

## Electronic Supplementary Information

### A flexible carbonized melamine foam/silicone/epoxy composite pressure sensor with temperature and voltage-adjusted piezoresistivity for ultrawide pressure detection

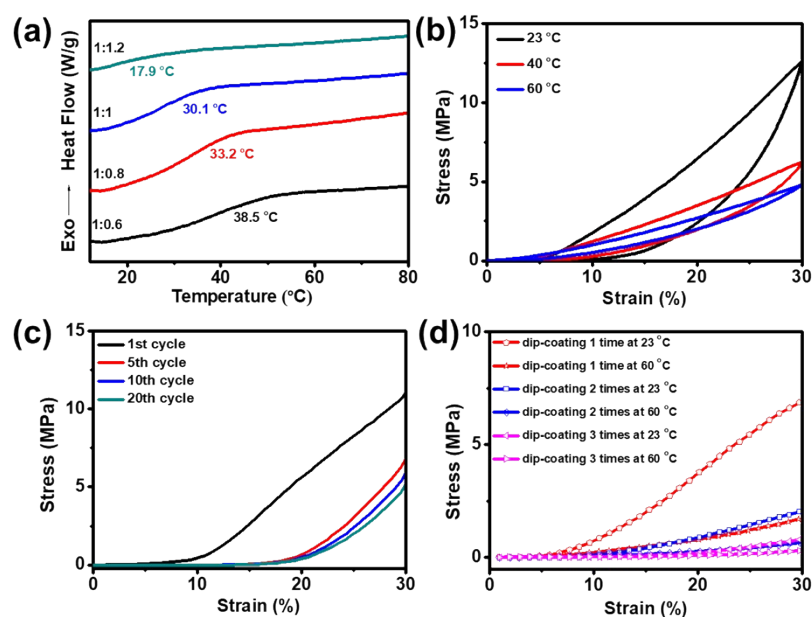
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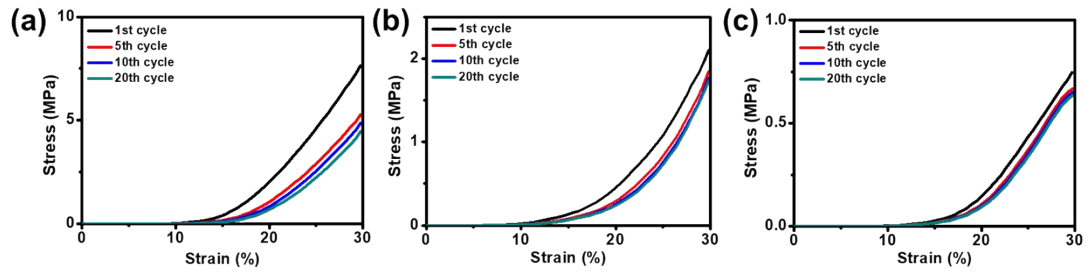
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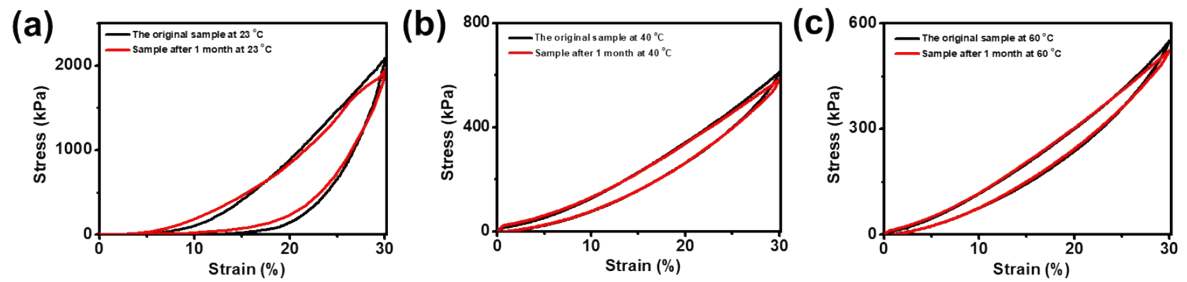
Email: [p.huang@cqu.edu.cn](mailto:p.huang@cqu.edu.cn), [syfu@cqu.edu.cn](mailto:syfu@cqu.edu.cn)



