Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.

Supplementary Information

Strain-invariant conductance in elastomeric nanocomposite mesh conductor for stretchable electronics

*Jiachen Wang, Kuikui Zhang, Jing Wang, Menghu Zhang, Yunlei Zhou, Jing Cheng, Desheng Kong**

College of Engineering and Applied Sciences, National Laboratory of Solid State Microstructure, Collaborative Innovation Center of Advanced Microstructures, and Jiangsu Key Laboratory of Artificial Functional Materials, Nanjing University, Nanjing 210093, China.

*Correspondence should be addressed to: dskong@nju.edu.cn

Supplementary Figures

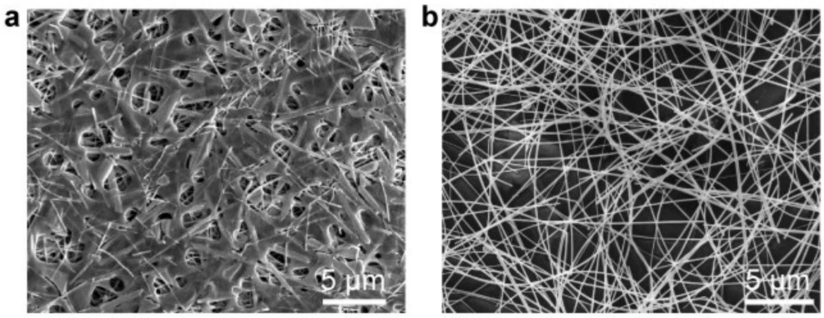

Figure S1. a) SEM image of a stretchable AgNW/TPU conductor by the preparation procedure established in this study. b) SEM image of spray-deposited AgNW network over a TPU substrate. The silver nanowires are partially embedded in the TPU film, which is ascribed to the infiltration of TPU precursor into the pores of AgNW network during spin-coating process. The microstructure is in sharp contrast with spray-deposited silver nanowires that covers the surface of the TPU film.

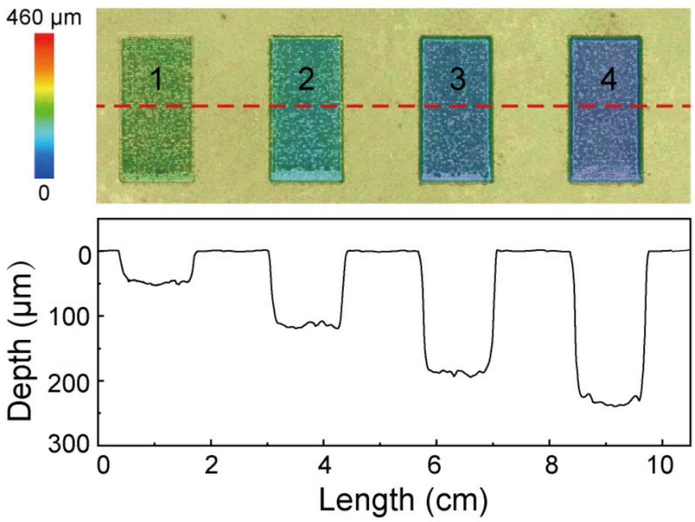

Figure S2. 3D optical reconstruction and height profile (corresponding to the red dashed line in the image) of an array of rectangular grooves fabricated over the AgNW/TPU nanocomposite with different numbers of laser passes (labelled in black) with power settings at 15W and a scan speed of 2000 mm s^{-1}.

