

Highly sensitive flexible strain sensor based on microstructured biphasic hydrogels for human motion monitoring

Xin Gao^{1,2,*}, Xinyu Wang^{2,*}, and Xingce Fan (✉)¹

1 Key Laboratory of Quantum Materials and Devices of Ministry of Education, School of Physics, Southeast University, Nanjing 211189, China

2 School of Chemistry and Chemical Engineering, Southeast University, Nanjing 211189, China

E-mail: fanxingce@126.com

* X.G. and X.W. contributed equally to this work.

Supplementary materials

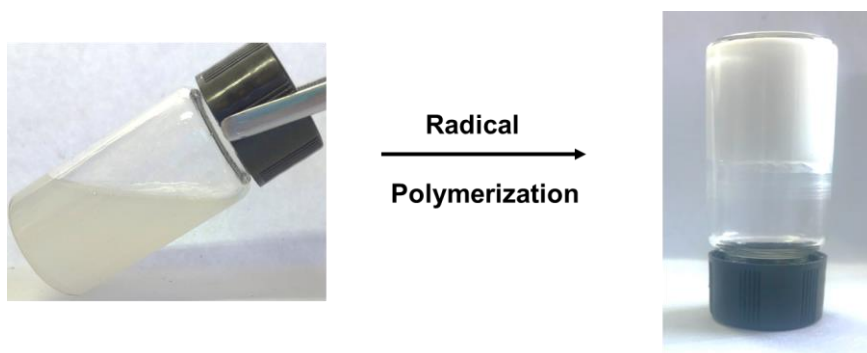


Fig. S1 Optical photos show the preparation process of biphasic hydrogel via emulsion polymerization.

Table S1 Components of BH-Xs and G-100%

Sample	w/g								V/vol.%	W/wt.%
	AM	HEA	SMA	EGDMA	SDBS	H ₂ O	APS	AIBN	SMA	SMA
BH-60%	0.2	0.088	3.456	0.009	0.05	2.67	0.02	–	60	53
BH-70%	0.2	0.088	3.456	0.009	0.05	1.714	0.02	–	70	62
BH-80%	0.2	0.088	3.456	0.009	0.05	1	0.02	–	80	72
BH-85%	0.2	0.088	3.456	0.009	0.05	0.7	0.02	–	85	76
G-100%	–	–	3.456	0.009	0.05	–	–	0.03	100	97

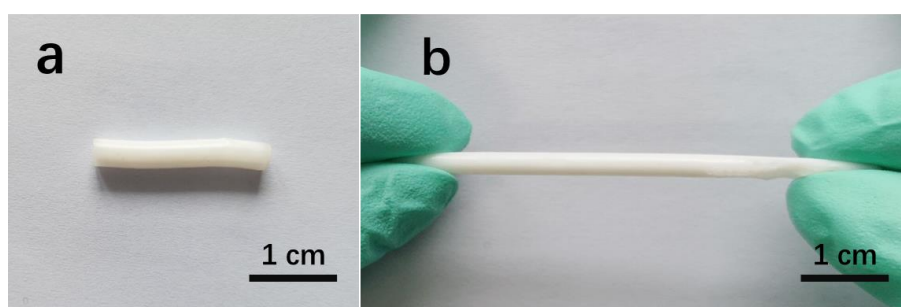
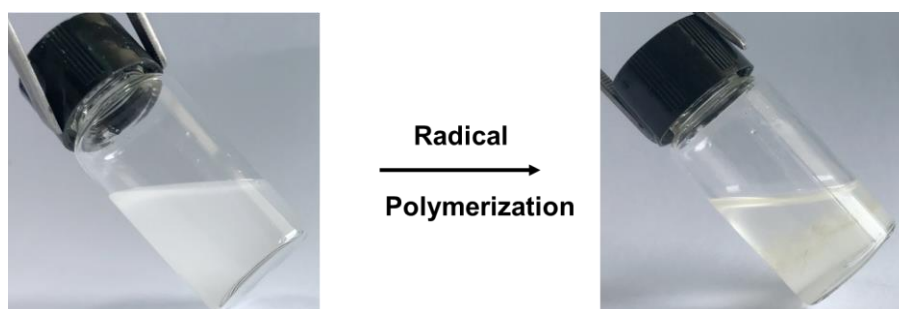
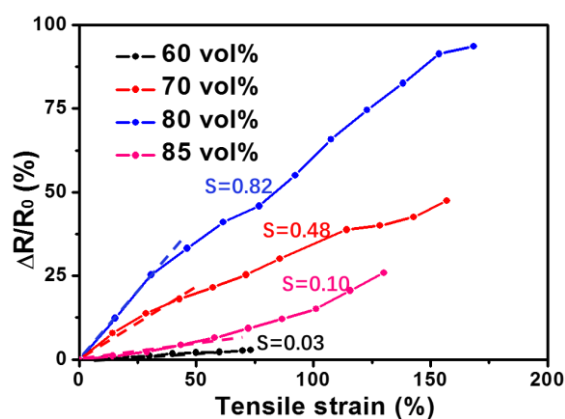
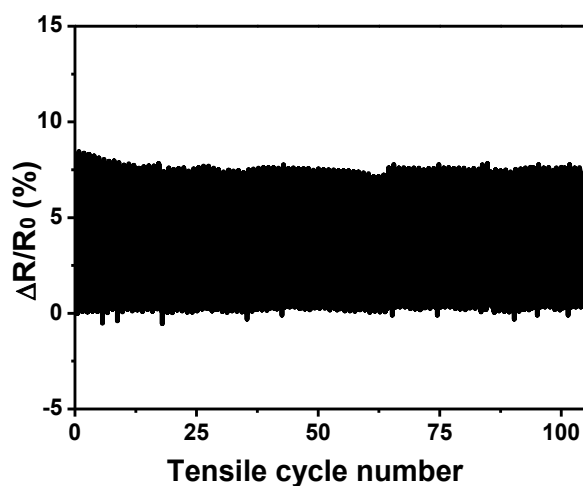


Fig. S2 Optical photos of (a) pristine and (b) stretched BH-80% to show the elasticity of the materials.

