

Supporting information

Conductive Nanocomposite Hydrogels for Flexible Wearable Sensor

Wen-Yan Guo,^a Ming-Guo Ma^{a,b,*}

^a*MOE Engineering Research Center of Forestry Biomass Materials and Bioenergy, Beijing Key Laboratory of Lignocellulosic Chemistry, Research Center of Biomass Clean Utilization, College of Materials Science and Technology, Beijing Forestry University, Beijing 100083, PR China. Email: mg_ma@bjfu.edu.cn*

^b*State Silica-based Materials Laboratory of Anhui Province, Bengbu 233000, PR China.*

Abbreviated summary:

Carbon Black (CB), Carbon Nanotube (CNT), Graphene Oxide (GO), Reduced Graphene Oxide (RGO), Polyaniline (PANI), Polypyrrole (PPy), Two-Dimensional (2D), Polyvinyl Alcohol (PVA), Polyacrylamide (PAM), Glycerol (Gly), Electrocardiograph (ECG), Electromyography (EMG), Carboxylated Multi-Walled CNTs (C-MWCNT), Bacterial Cellulose (BC), Tannic Acid (TA), B-Cyclodextrin (B-CD), N-Isopropylacrylamide (NIPAM), Triboelectric Nanogenerator (TENG), Polymer Polydopamine (PDA), Liquid Metal (LM), Acrylic Acid (AA), Cellulose Nanocrystals (CNCs), Cellulose Nanofibers (CNFs), Polyaniline (PANI), Bacterial Nanocellulose (BNCs), Ethylene Glycol (EG), Polyethylene Glycol (PEG), Polyacrylic Acid (PAA), Pyrimidinone (UPy), Silver Nanoparticle (AgNP), Gold Nanoparticles (AuNPs), Silver Nanowires (AgNWs), Electromagnetic Interference (EMI), Nanogenic Fibrillated Cellulose (NFC), Diels-Alder (DA), Poly(3,4-Ethylenedioxythiophene): Sulfonated Lignin (PEDOT:PSS), Single-Walled CNT (SWCNT), Gelatin Methacrylate (GelMa), Amphipathic Proline (ZP).

Table S1. Properties and applications of composite conductive hydrogels with different nanofillers.

Filler type	Nanomaterials	Stretchability	Conductivity	Sensing types	Gauge Factor	Ref.
		y				
Carbon-based nanofillers	CB	643.2%	0.16 S m ⁻¹	Temperature and strain sensor	2.1 (0-600%); TCR (-0.935% °C ⁻¹).	52
		313%	/	Strain and pressure sensor	0.725 (0-60%); 2.216 (60-145.2%); 5.01 (145.2-200%); 0.033kPa ⁻¹ (0-29 kPa) ; 0.009kPa ⁻¹ (29-172 kPa) ; 0.004kPa ⁻¹ (172-337 kPa).	61
		710%	/	Strain and pressure sensor	5.17 (0-160%); 9.21 (160-300%); 68.64 (300-355%); 0.229kPa ⁻¹ (0-0.375 MPa) ; 0.0312 kPa ⁻¹ (0.375-8.053 MPa) ; 0.0023kPa ⁻¹ (8.053-15 MPa).	53
	CNTs	900%	0.19 S m ⁻¹	Strain sensor	1.57 (0-50%); 2.86 (50-200%); 4.97 (200-400%); 7.8 (400-900%).	54
		600%	/	Temperature, strain and pressure sensor	2.1 (0-600%); TCR (3.81% °C ⁻¹).	45
	GO	657.5%	1.98 S m ⁻¹	Temperature, strain and pressure sensor	2.59 (0-93%); 3.76 (93%-209%); 4.09 (209%-325%); 4.87 (325%-418%); 6.04 (418%-500%); TCR (0.71% °C ⁻¹).	17
		10300%	/	Strain sensor	3.28 (0-600%); 7.25 (600-1500%); 13.45 (1500-4800%).	66
		rGO	5000%	/	Strain sensor	4.29 (0% -- 60%); 5.26 (60% --260%); 14.14 (260--550%).

		2800%	0.25 S m ⁻¹	Strain and pressure sensor	1.77 (0-100%); 6.4 (100-600%); 9.86 (600-1000%).	69
Filler type	Nanomaterials	Stretchability	Conductivity	Sensing types	Gauge Factor	Ref.
		600%	0.6 S m ⁻¹	Strain sensor	0.9 (0-600%).	40
	CNCs	257.4%	2.3 mS cm ⁻¹	Strain sensor	1.98 (0-60%); 3.97 (60-200%).	76
		3200%	17.36 mS cm ⁻¹	Strain sensor	1.76 (0-500%); 2.55 (5000-1000%); 3.27 (1000-1500%).	80
	CNFs	696%	/	Temperature, strain and pressure sensor	0.96 (0-100%); 1.57 (100-300%); 0.28 kPa ⁻¹ (0-2 kPa); 0.0067 kPa ⁻¹ (2-40 kPa); TCR 4.66% °C ⁻¹ (0-6°C); TCR 0.63% °C ⁻¹ (6-60°C).	77
Polymer-based nanofillers		925%	995 mS·m ⁻¹	Strain sensor	0.6 (0-550%); 1.8 (550-710%); 4.6 (714-810%); 25.6 (810-873%).	78
		991%	/	Temperature, strain and pressure sensor	3.93 (0-75.63%); 9.01 (75.63-169.04%); 18.28 (169.04-268.9%); TCR (-0.016 °C ⁻¹).	82
	PANI	2590%	3.35 S m ⁻¹	Strain and pressure sensor	2.6 (0-300%); 7.8 (300-1210%); 17.9 (1210-1520%).	83
		700%	13 S m ⁻¹	Strain sensor	3.4 (0-300%).	87
	PPy	641%	1.13 S m ⁻¹	Strain sensor	1.98 (0-100%); 3.64 (100-200%); 4.98 (200-400%).	89
		523.3%	0.89 mS·cm ⁻¹	Strain sensor	2.1 (0-400%).	84

Filler type	Nanomaterials	Stretchability	Conductivity	Sensing types	Gauge Factor	Ref.
Metal-based nanofillers	AgNPs	261%	/	Temperature and strain sensor	1.755 (0-250%); TCR (-2.99% °C ⁻¹).	90
	AuNPs	470%	0.26 S m ⁻¹	Strain sensor	0.99 (0-350%).	94
	AgNWs	1000%	83 S cm ⁻¹	Strain sensor	/	36
	AuNPs	2000%	/	Strain sensor	0.144 (0-200%); 0.222 (200-600%); 0.303 (600-800%).	95
		1000%	/	Strain sensor	5.02 (0-200%); 44.85 (200-350%).	97
Two-dimensional material-MXenes	MXenes	247%	56 mS m ⁻¹	Strain sensor	3.42 (0-50%); 4.77 (50-100%); 5.82 (100-180%).	98
		4600%	/	Strain sensor	1.63 (0-1200%); 3.45 (1200-3000%); 6.6 (3000-4500%).	99
		660%	0.016 S m ⁻¹	Strain and pressure sensor	4.12 (0-200%); 7.17 (200%-500%); 0.63 kPa ⁻¹ (0-70 kPa).	101