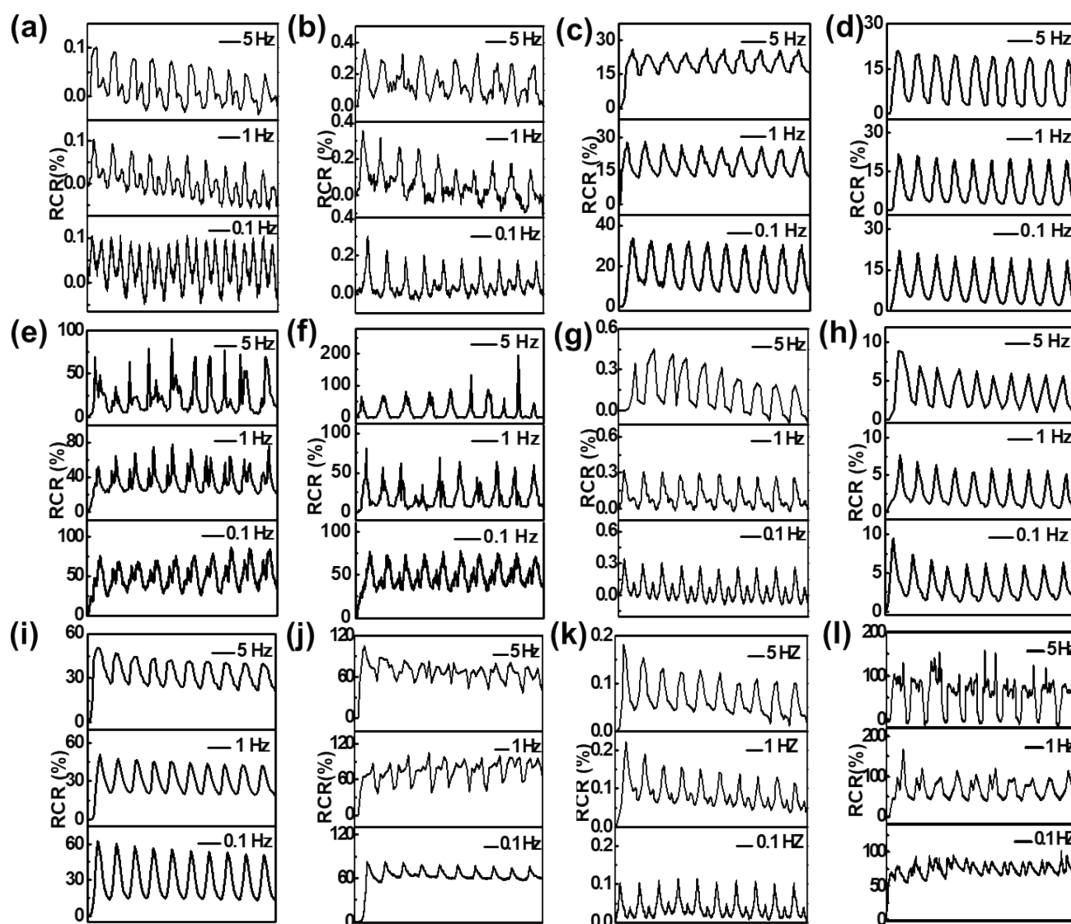
**Fig. S1.** a) DSC curve of epoxy; b) compressive strength of epoxy at 23, 40 and 60 °C respectively at the strain rate of 1 mm/min; c) compressive stress-strain curves of epoxy at varied loading cycles; d) compressive stress-strain curves of CMS/silicone/epoxy composites at 23 and 60 °C at the strain rate of 1 mm/min.



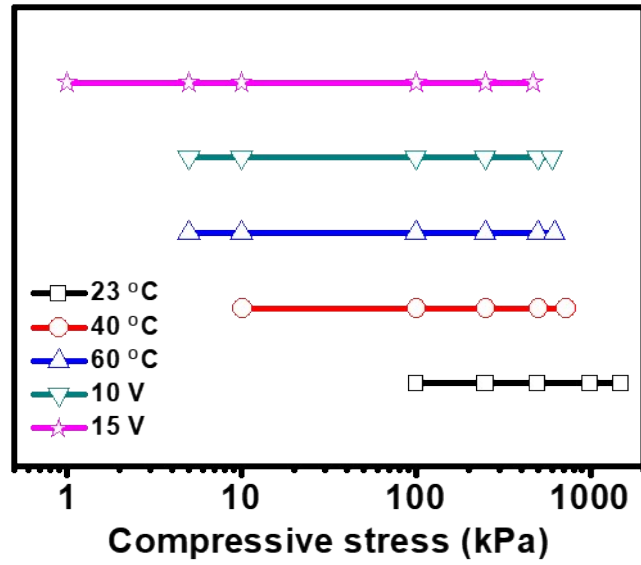
**Fig. S2.** Compressive stress-strain curves of CMS/silicone/epoxy composite with 1 (a), 2 (b) and 3 (c) cycle(s) of dip-coating.



