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Supporting Information

All-Printed, Tunable Sensing Range Strain Sensors Based on Ag Nanodendrites Conductive Ink for Wearable Electronics

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Table S1. Viscosity of various Ag NDs inks at different shear rates.

	0.1 s^{-1} @ Avg. (0-30 s)	200 s^{-1} @ Avg. (30-60 s)	0.1 s^{-1} @ 61 s	Recovery @ 61 s	0.1 s^{-1} @ 70 s	Recovery @ 70 s
Ag NDs Ink-55 wt.%	504.6 Pa s	0.78 Pa s	316.3 Pa s	62.7%	480.4 Pa s	95.2%
Ag NDs Ink-50 wt.%	33.9 Pa s	0.73 Pa s	2.7 Pa s	8%	21.8 Pa s	64.3%
Ag NDs Ink-45 wt.%	1.3 Pa s	0.29 Pa s	0.34 Pa s	26.3%	0.63 Pa s	48.5%

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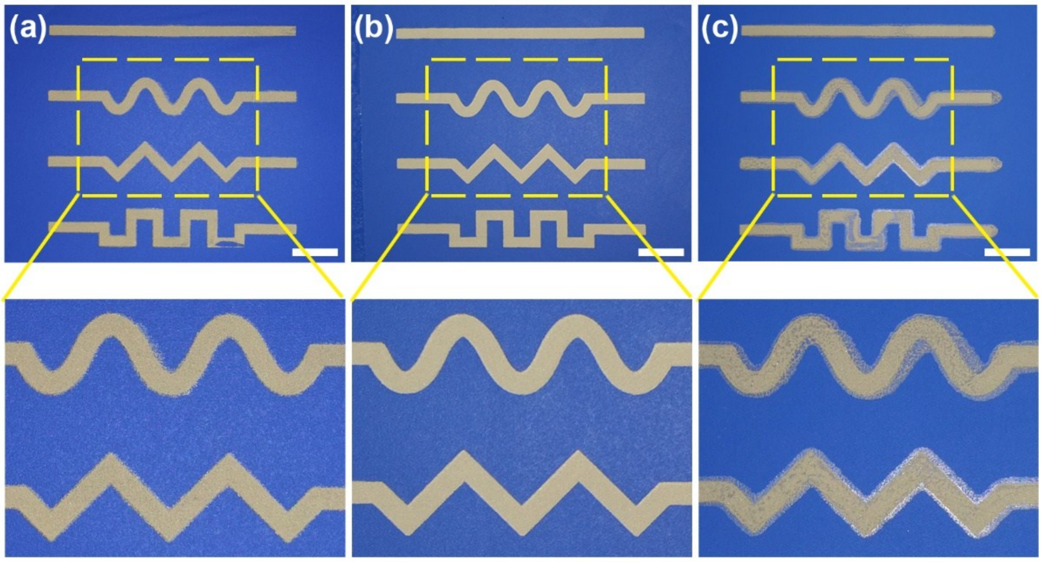

Figure S1. (a), (b) and (c) Optical photographs and corresponding magnified photographs of Ag NDs patterns printed from Ag NDs ink-55 wt.%, Ag NDs ink-50 wt.%, Ag NDs ink-45 wt.%, respectively, and the printing substrate is nitrile rubber (scale bar is 1 cm).

Table S2. Comparison of the solid content of the conductive materials, drying condition and conductivity of the conductive pattern.

Filler specifications	Polymer matrix	Solid content	Conductivity ($S\ m^{-1}$)	Reference
Ag platelet, 1.2-2.2 μm	PDMS	86 wt.%	3×10^4	[1]
Ag coated Cu flakes, 10% Ag	PDMS	83wt.%	6.7×10^4	[2]
Ag powder；1-3 μm	PDMS	82 wt.%	2.3×10^4	[3]
Ag powder, 2-3.5 μm	PDMS	79.3 wt.%	600	[4]
Ag powder, 2 μm	PDMS	73 wt.%	8.3×10^3	[5]
Ag Flake	Paper	70 wt.%	5.26×10^4	[6]
Ag coated polystyrene nanospheres (PS@Ag), ~600 nm, 90 wt% Ag	P(St-BA) latex	60 wt.%	$6.96 \pm 1.19 \times 10^4$	[7]
Ag flakes	PDMS	56 wt.%	7.38×10^4	[8]
Ag coated polystyrene microspheres (PS@Ag), 2-11 μm	PDMS	42.8 wt.%	4.12×10^4	[9]
PEDOT	PUF	30 wt.%	4.7×10^2	[10]
SWCNT	PDMS	10 wt.%	108	[11]
Ag NDs	Nitrile rubber	50 wt.%	1.14×10^5	This work

