Highly stretchable and conductive composite based on emulsion-templated silver nanowire Aerogel

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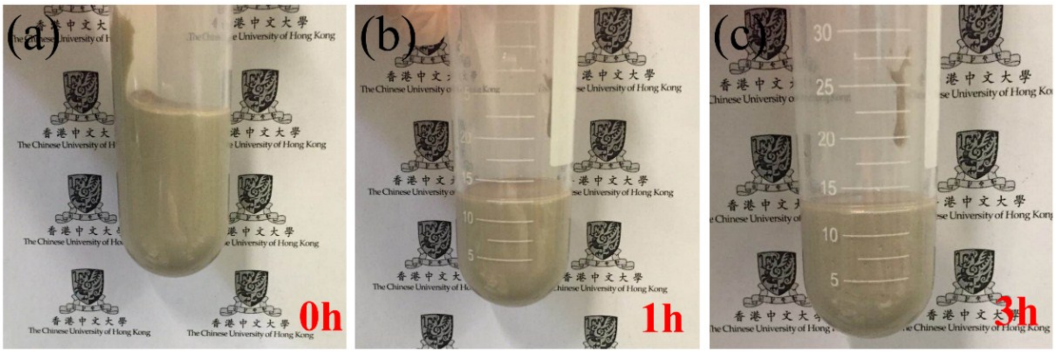

Figure S1 Photograph of emulsion (Ag NW/PVA and cyclohexane) at different interval

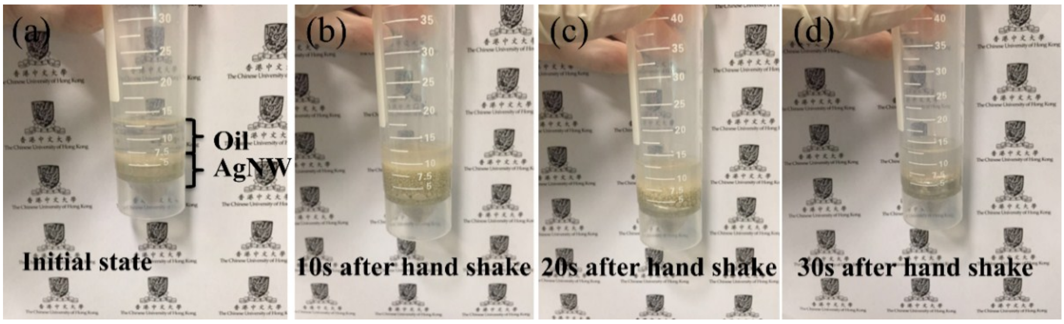

Figure S2 Photograph of mixture of Ag NW solution and oil (cyclohexane) at the different interval after handshake

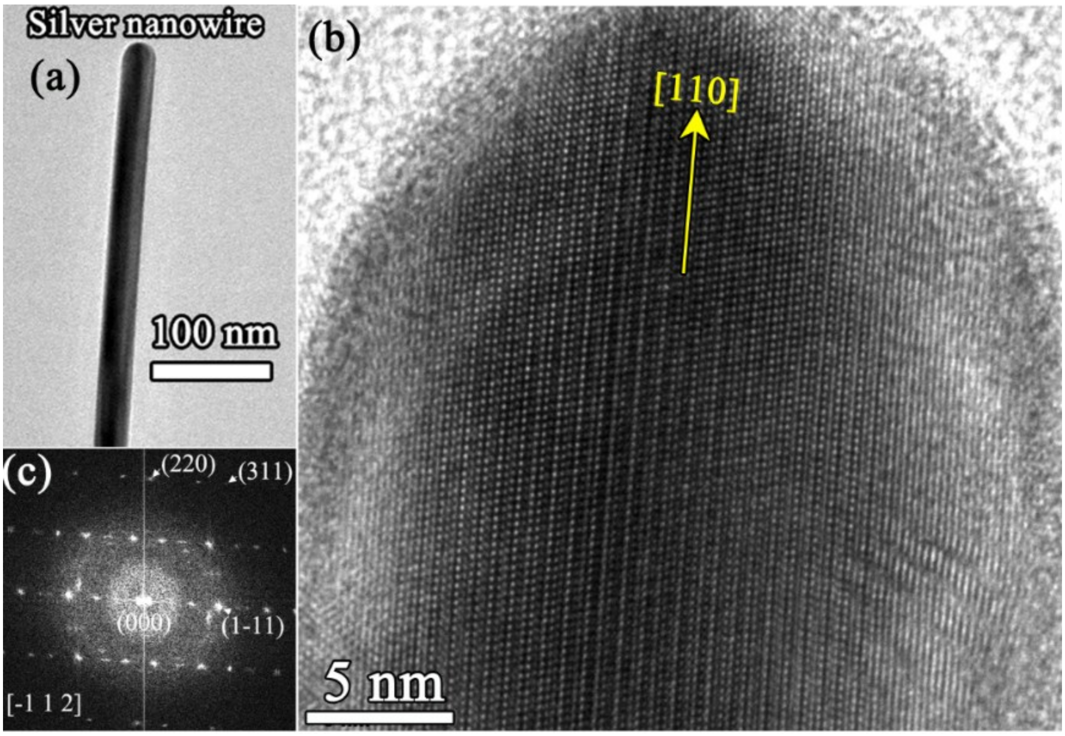

Figure S3 (a) TEM image of Ag NW, (b) high-resolution TEM image of AgNW, and (c) fast Fourier transformation of image (b)