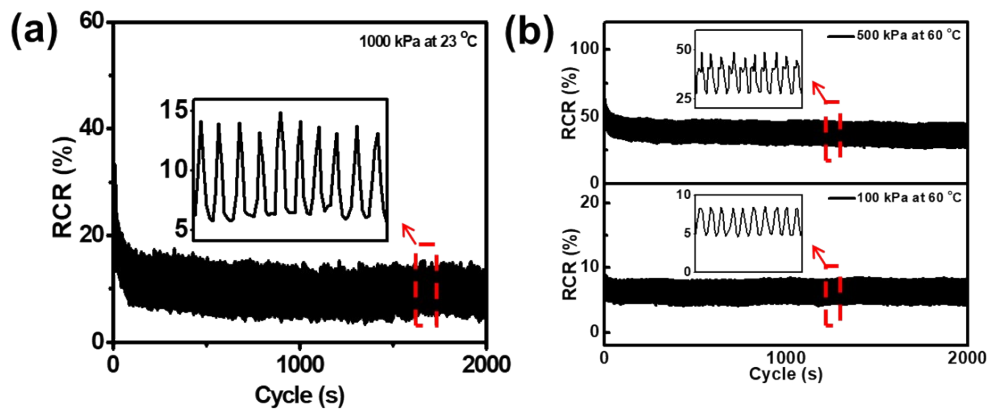
**Fig. S3.** Comparison of the mechanical properties of the composite before and after 1 month at 23 °C (a), 40 °C (b) and 60 °C (c).



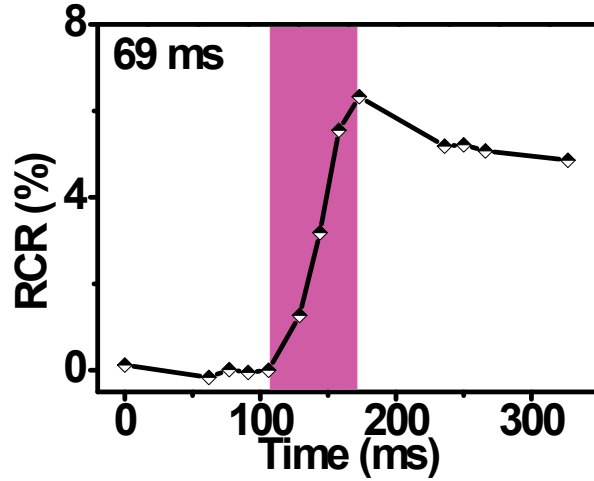
**Fig. S4.** Sensing performance of the CMS/silicone/epoxy composite sensor. a-b) RCR variation of the CMS/silicone/epoxy composite sensor to 5 (a), 10 (b) and 1000 kPa (c) at 23 °C; d-e) RCR variation of the CMS/silicone/epoxy composite sensor to 250 kPa (d) and 1000 kPa (e) at 40 °C; (f) RCR variation of the CMS/silicone/epoxy composite sensor to 1000 kPa at 60 °C; g-j) RCR variation of the CMS/silicone/epoxy composite sensor to 5 (g), 100 (h), 500 (i) and 1000 kPa (j) at 10 V; k-l) RCR variation of the CMS/silicone/epoxy composite sensor to 1 (k) and 1000 kPa (l) at 15 V.



**Fig. S5.** Effective working pressure ranges of the CMS/silicone/epoxy composite sensor at different temperatures and voltages.



**Fig. S6.** Durability tests for the CMS/silicone/epoxy composite sensor over 2000 cycles of loading-unloading. a) RCR response to 1000 kPa at 23 °C; b) RCR response to 100 and 500 kPa at 60 °C.



