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


Supplementary Information

# Soft elastomeric composite materials with skin-inspired mechanical properties for stretchable electronic circuit

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## Supplementary Figures

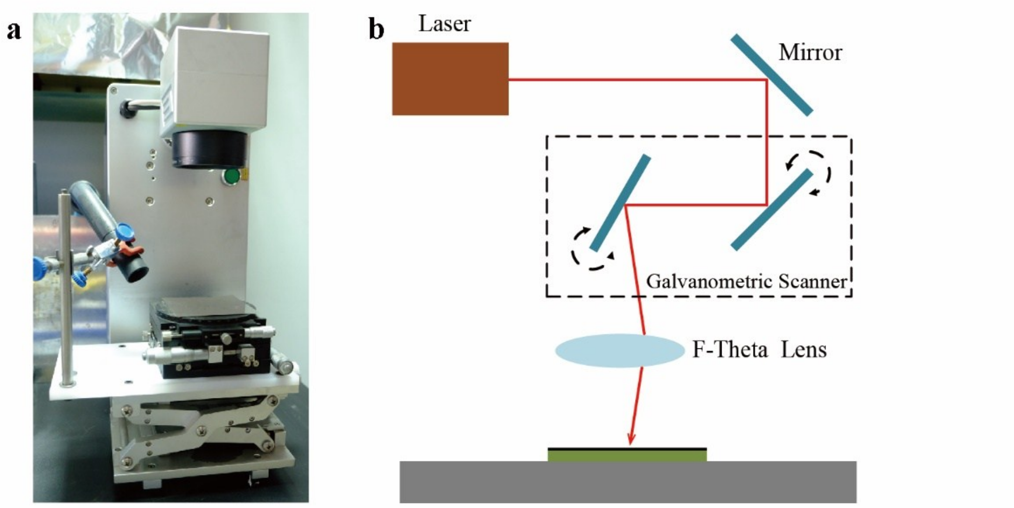


**Figure S1.** (a) Optical image of experimental set-up for laser micromachining. (b) Schematic illustration of the laser marking system.

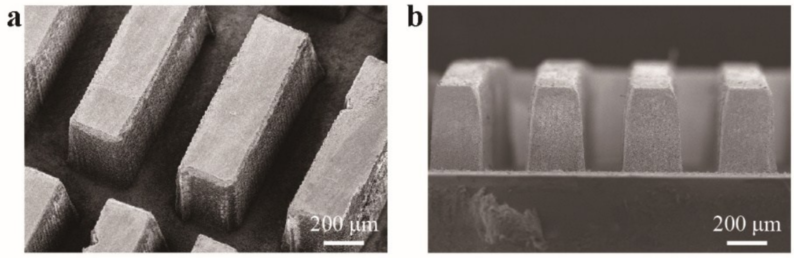


**Figure S2.** SEM images of micropillars generated by laser micromachining.

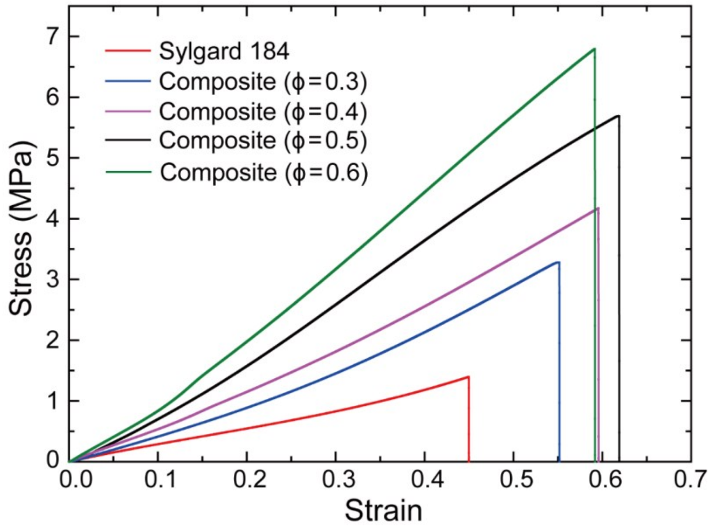


**Figure S3.** Influence of the compositions on tensile properties of elastomeric composites. The ratio between carbon black and Sylgard 184 base (ϕ) is varied from 0.3 to 0.6, whereas the base to crosslinker ratio is fixed as 5:1. All materials are thermally cured at 100 ℃ for 3h. The stress-strain curve of pristine Sylgard 184 is displayed for comparison.

