A novel smart composite: from self-powered sensors to multi-responsive shape memory actuators

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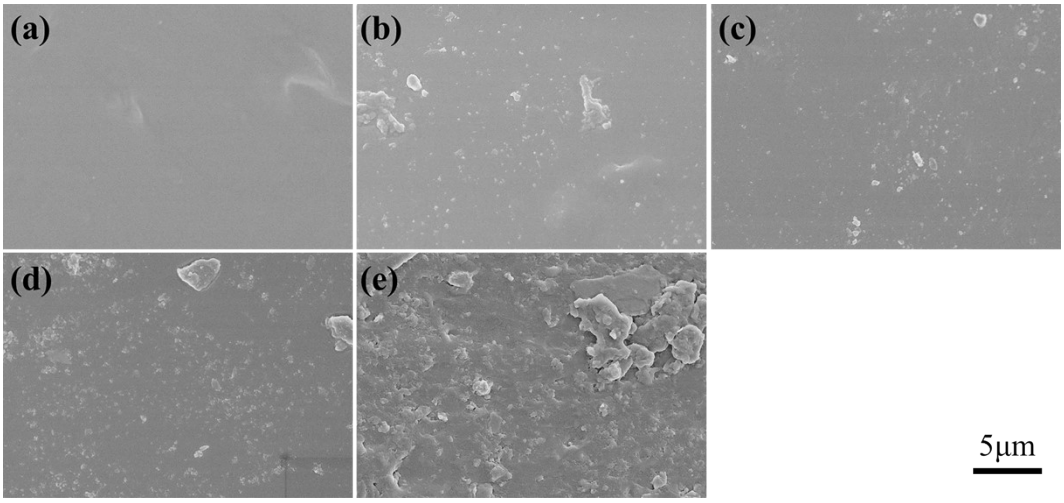

Figure S1 SEM image of (a) AP, (b) APG1, (c) APG2, (d) APG3, and (f)APG4.

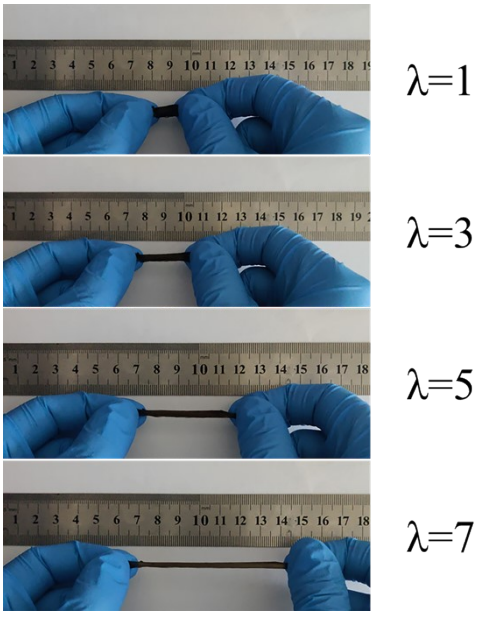

Figure S2 Digital photographs of the APG2 under different strain.

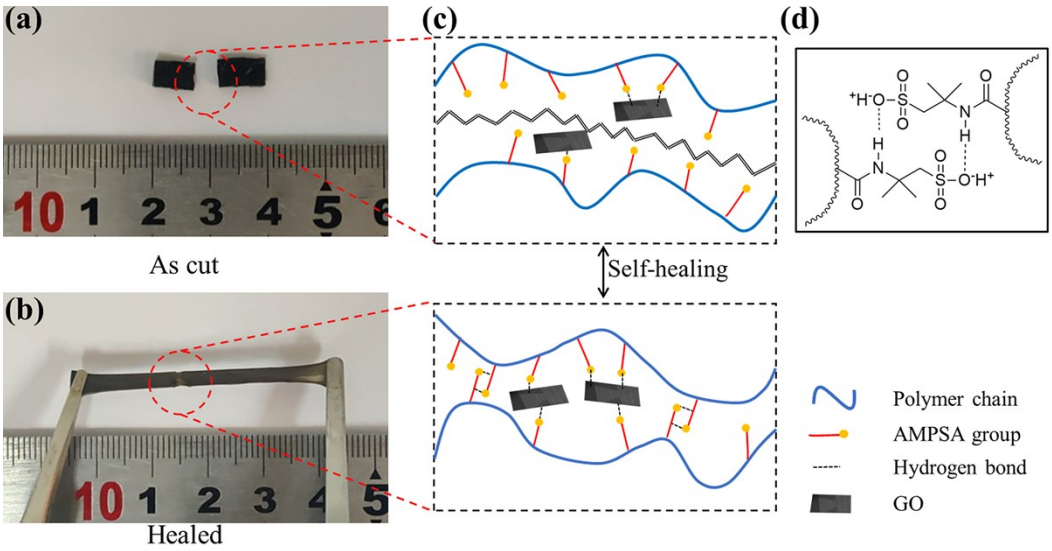

Figure S3 (a) Damaged sample. (b) Healed sample. (c) Schematic illustration of self-healing mechanism. (d) Hydrogen bond interaction of AMPSA groups.