**Fig. S7.** Response time of the CMS/silicone/epoxy composite sensor at the voltage of 15 V.

**Table S1.** Force and the corresponding pressure generated by human motions.

| Movement type                 | Force (N) | Pressure (kPa*)             |                            |                             |  | Refs. |
|-------------------------------|-----------|-----------------------------|----------------------------|-----------------------------|--|-------|
|                               |           | Finger (2 cm <sup>2</sup> ) | Fist (20 cm <sup>2</sup> ) | Foot (250 cm <sup>2</sup> ) | Artery of the wrist (0.5 cm <sup>2</sup> ) |       |
| Pulse                         | 0.75      | /                           | /                          | /                           | 15   | [1]   |
| Poking , Pressing             | 40-50     | 200-250                     | 20-25                      | /                           | /  | [2]   |
| Gripping                      | 370       | /                           | 185                        | /                           | /  | [2]   |
| Tapping on the screen         | 2-4       | 10-20                       | /                          | /                           | /  | [3]   |
| Punching (the lead hand)      | 1600-2900 | /                           | 800-1450                   | /                           | /  | [4]   |
| Pushing, Pulling              | 200-500   | /                           | 100-250                    | /                           | /  | [5]   |
| Walking                       | 500-1000  | /                           | /                          | 20-40                       | /  | [6]   |
| Running (downhill and uphill) | 700-1800  | /                           | /                          | 28-72                       | /  | [7]   |

\* The corresponding pressure values were calculated according to the assumed acting area in terms of the forces reported in the references.

**Table S2.** Comparison of the sensing performance of flexible pressure sensors.

| Sensor  | Lower limit (kPa)    | Upper limit (kPa)   | Sensitivity (kPa <sup>-1</sup> )   | Refs.               |
|---|----------------------|---------------------|--|---------------------|
| PDMS / Ti /Au   | 1.5×10 <sup>-3</sup> | 40                  | 14.286 (<0.7 kPa)<br>0.032 (0.7-40 kPa)  | [8]                 |
| GO/Laser-Scribed Graphene   | 0                    | 113                 | 0.96 (<50 kPa)<br>0.005 (50-113 kPa)   | [9]                 |
| Ecoflex/CNTs  | 0.1×10 <sup>-3</sup> | 130                 | 0.601 (<5 kPa)<br>0.077 (30-130 kPa)   | [10]                |
| PDMS/PPDL   | 0                    | 35                  | 44.5 (<100 Pa)   | [11]                |
| PVA/Ti <sub>3</sub> C <sub>2</sub> T <sub>x</sub> /MXene                    | 2×10 <sup>-3</sup>   | 250                 | 5.5 (<30 kPa)<br>1.5 (30-250 kPa)  | [12]                |
| PVA/Hollow Polyaniline Spheres-Phytic Acid                                  | -                    | 0.1                 | 3.6  | [13]                |
| Chitosan-Poly (hydroxyethyl acryla-mide) Double-Network/Na <sub>3</sub> Cit | -                    | 3.5×10 <sup>3</sup> | 0.023 (<136 kPa)<br>0.002 (136-1140 kPa)<br>0.224×10 <sup>-3</sup> (1140-3230 kPa) | [14]                |
| Polyacrylic Acid /Sodium Alginate/CNTs/Ca <sup>2+</sup>                     | -                    | 3                   | 1.25 (<0.3 kPa)<br>0.46 (0.3-1.8 kPa)<br>0.07 (1.8-3.0 kPa)                        | [15]                |
| Ecoflex/CIP/CS  | 70×10 <sup>-3</sup>  | 330                 | 0.055 (0-2 kPa)  | [16]                |
| Sponge/rGO/polyaniline  | -                    | 27                  | 0.152  | [17]                |
| <b>CMS/silicone/epoxy composite sensor</b>                                  | <b>1</b>             | <b>2110</b>         | <b>11.5×10<sup>-2</sup> (0-100 kPa)</b>  | <b>Present work</b> |

**Table S3.** Sensitivity of the CMS/silicone/epoxy composite sensor at different

temperatures or voltages in the pressure range of 0 to 100 kPa.

| Condition | Sensitivity (kPa <sup>-1</sup> ) |
|-----------|----------------------------------|
| 23 °C     | $2.1 \times 10^{-2}$             |
| 40 °C     | $7.2 \times 10^{-2}$             |
| 60 °C     | $8.8 \times 10^{-2}$             |
| 5 V       | $3.1 \times 10^{-2}$             |
| 10 V      | $8.6 \times 10^{-2}$             |
| 15 V      | $11.5 \times 10^{-2}$            |

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