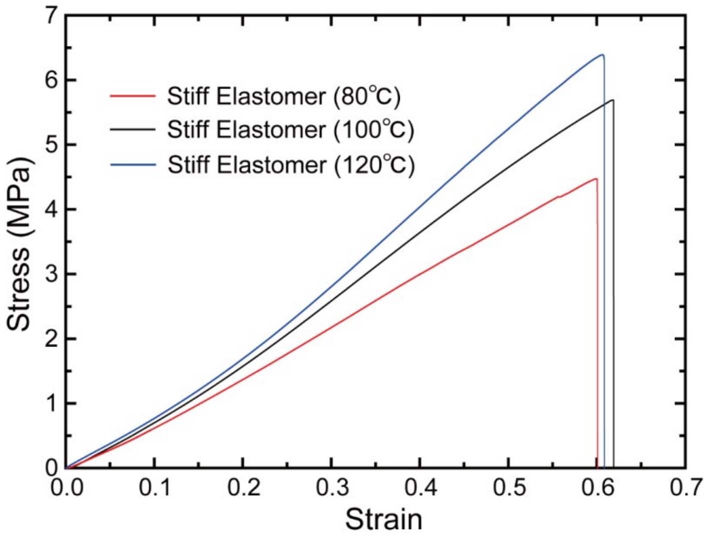


**Figure S4.** Influence of curing temperatures on tensile properties of stiff elastomer (carbon black/Sylgard 184 base = 0.5). The composites are all thermally cured for 3h.

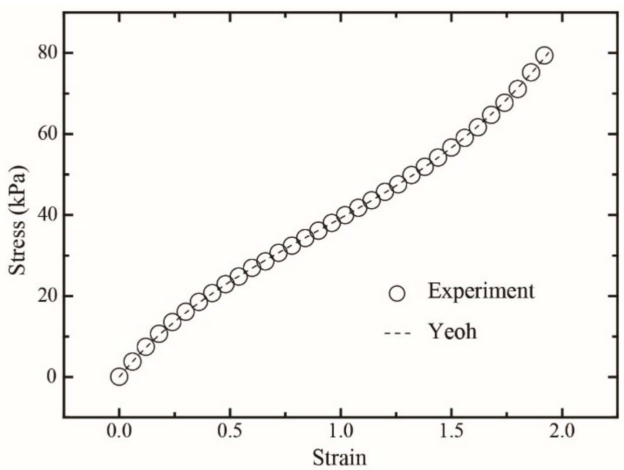


**Figure S5.** Experimental stress versus strain for soft elastomer under uniaxial stretching. The tensile response is well captured by a Yeoh hyperelastic constitutive model ($C_1$=11.25×10$^3$ Pa, $C_2$=-0.124×10$^3$ Pa, $C_3$=3.753×10$^1$ Pa).


**Figure S6.** Optical image of soft elastomer in response to 250 g weight. Original dimension of the elastomer is marked by the dashed line.

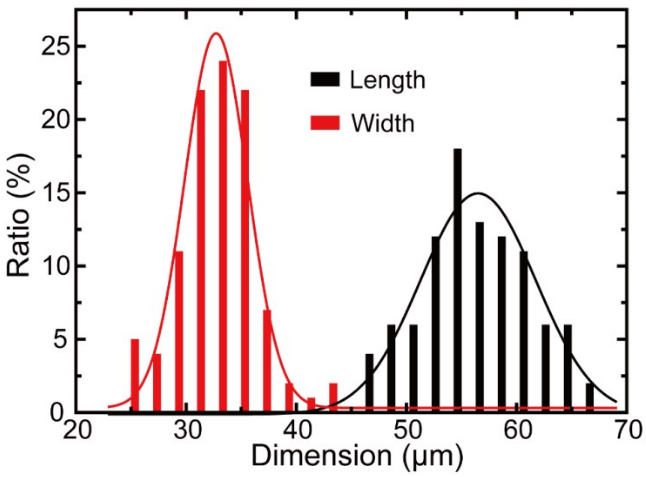


**Figure S7.** Histograms of length and width distributions for Galinstan microparticles in classic droplet shape. Gaussian fits to the distributions (smooth curves) yield the dimension of microparticles as 32.7±2.9 μm × 56.5±5.2 μm.