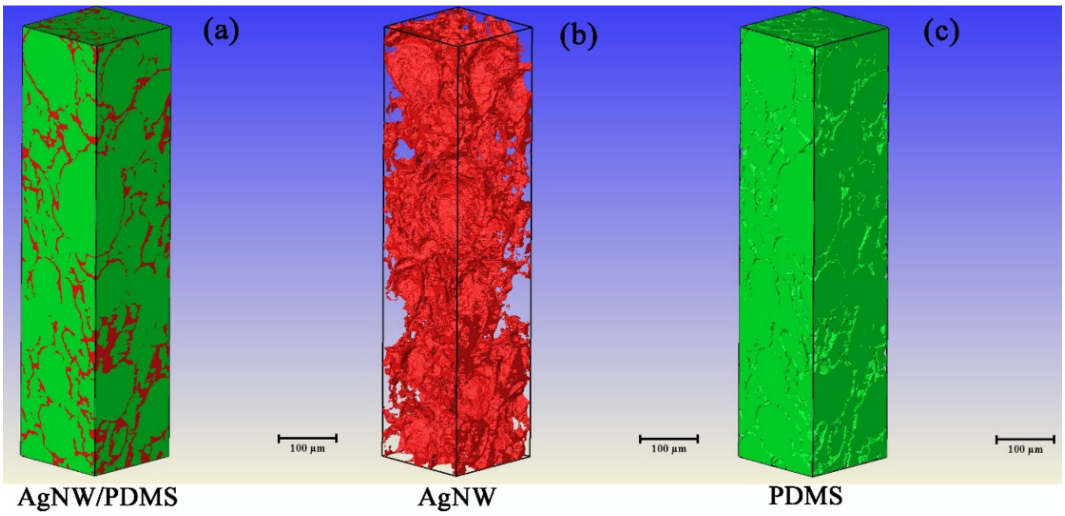

Figure S4 XRT image of (a) Ag NW/PDMS composite (b) Ag NW skeleton, and (c) PDMS framework (Ag NW density: 50 mg/cm^3)

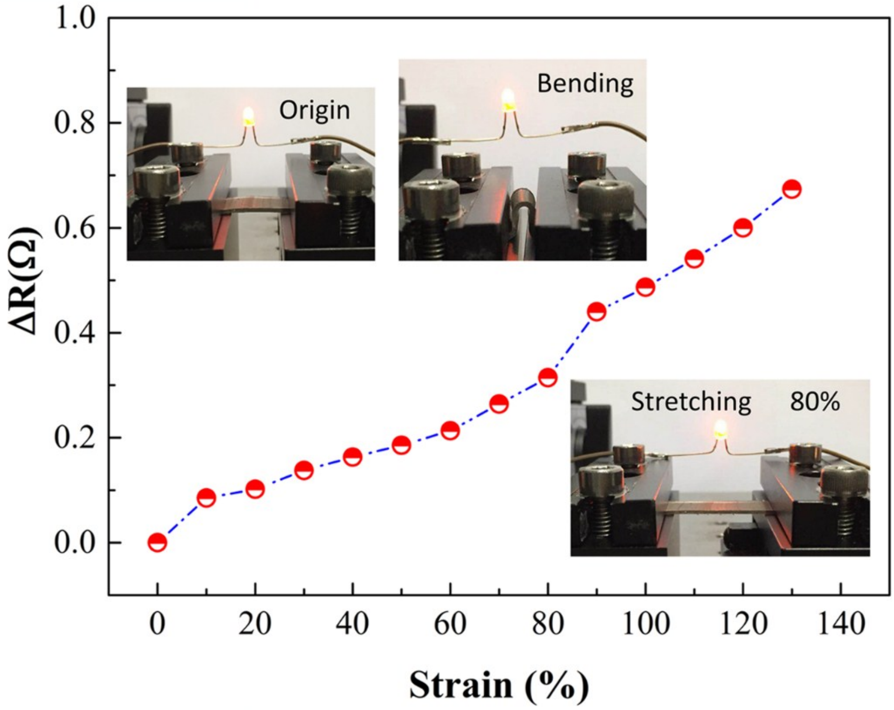

Figure S5 ΔR of AgNW/PDMS as a function of uniaxial tensile strain at a density of 50 mg/cm^3.