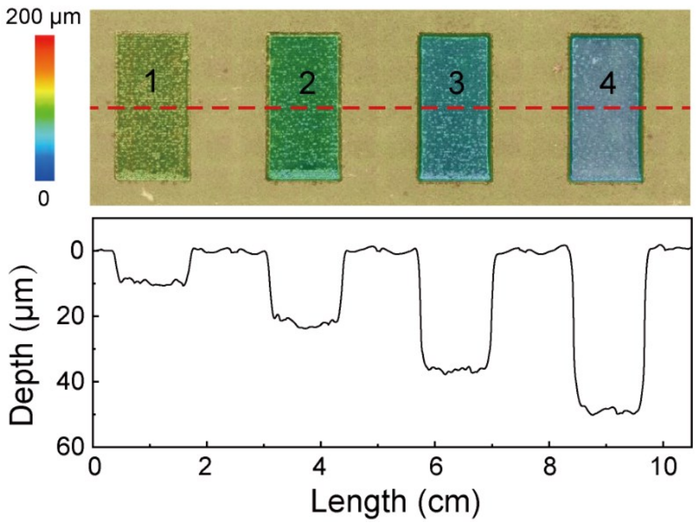

Figure S3. 3D optical reconstruction and height profile (corresponding to the red dashed line in the image) of an array of rectangular grooves fabricated over the AgNW/TPU nanocomposite with different numbers of laser passes (labelled in black) with power settings at 0.03W and a scan speed of 2000 mm s^{-1}.

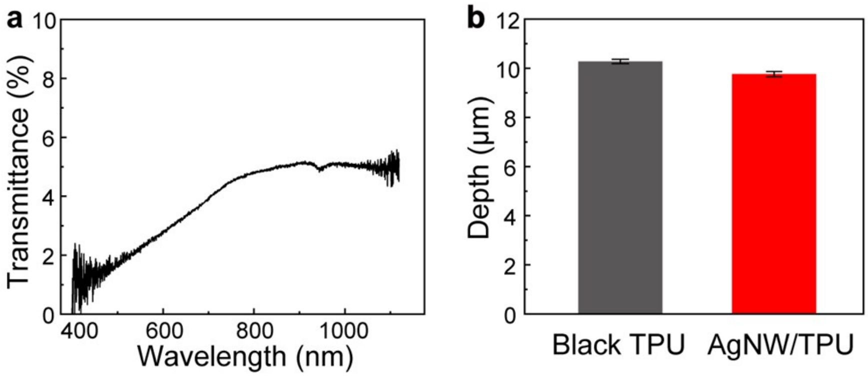

Figure S4. a) Transmittance spectrum of AgNW percolation network with an area density of 1.2mg/mm^2. b) Thickness loss as a result of laser ablation for black TPU and AgNW/TPU nanocomposite (laser power = 15W, scan speed = 2000 mm/s). The presence of AgNWs gives rise to negligible influence on the ablation depth, thereby confirming the subtractive patterning of AgNWs through engraving underlying substrate.

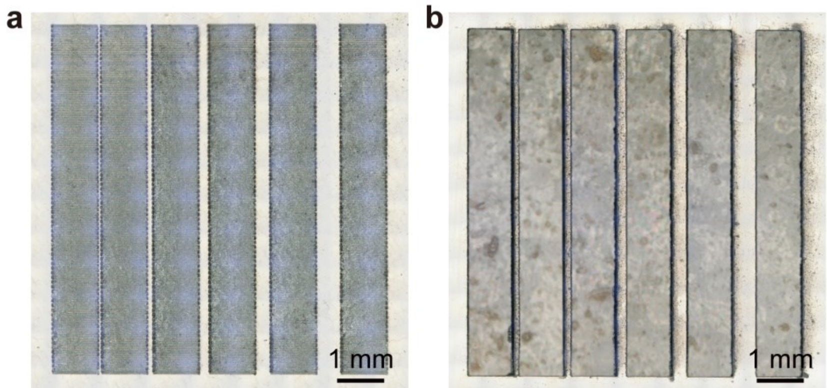

Figure S5. Feature resolution by laser ablation. a) Optical microscope image of the solid pattern to define an array of lines with various widths, which reveals the minimal line width of ~40 μm of the solid structure. b) Optical microscope image of the hollow pattern, which reveals the minimal line width of ~80 μm of the hollow structure.

