Electronic Supplementary Material (ESI) for Journal of Materials Chemistry C.
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Electronic Supplementary Information

Self-Powered Flexible Sensing System Based on Super-Tough, High Ionic Conductivity and Rapid Self-Recovery Fully Physically Crosslinked Double Network Hydrogel

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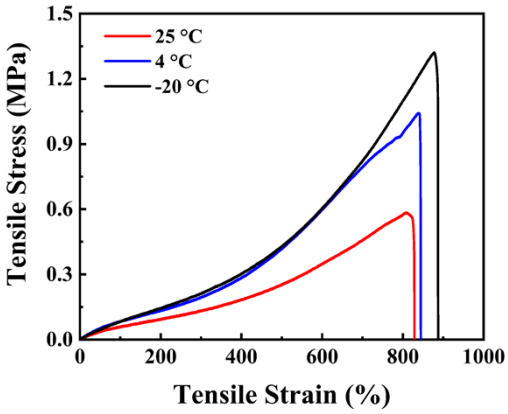

Fig. S1 Stress-strain curves of $P_8N_6H_{30}$ DN hydrogels prepared by UV light polymerization after refrigerated at -20 °C, 4 °C, 25 °C for 2 h.

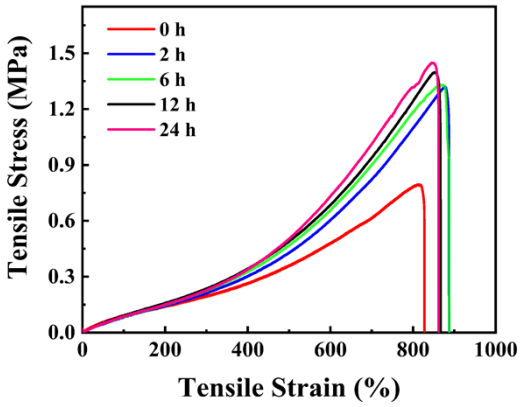

Fig. S2 Stress-strain curves of $P_8N_6H_{30}$ DN hydrogels prepared by UV light polymerization after refrigerated at -20 °C for 0, 2, 6, 12 and 24 h.

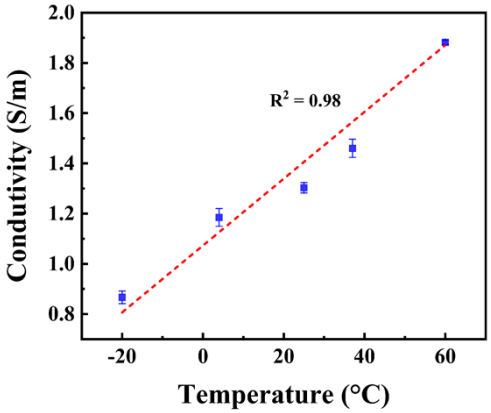

Fig. S3 Conductivity of the PNH DN hydrogel at -20 °C, 4 °C, 25 °C, 37 °C and 60 °C.

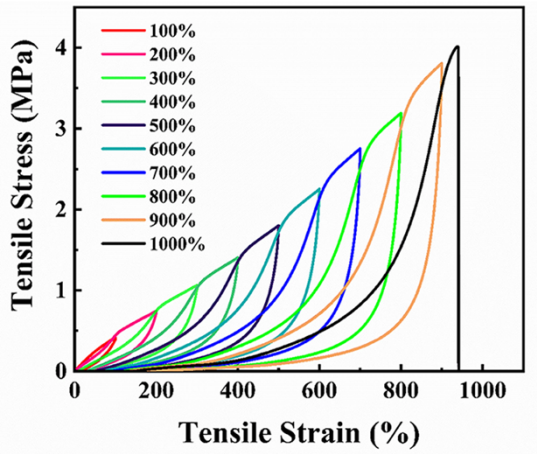

Fig. S4 The successive loading-unloading cycles of the PNH DN hydrogel.