The formula for calculating the conductivity;

$$R_{\square} = R_x \times F\ (D/S) \times F\ (W/S) \times F_{sp} \tag{1}$$

$$\sigma = 1/R_{\square} \times W \tag{2}$$

where $R_{\square}$ is the sheet resistance, R_x is the resistance measured by low resistance tester, D is the sample diameter, S is the average probe distance, W is the sample thickness, F_{sp} is the probe spacing correction factor, F (D/S) is the sample diameter correction factor, F (W/S) sample thickness correction factor, σ is the conductivity.

In this work, the average R_x measured is 0.053 Ω; F (D/S) is 4.171, F (W/S) is 1, F_{sp} is 0.995, Selected by the instrument's Schedule; W is 40.64 μm.

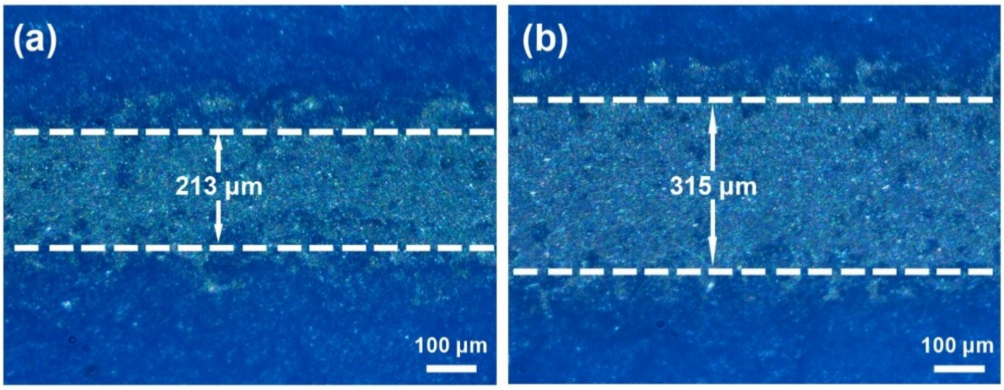

Figure S2 Optical micrograph of printed traces with line widths of 200 μm (a) and 300 μm (b).

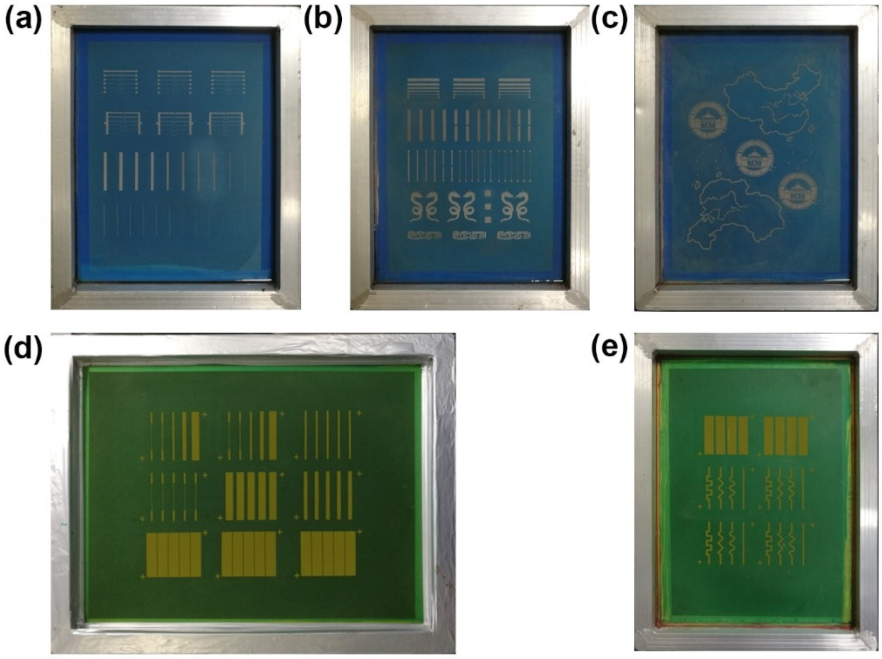

Figure S3. Optical photographs of screen-printing plates.