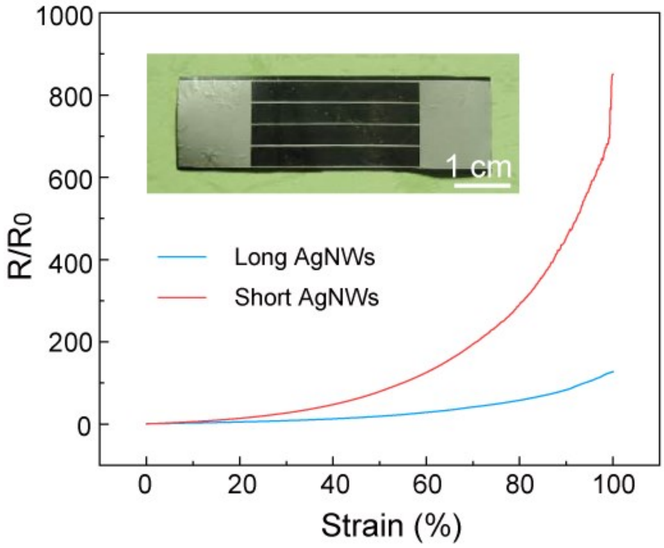

Figure S6. Change in resistance as a function of tensile strain for AgNW/TPU conductor based on short and long AgNWs, respectively. Inset: Optical image of the measurement sample in the form of parallel lines of 300 μm in width. Stretchable conductors based on long AgNWs exhibit increased resistance by ~20 times at 50% strain, whereas the conductors based on short AgNWs show more pronounced increase of the resistance up to ~79 times at 50% strain.

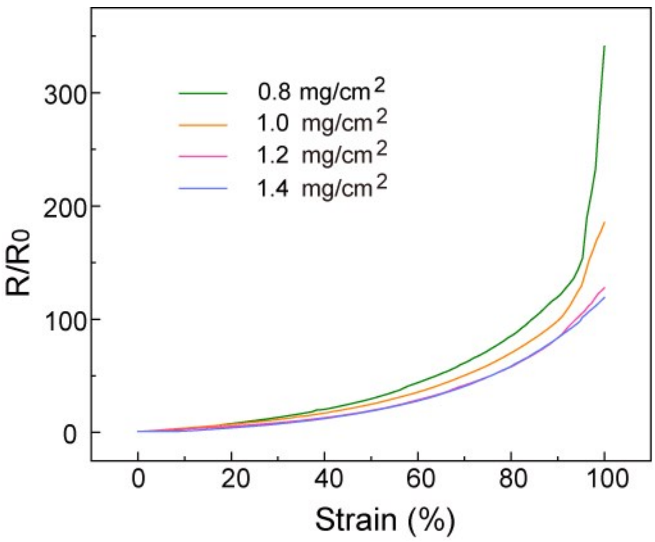

Figure S7. Change in resistance as a function of tensile strain for AgNW/TPU conductors in the form of straight lines, which consists of long AgNWs with varying area density of 0.8, 1.0, 1.2 and 1.4 mg/cm^2. Area density is demonstrated as another key fact that influences their electrical performance. The change of nominal resistance in deformed conductor decreases by increasing the area density of AgNWs and reaches saturation until an area density of 1.2 mg/cm^2.

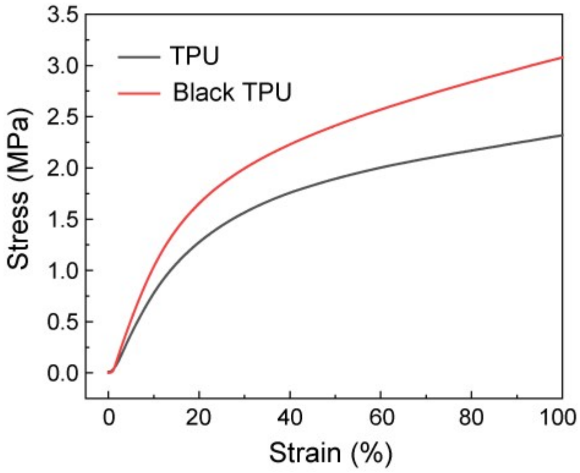

Figure S8. Strain-stress curves of TPU and black TPU under uniaxial tension.