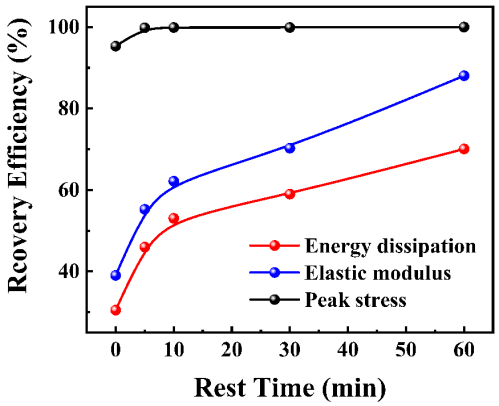

Fig. S5 Recovery efficiency of the energy dissipation, elastic modulus and peak stress of the PNH DN hydrogel with rest time of 0, 5, 10, 30 and 60 min.

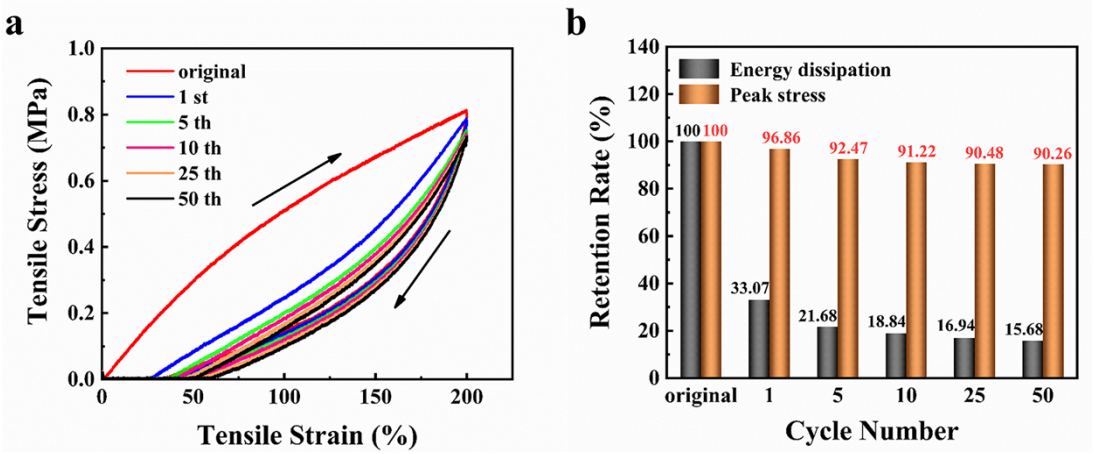

Fig. S6 (a) The anti- fatigue test and (b) retention rate of energy dissipation and peak stress of the PNH DN hydrogel.

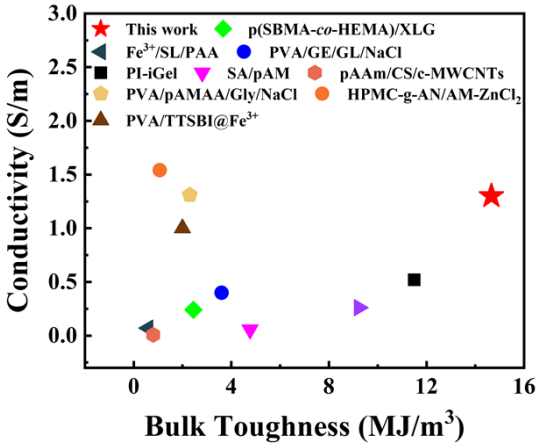

Fig. S7 A comparison of bulk toughness and conductivity among different hydrogels, including PNH DN hydrogel in this work, p(SBMA-*co*-HEMA)/XLG,[1] Fe^{3+}/SL/PAA,[2] PVA/GE/GL/NaCl,[3] PI-iGel,[4] SA/pAM,[5] pAAm/CS/c-MWCNTs,[6] PVA/pAMAA/Gly/NaCl,[7] HPMC-g-AN/AM-$ZnCl_2$,[8] Strach/PVA/Gly/$CaCl_2$,[9] and PVA/TTSBI@Fe^{3+}.[10]

