Direct Ink Writing of Graphene/CNT/Silicone Composite Strain Sensor with Near-Zero Temperature Coefficient of Resistance

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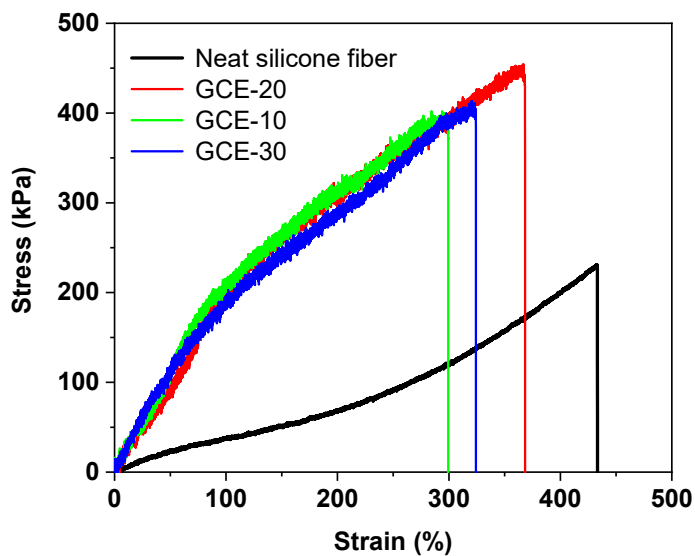
1 Supporting Figures

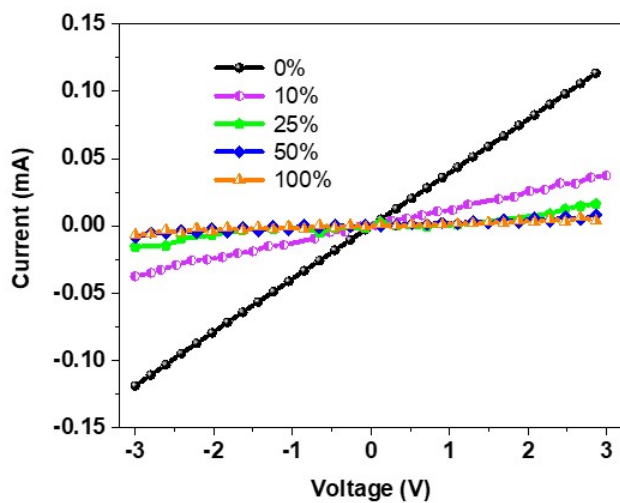Figure S1. The typical stress-strain curves of the neat silicone fiber and GCE fibers.

Figure S2. Current-voltage (I-V) curves of the GCE-20 fiber strain sensor at different strains with the voltage ranging from −3 to 3 V.
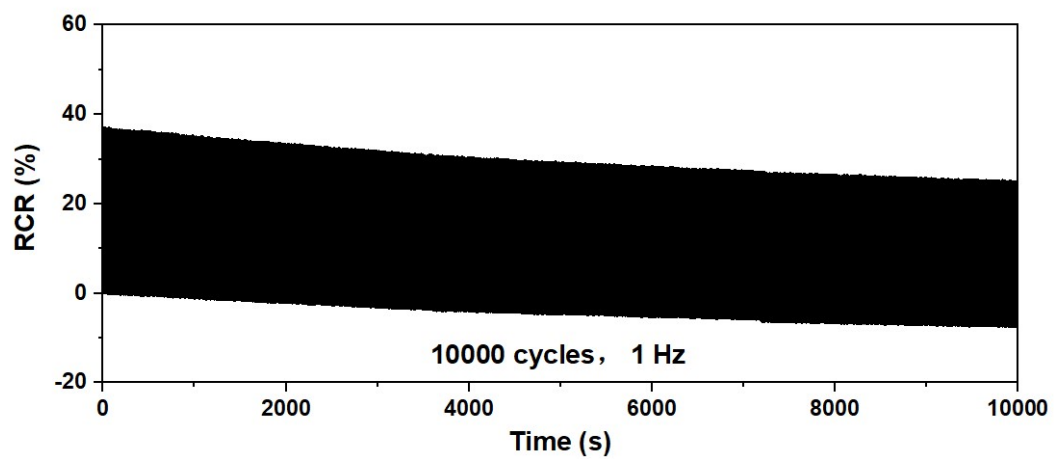
Figure S3. Long-term cyclic stability testing of the GCE fiber strain sensor under stretching-releasing cycles (10000 cycles) with a loading strain of 20%.