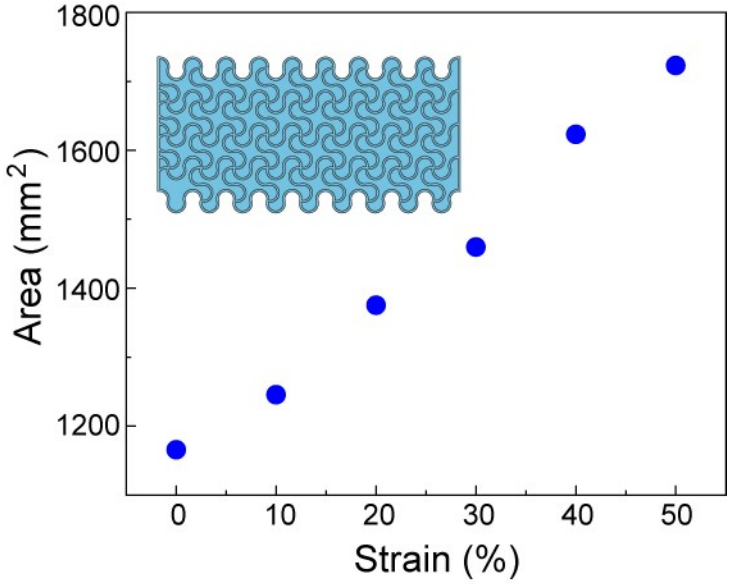

Figure S9. Geometric area as a function of tensile strain for the hollow mesh heater according to finite element analysis. Inset: Schematic illustration of the region (marked in blue) for the area calculation.

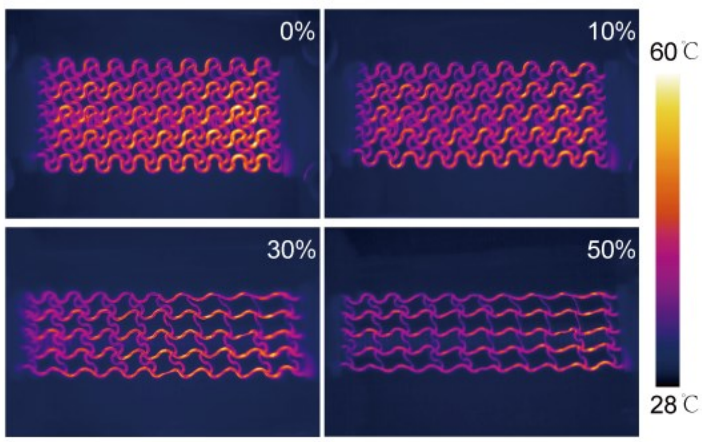

Figure S10. Infrared (IR) camera images of a hollow mesh heater powered by an applied voltage of 2.0 V under tensile strains of 0, 10, 30, and 50%, respectively.

Supplementary Tables

Table S1. Physical properties of stretchable conductors

Conductive composites	ΔR/R0	Strain	Approach	References
GO[1]-AgNW/PUA[2]	220%	40%	bottom-up	25
	960%	80%		
AgNW coated TPU	2800 %	100%	bottom-up	19
buckled PUS[3]-AgNW conductor	80%	50%	bottom-up	16
Zn–Bpy[4]–PDMS/AgNWs	180%	60%	bottom-up	17
Ag/PDMS	20%	50%	bottom-up	21
CuNWs/PDMS	150%	50%	bottom-up	22
	700%	70%		
PU-AgNPs/GNPs threads	900%	50%	bottom-up	23
AgNW/TPU serpentine mesh	20% 173%	50% 100%	top-down	This work

1. Graphene oxide
2. Polyurethane acrylate
3. Polyurethane sponges
4. Bipyridine