Table S2 Tensile properties of BH-Xs

Sample	σ_y /kPa ^{a)}	ε_b /%	E /kPa ^{b)}	Toughness/(kJ·m ⁻³) ^{c)}
BH-60%	13.1 ± 2.2	83.6 ± 11.3	13.1 ± 1.7	6.9 ± 2.5
BH-70%	22.4 ± 5.7	170.1 ± 51.1	13.4 ± 1.8	23.2 ± 12.7
BH-80%	53.6 ± 18.8	205.7 ± 35.8	23.4 ± 4.8	68.73 ± 31.7
BH-85%	60.7 ± 3.9	134.1 ± 23.8	42.9 ± 6.7	35.3 ± 31.9
G-100%	67.9 ± 17.7	135.9 ± 45.6	48.1 ± 4.6	59.3 ± 30.8

a) Yield stress of samples. b) Young's modulus (E) determined from the slope of the fitting line to the linear elastic regime of stress-strain curves. c) Tensile toughness determined by integrating the area under stress-strain curves up to the specimen breaking point.

**Fig. S3** Optical photos showing that biphasic hydrogel cannot form when the volume percentage of SMA rises to 90%.**Fig. S4** Tensile strain-resistance curves of the biphasic hydrogel with different contents of SMA.**Fig. S5** The tensile electrical cyclic curves of BH-80% for 100 times.

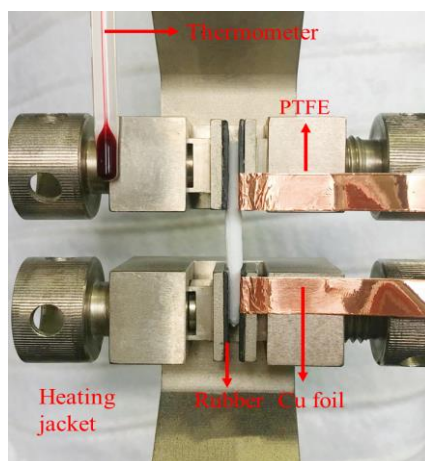


Fig. S6 An optical photo of the tensile test and its setup. The fixture adhered by flexible copper electrode and PTFE (as an insulator). The wires connected to Keysight 34461A are associated with flexible copper electrode. The heating jacket was used to control environment temperature maintaining at around body temperature (37 °C).

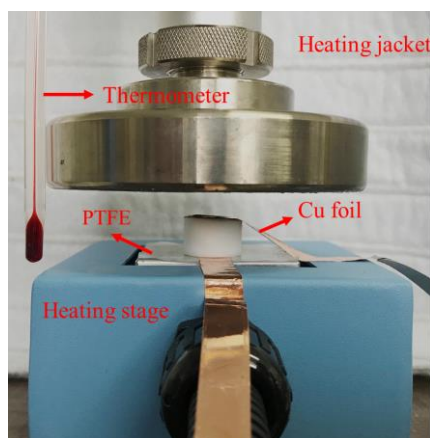


Fig. S7 An optical photo of the compressive test and its setup. The fixture adhered by flexible copper electrode and PTFE (as an insulator). The wires connected to Keysight 34461A were associated with flexible copper electrode. The heating jacket and heating stage were used to control environment temperature maintaining at around body temperature (37 °C).

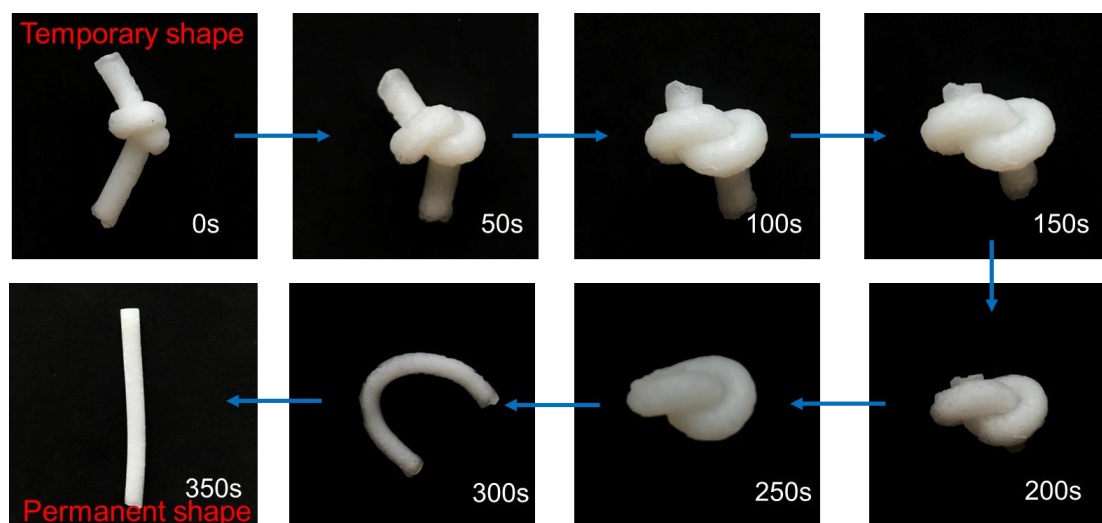


Fig. S8 Shape memory behaviors of BH-80%. The knotted BH-80% gradually restores the original long strip shape at 70 °C after 350 s.