2 Supporting Tables

Table S1. Contents of components of the prepared inks.*

Sample	GNPs content in GNPs/CNTs hybrid fillers	Filler contents
GCE-0	0 wt%	0 wt% GNP, 2.5 wt% CNT
GCE-10	10 wt%	0.25 wt% GNP, 2.25 wt% CNT
GCE-20	20 wt%	0.5 wt% GNP, 2 wt% CNT
GCE-25	25 wt%	0.625 wt% GNP, 1.875 wt% CNT
GCE-30	30 wt%	0.75 wt% GNP, 1.75 wt% CNT
GCE-100	100 wt%	2.5 wt% GNP, 0 wt% CNT

* Note: the total mass loading of 2.5 wt% is optimized by the experiment with good electrical conductivity for the further application as characteristic content. Specially, the electrical conductivities of 0.5 wt%, 1 wt%, 2 wt%, 2.5 wt%, 3 wt% and 4 wt% GNPs/elastomer composites are about $8.58*10^{-8}$ S/m ,$1.35*10^{-4}$ S/m, 0.03 S/m, 2.38 S/m, 2.87 S/m and 3.75 S/m, respectively. And the composites with 2.5 wt% filler content have well-balanced performances between sensitivity and work stability.

Table S2. Parameters obtained by fitting RCR curves.

Parameters	C_1	C_2	C_3	C_4	C_5	C_6
GCE	0.5135	-0.2406	0.7243	$-2.384*10^{-3}$	$2.878*10^{-5}$	$-9.623*10^{-8}$

Table S3. Comparison of various stretchable strain sensors.*

Strain sensors	Tensile strain (%)	GF	Refs.
Graphene films	187	1500	[1]
CNT/silicone fibers	300	1378	[2]
	600	153	
PANI-based polymer	450	4.7	[3]
Carbonized Silk Fabric	500	37.5	[4]
CNT/PVA hydrogel	1000	1.5	[5]
Polyaniline-based hydrogel	100	2.4	[6]
PPy@TPU pruney fiber	150	3	[7]
PVA/graphene/PDMS yarn	150	1.8	[8]
MXene/CNT	130	772	[9]
Gold/PDMS fiber	120	33	[10]
Silver nanowire textile	100	6.3	[11]
Carbonized silk georgette	100	173	[12]
Graphene/cellulose paper	100	7	[13]
Graphene-based fiber	100	2.5	[14]
Graphene/CNT/PDMS	85	35	[15]
RGO/elastic tape	82	150	[16]
Silver nanowire/PDMS	70	14	[17]
Graphite/printing papers	60	536.6	[18]
AgNPs/graphene-microsheets/PU	50	500	[19]
CNT/thermal plastic elastomer	34.2	1135	[20]
Au nanopopcorn/MoS_2 fiber	30	0.7	[21]
Carbonized cotton thread	10	18.5	[22]
silver nanowire/PDMS	9.6	926	[23]
Graphene woven fabric/PDMS	3	230	[24]
GCE-20 fiber	100	14550.2	This work

* Note: CNT represents carbon nanotube; AgNPs is silver nanoparticle; PDMS denotes

polydimethylsiloxane; PANI is polyaniline; PVA is polyvinyl alcohol; PPy is polypyrrole;

TPU represents thermoplastic polyurethane; RGO is reduced graphene oxide. MoS$_2$ is

Molybdenum sulfide; PU denotes polyurethane.

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