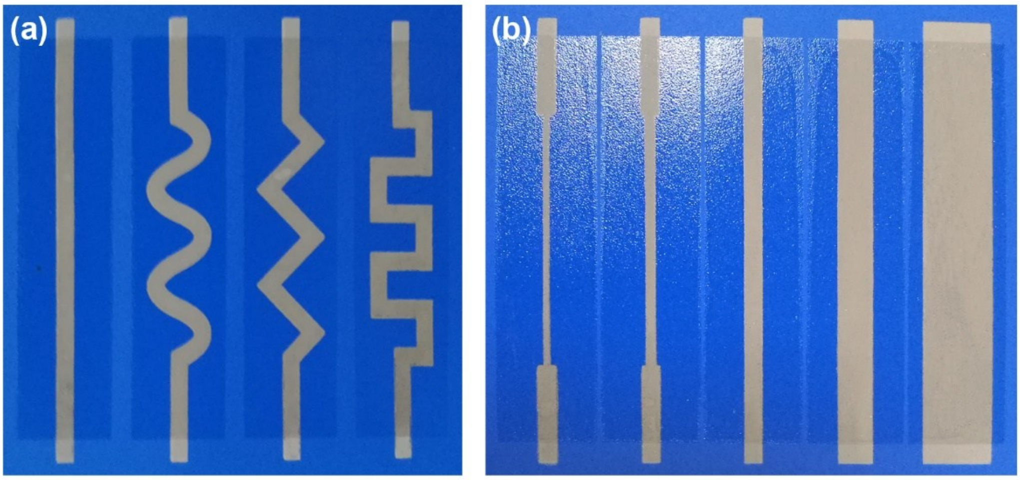

Figure S4. Optical photographs of PSSs with different line-types (a) and line-widths (b).

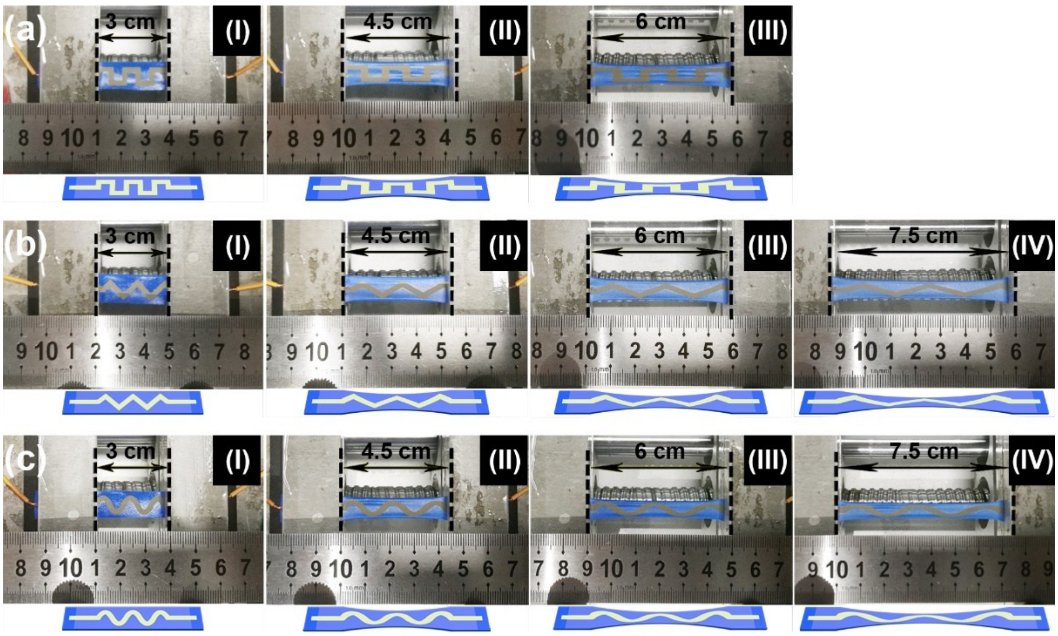

Figure S5. Optical photographs of PSSs with different line-types (rectangular wave (a), zigzag (b), sinusoid (c)) under 0% (I), 50% (II), 100% (III), and 150% (IV) strain, respectively.

