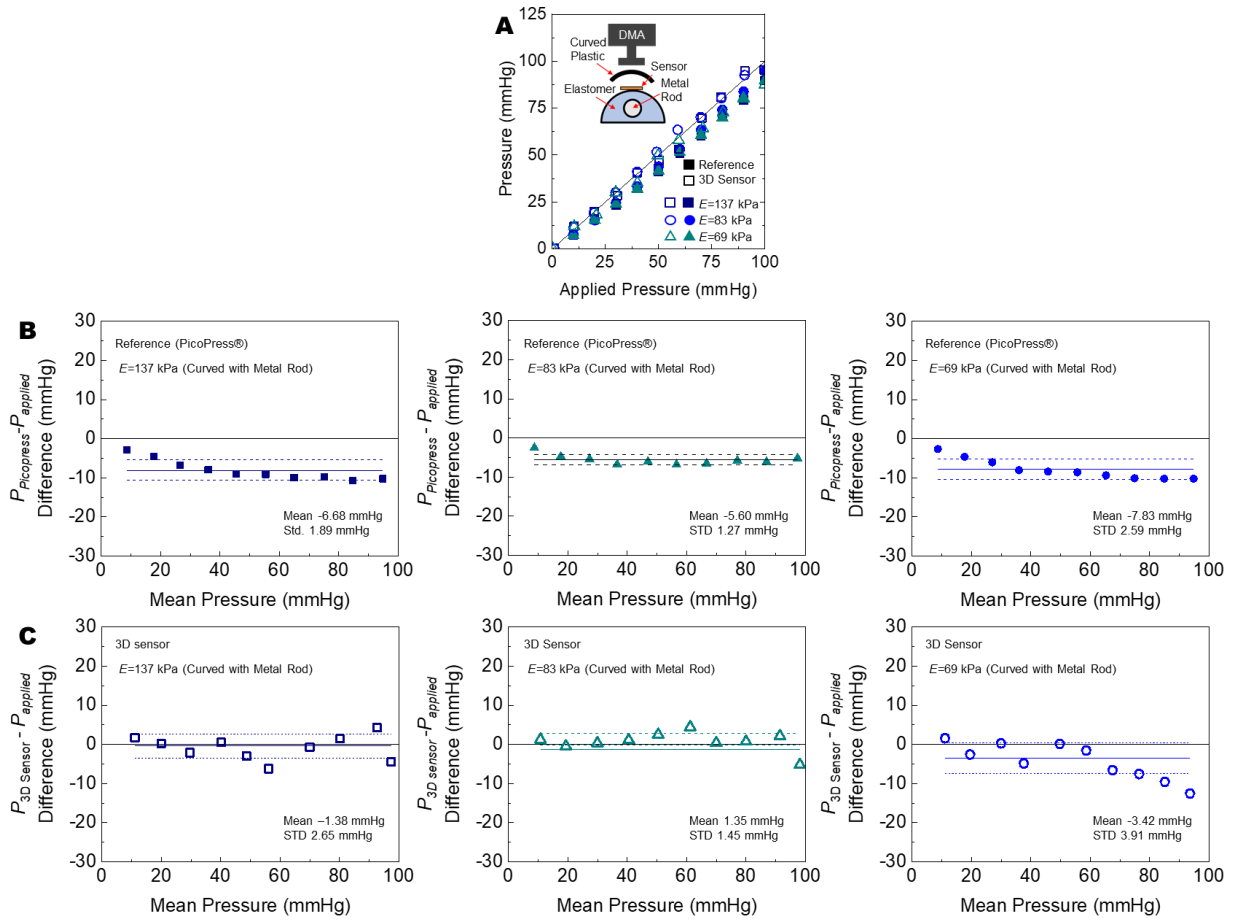
**Fig. S10. Bland-Altman plots between the two paired measurements of Fig 4C.** Measurement from (top) reference sensor and applied pressure from UTM and (bottom) 3D pressure sensor and applied pressure on flat substrates consist of three different elastomer (left) dragon skin 10;  $E = 137$  kPa, (middle) Ecoflex 00-50;  $E = 83$  kPa, (right) Ecoflex 00-30;  $E = 69$  kPa.