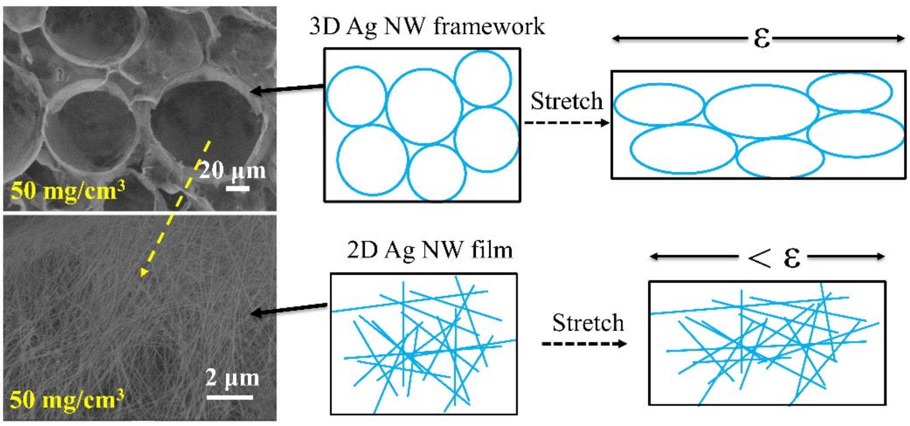

Figure S6 Illustration of effects of elongation on the Ag NW network.

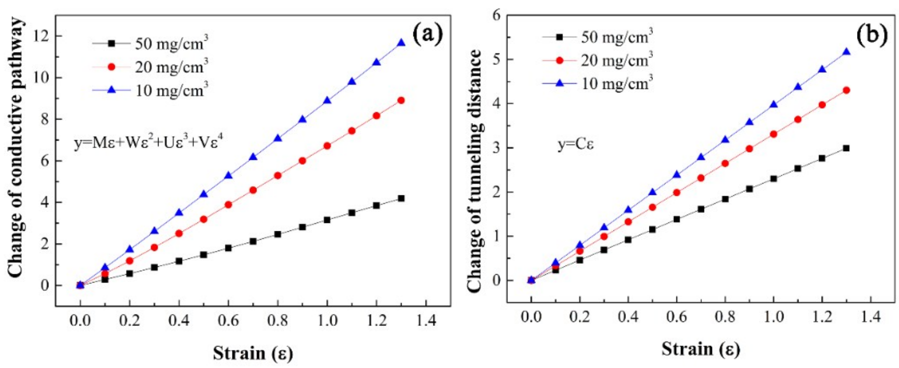

Figure S7 (a) Change of conducting pathway and (b) tunneling distance of AgNW/PDMS composites at different density as a function of tensile strain

Simmons *et al*. put forward a model to illustrate the relationship between the conductivity and strain based on tunneling theory.[S1] The resistance R of the composites can be expressed as equation S1 and S2.

$$R = \left(\frac{L}{N}\right)\left(\frac{8\pi hs}{3\gamma a^2 e^2}\right)\exp(\gamma s) \quad \text{(S1)}$$

$$\gamma = \frac{4\pi\sqrt{2m\varphi}}{h} \quad \text{(S2)}$$

Where L is the number of conductive fillers forming a single conductive path, N is the number of conducting paths, h is the Plank's constant, s is the least distance between conductive fillers, a^2 is the effective cross-section area, e is the electron charge, m is the electron mass, and φ is the height of potential barrier between adjacent fillers.[S2]

While the strain is applied to the composites, the resistance will be increased because of particle separation and the interparticle distance changes linearly and proportionally with increased strain from s_0 to s. Then, it can be expressed as follows

$$s = s_0\left[1 + C\left(\frac{\Delta L}{L_0}\right)\right] \quad \text{(S3)}$$

where ε is the tensile strain of the composites, ΔL is the elongation, L is the initial length, and C is the constant.

The number of conducting pathways can be calculated by:[S3, S4]

$$N = \frac{N_0}{\exp(M\varepsilon + W\varepsilon^2 + U\varepsilon^3 + V\varepsilon^4)} \quad \text{(S4)}$$

where M, W, U, and V are constants.

Substituting of equation S3 and S4 into equation S1 yields equation S5:

$$R = B(1 + C\varepsilon)\exp[A + (2M + AC)\varepsilon + 2W\varepsilon^2 + 2U\varepsilon^3 + 2V\varepsilon^4] \quad \text{(S5)}$$

Through fitting the curve of resistance vs strain, the parameters can be obtained as shown in

Table S1. Then the change of the conductive pathway ($M\varepsilon + W\varepsilon^2 + U\varepsilon^3 + V\varepsilon^4$) and change of tunneling distance ($C\varepsilon$) can also be extracted as plotted in Figure S7.

Table S1 Fitted parameters in Equation S5 for AgNW/PDMS composites (AgNW density: 10, 20, and 50 mg/cm^3)

	A	B	C	M	U	V	W
10 mg/cm^3	-4.54	213.01	3.97	8.46	-0.74	0.28	0.88
20 mg/cm^3	-4.29	100.50	3.31	5.45	-2.10	0.64	2.73
50 mg/cm^3	-3.04	14.89	2.30	2.86	0.73	-0.34	-0.10

References

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