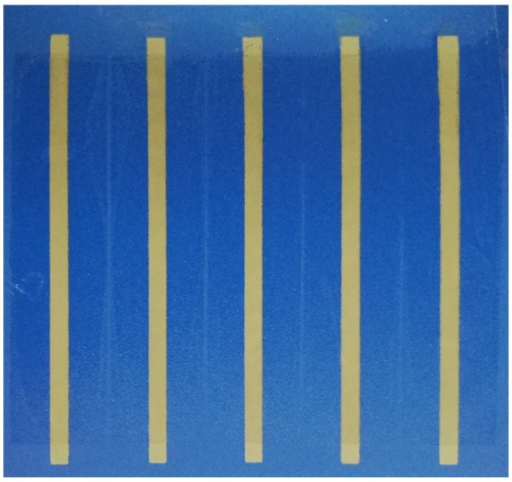

Figure S6. Optical photograph of multiple PSSs obtained simultaneously.

Table S3. Comparison of the manufacturing method of strain sensors and their sensing performance.

Materials	Manufacturing method	Workable strain range	Maximum gage factor	Fastest response time	Reference
Gold nanofilms/Paper	Direct-current sputtering method	0.59%	75.8 (0-0.59%)	20 ms (0.11%-0.12%)	[12]
CNTs/PDMS	Mold	25%	15 (15%-25%)	Not shown	[13]
Ag NWs/PDMS	Glass mold	70%	14 (30%)	200 ms (90%)	[14]
Carbon black/PDMS	Mold	80%	5.5 (0-10%)	Not shown	[15]
Ag flake/ Nanoparticle/PDMS	Patterned tape	80%	7.1 (80%)	Not shown	[16]
Fragmented carbonized melamine sponges/PDMS	Vacuum filtration + Casting	80%	18.7 (40%-80%)	240 ms	[17]
Graphene–Nanocellulose Nanopaper/PDMS	Coating	100%	7 (100%)	Not shown	[18]
Reduced graphene oxide-based fiber	Dip-coating	100%	10 (0-1%)	＜100 ms (0.5%)	[19]
Carbonized cotton fabric/Ecoflex	Dip-coating	140%	64 (80-140%)	Not shown	[20]
Graphene/PDMS	Deposition + Coating	150%	15	Not shown	[21]
Ag NWs/ Dragon Skin	Silicon mold	150%	81 (130-150%)	Not shown	[22]
CNTs/PDMS	Spain-coating	150%	160 (0-2%)	Not shown	[23]
Ionic liquids/Ecoflex	Soft lithography + Spin coating + Injection method +Mask	200%	40 (200%)	Not shown	[24]
Ag NWs/Polyurethane	Layer-by-layer filtration	250%	70	Not shown	[25]
Reduced graphene oxide/Ecoflex	Mask + Injection method	400%	31.6 (390%-400%)	60.3 ms (80%)	[26]
Ag NDs/Nitrile rubber	Screen printing	straight line 0.5mm;	straight line 0.5mm;	18 ms (1%)	This work

50% straight line 2mm; 105% sinusoid; 170%	117.2 (50%) straight line 2 mm; 294.8 (105%) sinusoid; 488.7 (170%)