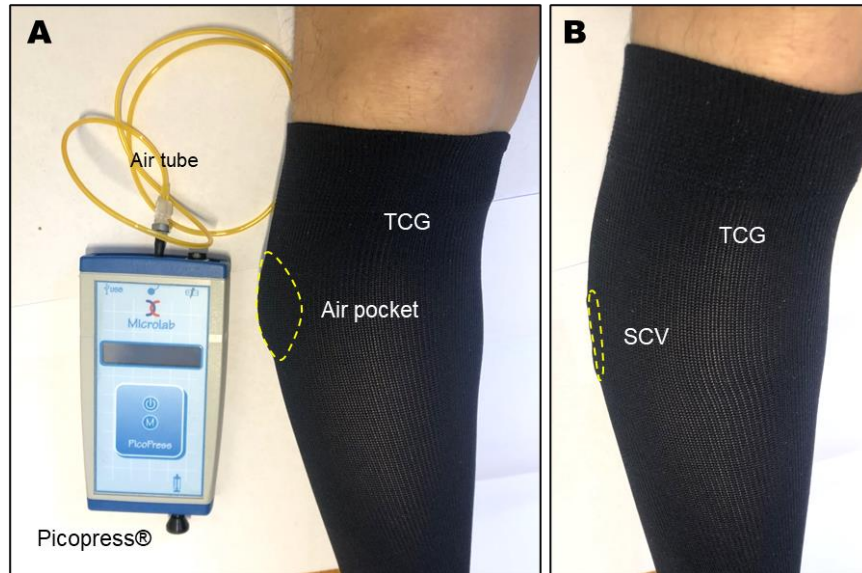
**Fig. S11. Bland-Altman plots between the two paired measurements of Fig 4D.** Measurement from (top) reference sensor and applied pressure from UTM and (bottom) 3D pressure sensor and applied pressure on curved substrates consist of three different elastomer (left) dragon skin 10;  $E = 137$  kPa, (middle) Ecoflex 00-50;  $E = 83$  kPa, (right) Ecoflex 00-30;  $E = 69$  kPa.



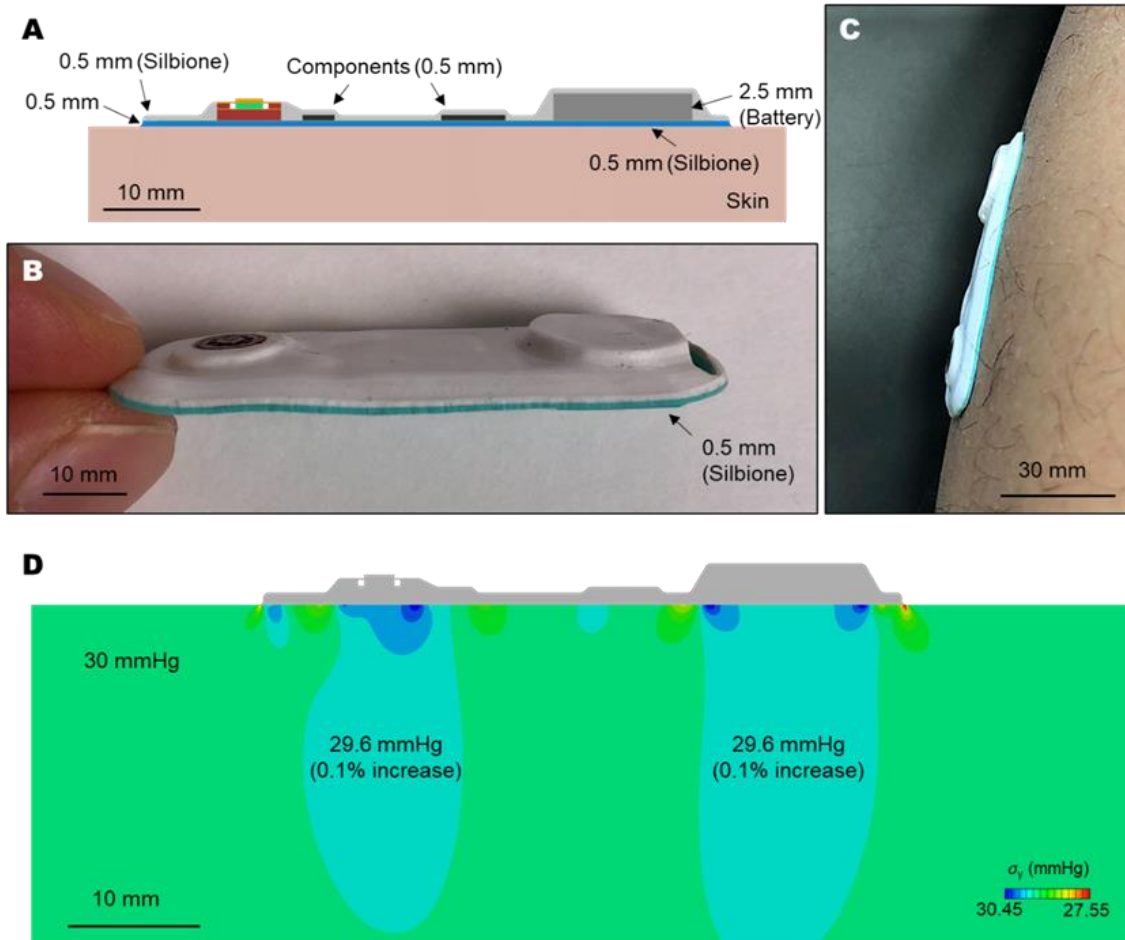
**Fig. S12. Measurement of 3D sensor and reference equipment on the curved surface with metal rod inside.** (A) Changes in resistance of 3D sensor and in pressure of reference equipment as a function of applied pressure using DMA on curved surface with metal rod inside with different materials (elastomers with different elastic modulus; dragon skin 10 ( $E = 137$  kPa), Ecoflex 00-50 ( $E = 83$  kPa), Ecoflex 00-30 ( $E = 69$  kPa)). Bland-Altman plots between the two paired measurements; (B) reference sensor and applied pressure from UTM and (C) 3D pressure sensor and applied pressure on curved substrates with metal pin consist of three different elastomer (left) dragon skin 10;  $E = 137$  kPa, (middle) Ecoflex 00-50;  $E = 83$  kPa, (right) Ecoflex 00-30;  $E = 69$  kPa.