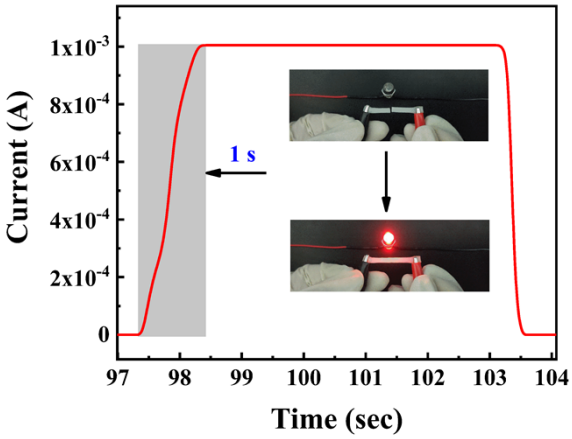

Fig. S8 The resistance recover time of the PNH DN hydrogel during self-healing without external stimulation.

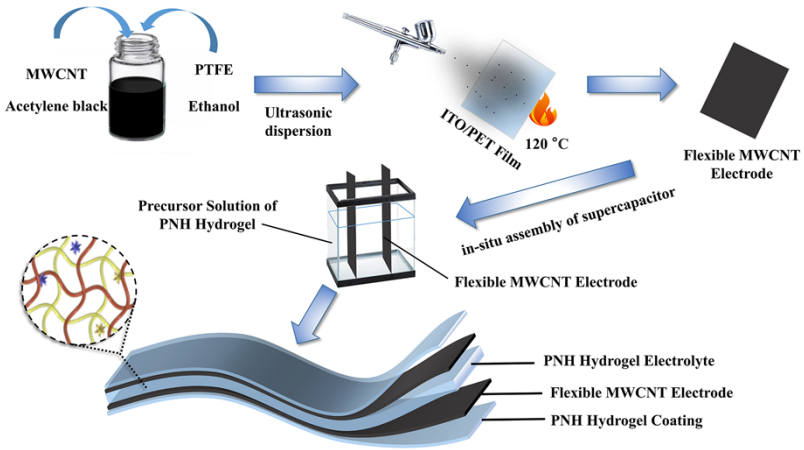

Fig. S9 Schematic diagram of preparation of flexible solid state supercapacitor based on the PNH DN hydrogel.

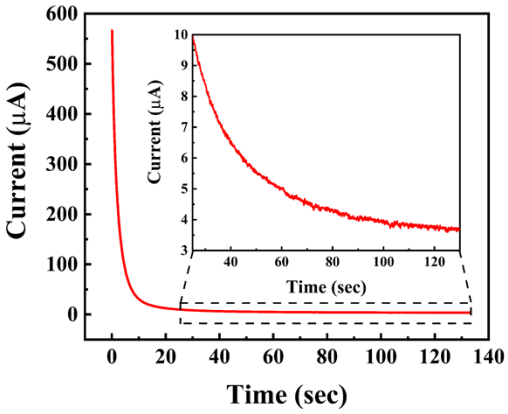

Fig. S10 Self-discharge behavior of flexible solid state supercapacitor based on the PNH DN hydrogel.

Table S1. The properties of reported conductive hydrogels for flexible strain sensors.

Composition	Maximal strain (%)	Maximal strength (KPa)	Maximal gauge factor	Sensing ranges (%)	Anti-freezing	Ref.
PVA/NaCl/pHEAA	872	3760	1.74	0-735	Yes	This work
PAA/PANI	1160	300	1.05	0-1130	No	[11]
κ-carrageenan/PAAm	2100	560	0.63	0-1000	No	[12]
PVA/G/PDA/AgNPs	331	1174	0.94	0-315	No	[13]
PVA/Gly/NaCl	350	1400	1.56	0-355	Yes	[14]
PAAm/PDA/KCl	1000	25	0.7	0-1000	No	[15]
Cellulose/NaCl	236	50	0.29	0-230	Yes	[16]
PAAm/Casein/LiCl	1465	170	0.4	0-100	Yes	[17]
PSBMA/PVA	400	600	1.5	0-300	No	[18]
PAA/GO/$FeCl_3$	630	400	1.32	0-500	No	[19]
PAAm/PSBMA/NaCl	1150	600	<1	0-700	No	[20]
PAAm/Alginate/$CaCl_2$	1700	375	0.3	20-800	No	[21]

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