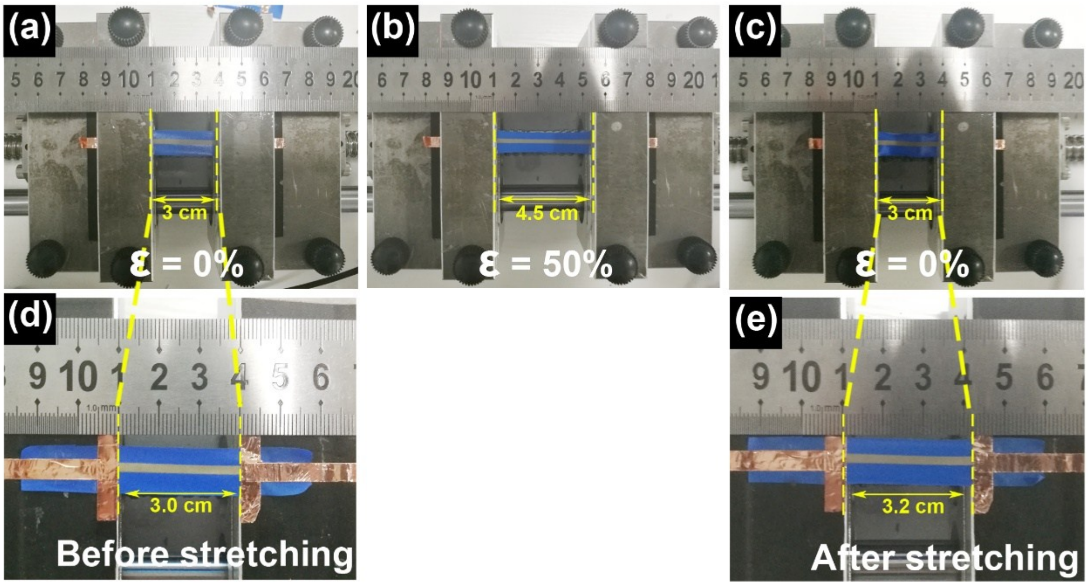

Figure S7. The change in length of the PSSs before and after 50% strains stretching.

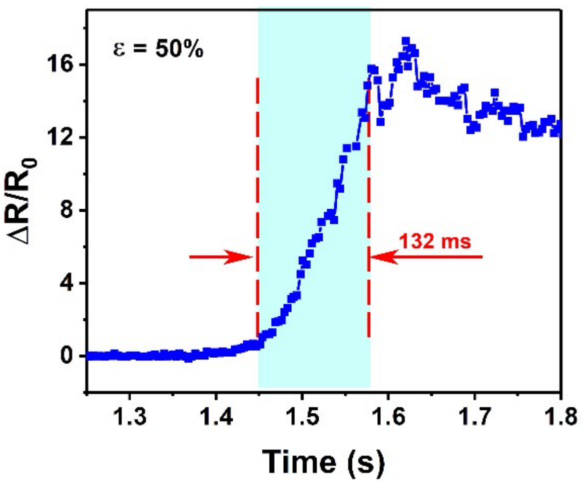

Figure S8 Time response of the PSSs ($\varepsilon = 50\%$).

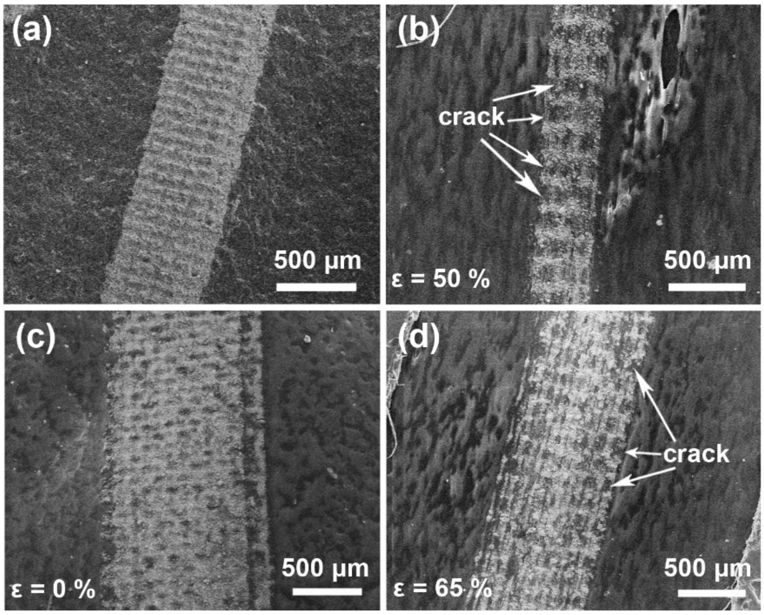

Figure S9. SEM images of the PSSs with line-widths of 0.5 mm at 0% (a) and 50% (b) strain. SEM images of the PSSs with line-widths of 1 mm at 0% (c) and 65% (d) strain.

Figure S10. Optical photograph of intelligent glove.

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