**Fig. S13. Optical images of wearing GCS adhering reference equipment and SCV inside. (A)** Air pocket, air tube and monitor of an air bladder type reference equipment (PicoPress®). **(B)** SCV inside GCS. Photo credit: Yoonseok Park, Northwestern University.

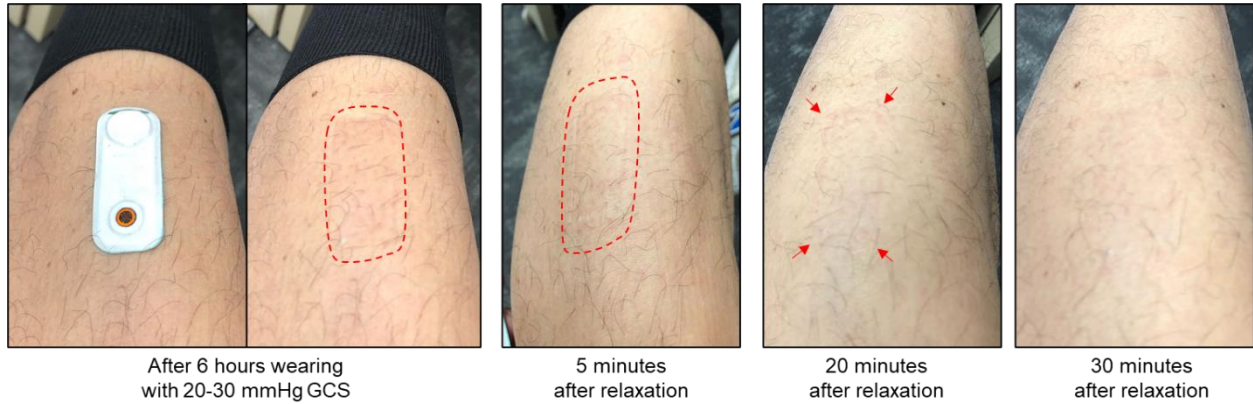


**Fig. S14. Schematic and optical images of SCV and a corresponding FEA result. (A)** Schematic of SCV with a dimensional information of major components. Optical image of **(B)** a SCV and **(C)** on a leg. **(D)** FEA result of distribution of pressure under uniform nominal pressure (30 mmHg) over skin and SCV. Photo credit: Yoonseok Park, Northwestern University.





**Fig. S15. Optical images of a pressed mark on a leg.** After 6 h with SCV while wearing 20-30 mmHg GCS and recovery over time (5, 20 and 30 minutes after relaxation). Photo credit: Yoonseok Park, Northwestern University.



**Table S1 Correlation constants for pressure/temperature measurement.**

Device Number	Temperature		ADC <sub>ntc</sub> (32° C)	Pressure			ADC <sub>pressure</sub> (0 mmHg)
	$C_T$	$n$		$C_{p1}$	$C_{p2}$	$m$	
1	0.0049	4257	2273	0.15	0.49	101.7	2161
2	0.0052	3655	2875	0.24	0.41	365.1	2480
3	0.0049	2650	3880	0.22	0.51	401.1	3386
4	0.0049	4150	2380	0.24	0.42	409.6	2045

**Table S2 Information of participants who participated in this study.**

Participant number	age	Circumstance (Left / Right)		Sex	Ethnicity	Pathology
		Ankle	Calf			
1	89	24 / 24	34 / 34	M	African American	-
2	74	36 / 35	56 / 49	F	African American	Venus leg ulcers
3	87	26 / 25	34 / 34	F	African American	-
4	87	24 / 24	40 / 39	F	South Asian	-
5	69	26 / 26	41 / 40	F	Caucasian	Varicose veins
6	61	27 / 26	40 / 40	M	Caucasian	-
7	62	22 / 22	38 / 39	F	Caucasian	-
8	74	26 / 26	37 / 37	F	Caucasian	-