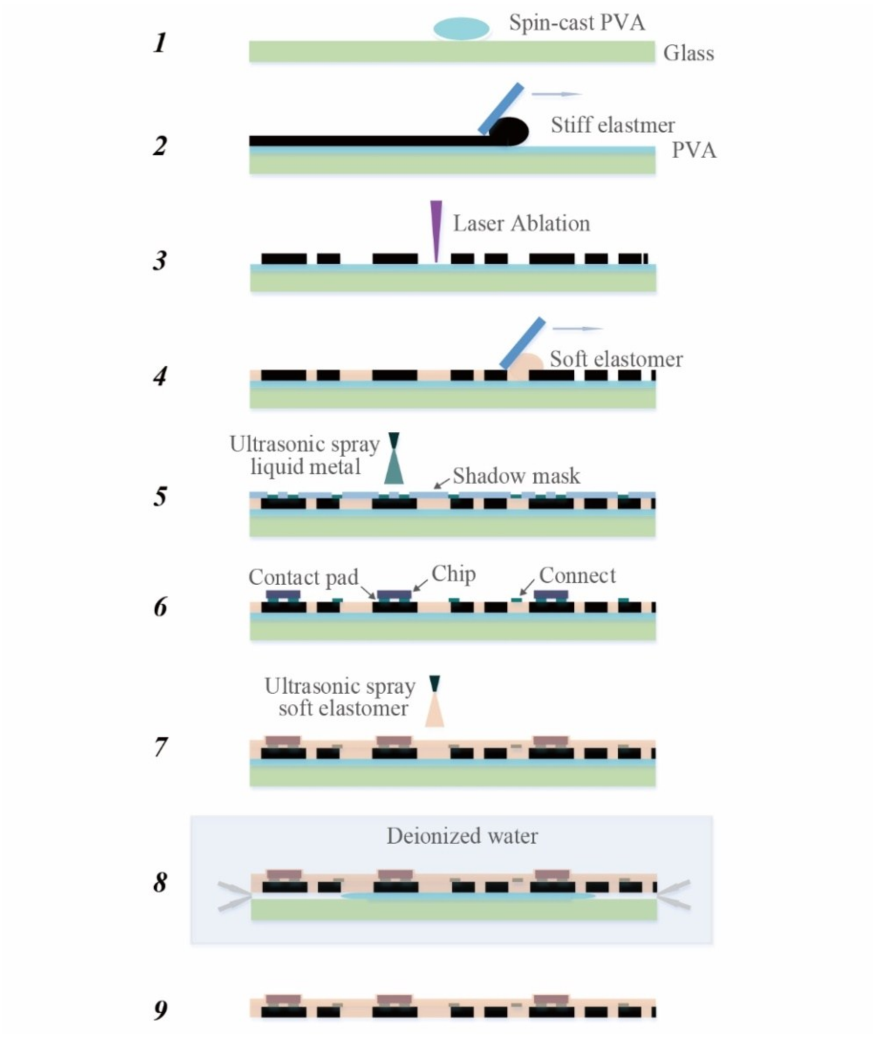


**Figure S8.** Schematic illustration of the fabrication process flow for stretchable electronic circuit.

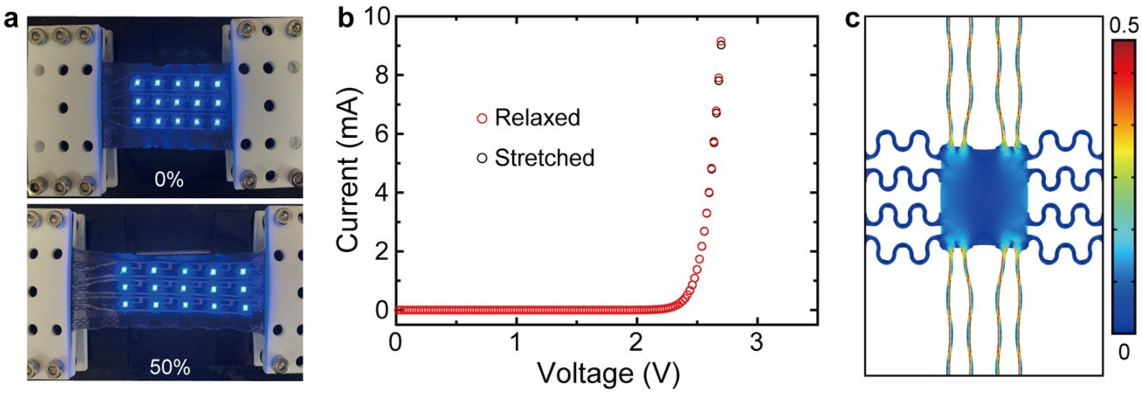


**Figure S9.** a) LED matrix operates under 0 and 50% tensile strain, respectively. b) Current-voltage curve for an array of 5 LEDs in series at relaxed and stretched (50% strain) states. c) Computational morphology and strain distribution (denoted by color) of embedded elastomeric structure within the composite under 50% tensile strain.

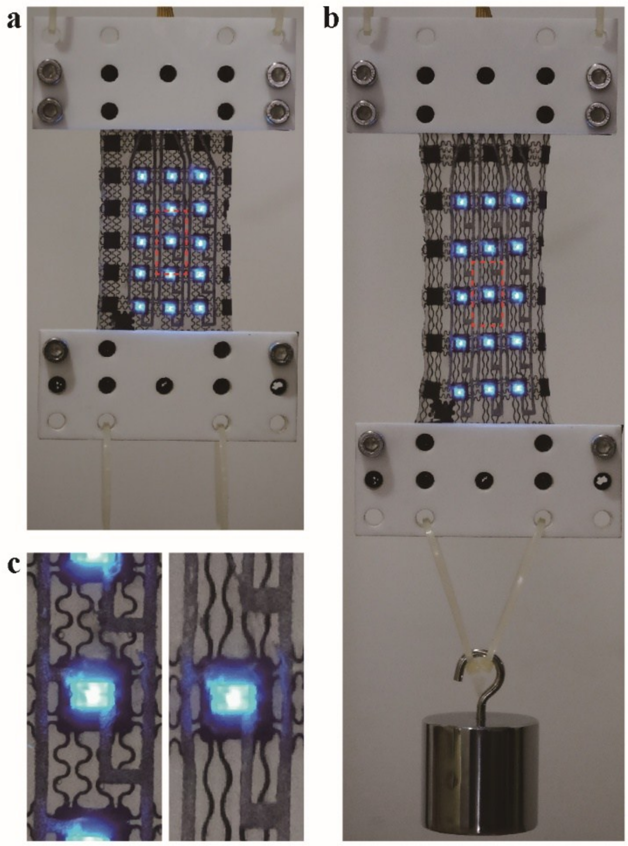


**Figure S10.** (a) Stretchable electronic circuit prototype in the form of an LED matrix operating at relaxed state. (b) Deformed LED matrix with 300 g weight. (c) Magnified images (corresponding to regions marked by red dashed line) to reveal the deformations of stiff elastomer to modulate the mechanical behaviors of the composite.

## Supplementary Tables

**Table S1.** Mechanical properties of elastomeric composites with varying chemical compositions. ϕ represents the weight ratio between carbon black and Sylgard 184 base.

| ϕ | Modulus (MPa) | Fracture strain （%） |
|---|---|---|
| 0 | 2.89±0.30 | 45±8 |
| 0.3 | 4.21±0.21 | 55±6 |
| 0.4 | 6.87±0.15 | 60±10 |
| 0.5 | 7.30±0.20 | 62±12 |
| 0.6 | 8.10±0.62 | 59±12 |

**Table S2.** Mechanical properties of stiff elastomer (carbon black/Sylgard 184 base = 0.5) with different curing temperatures.

| Curing temperature (℃) | Modulus（MPa） | Fracture strain （%） |
|---|---|---|
| 80 | 6.32±0.32 | 60±8 |
| 100 | 7.30±0.20 | 62±12 |
| 120 | 7.55±0.45 | 61±11 |

## Supplementary Videos

**Video S1.** Direct patterning of Nanjing University logo over stiff elastomer by laser ablation.

**Video S2.** The operation of a stretchable LED Matrix under repetitive stretching from 0 to 35% strain.

**Video S3.** Dynamic deformation process of a stretchable LED Matrix in response to 200 g weight.