

Supplementary Materials

Thermal-Recoverable Tough Hydrogels Enhanced by Porphyrin Decorated Graphene Oxide

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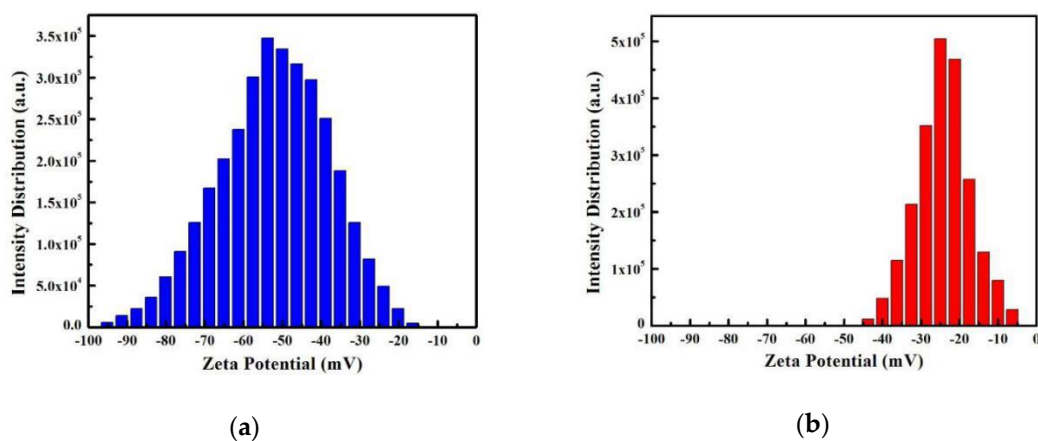


Figure S1. Zeta potential of (a) GO and (b) PGO.

Table S1. Compressive properties of tough hydrogels with a maximum strain at 99%.

Sample	Young's Modulus (kPa)	Strength (MPa)	Toughness (kJ m ⁻³)
DN	4.85 ± 1.58	9.00 ± 0.30	811.65 ± 59.49
GDN	45.98 ± 11.68	19.17 ± 0.36	2291.01 ± 124.55
PDN	31.69 ± 7.00	18.32 ± 0.30	2140.73 ± 106.94

Table S2. Compressive Properties of tough hydrogels with different strain.

Samples	30%		60%		90%	
	Strength (kPa)	Hysteresis Energy (kJ m ⁻³)	Strength (kPa)	Hysteresis Energy (kJ m ⁻³)	Strength (MPa)	Hysteresis Energy (kJ m ⁻³)
DN	37.37 ± 2.88	1.73 ± 0.21	222.74 ± 20.27	15.35 ± 2.22	2.50 ± 0.23	207.61 ± 2.88
	114.61 ± 22.27	5.58 ± 1.24	730.86 ± 55.14	80.14 ± 13.56	6.38 ± 0.51	650.28 ± 17.78

Table S3. Cyclic compressive properties of tough hydrogel with different strain.

Samples	Cycle	30%		60%		90%	
		Hysteresis Energy (kJ m ⁻³)	Strength (kPa)	Hysteresis Energy (kJ m ⁻³)	Strength (kPa)	Hysteresis Energy (kJ m ⁻³)	Strength (MPa)
DN	1	2.58 ± 0.85	50.70 ± 9.17	20.11 ± 3.16	382.10 ± 27.01	272.24 ± 77.47	3.54 ± 1.18
		2.02 ± 0.78	51.45 ± 7.00	15.16 ± 2.87	360.90 ± 22.34	N/A	N/A
	2	1.84 ± 0.71	51.05 ± 6.01	14.83 ± 2.83	346.72 ± 13.46	N/A	N/A
		1.78 ± 0.71	50.70 ± 5.09	14.27 ± 2.10	343.35 ± 15.34	N/A	N/A
	3	1.75 ± 0.69	50.85 ± 4.74	14.40 ± 1.77	343.93 ± 13.75	N/A	N/A
		5.18 ± 1.31	106.64 ± 20.88	68.73 ± 15.82	705.45 ± 101.04	591.75 ± 95.53	6.08 ± 0.79
	4	4.08 ± 0.84	101.92 ± 20.03	36.77 ± 4.85	668.36 ± 97.45	363.91 ± 50.58	5.48 ± 0.79
		3.81 ± 0.76	99.45 ± 19.23	31.88 ± 3.07	634.29 ± 86.55	339.62 ± 48.71	5.21 ± 0.76
	5	3.66 ± 0.72	97.14 ± 19.01	29.69 ± 2.78	607.65 ± 79.59	324.31 ± 40.71	4.95 ± 0.65
		3.57 ± 0.56	95.29 ± 18.96	28.86 ± 3.27	589.37 ± 78.08	310.33 ± 38.15	4.72 ± 0.56

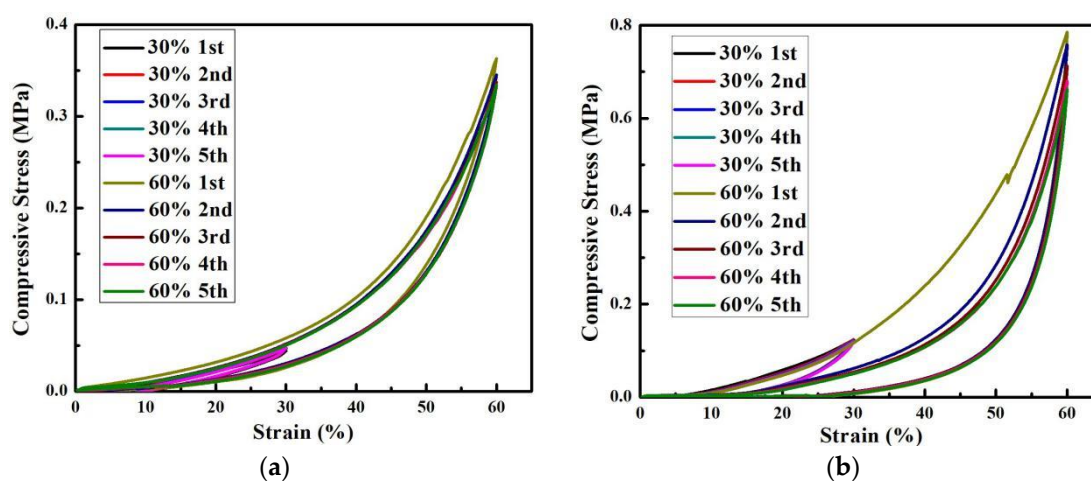


Figure S2 Representative cyclic loading–unloading curves of (a) DN and (b) PDN hydrogels for up to five cycles at 30% and 60% strain compression.

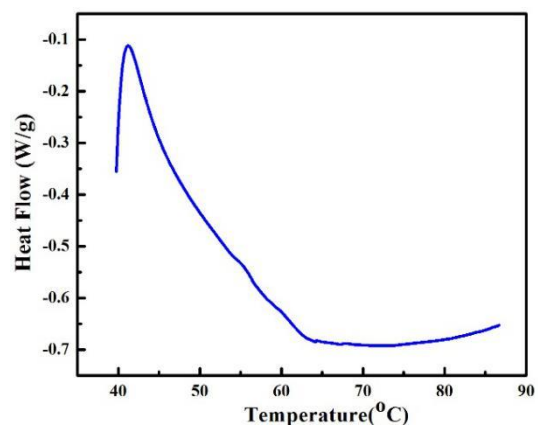


Figure S3 DSC curves of carrageen.