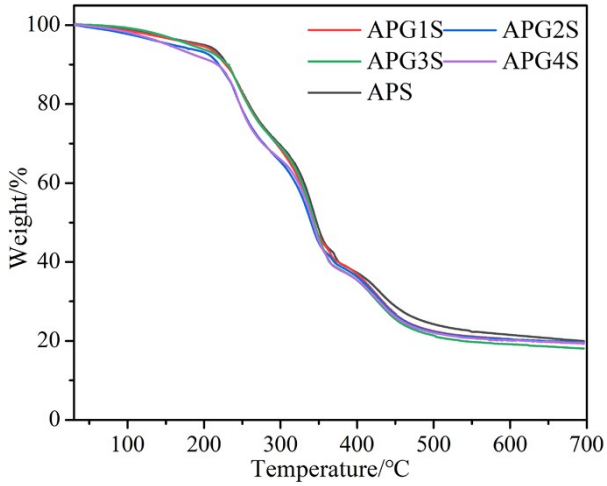

Figure S4 TGA curves of APGxS composites.

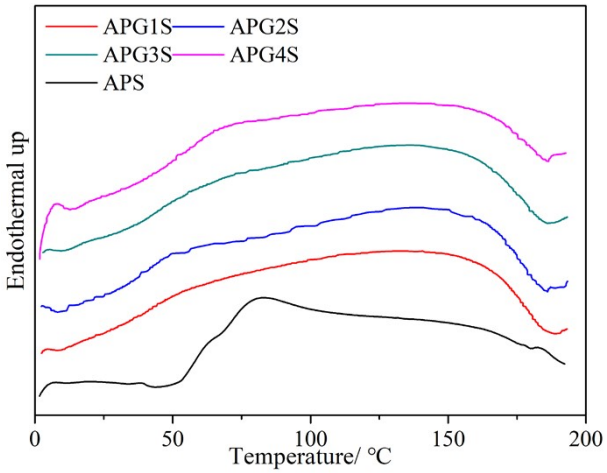

Figure S5 DSC curves of APGxs composites

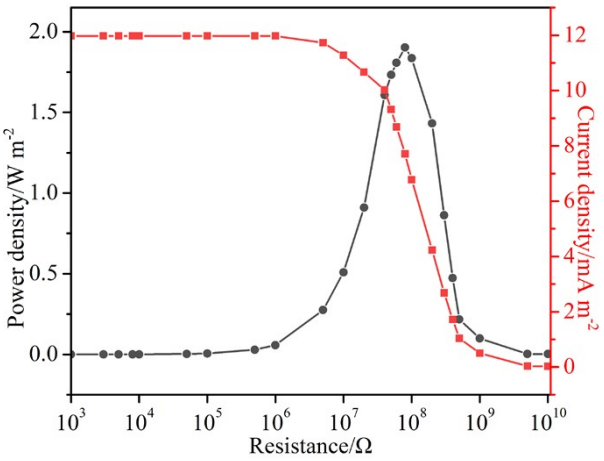

Figure S6 Current and peak power density depending on external resistances of reconstructed H-TENG

Table S1 Composition and mechanical properties of APGx hydrogels

Sample	GO content (%)	σ(MPa)	ε(%)
AP	0	0.147±0.004	798±84
APG1	0.25	0.147±0.001	887±13
APG2	0.5	0.242±0.02	1179±44
APG3	0.75	0.203±0.03	1009±84
APG4	1	0.182±0.014	953±26

Table S2 Mechanical properties, glass transition temperature, thermo- and NIR light-induced shape memory properties of APGxS composites

sample	σ(MPa)	ε(%)	T_g(°C)	R_f^a(%)	R_r^a(%)	R_f^b(%)	R_f^b(%)
APS	26.9±0.9	16.7±0.5	56.7	95.5±2.6	87.4±3.3	/	/
APG1S	30.6±2.3	17.5±1.4	54.4	96.1±1.5	95.7±2.2	98.1±1.1	95.1±1.3
APG2S	38.5±1.4	19.1±0.8	56.9	98.8±2.1	96.7±2.4	97.8±2.2	96.5±1.8
APG3S	26.0±1.8	18.6±0.6	54.6	98.4±2.3	95.2±3.5	98.6±1.5	95.1±2.7
APG4S	24.4±1.5	17.2±0.7	57.1	98.8±2.1	94.3±3.4	98.4±1.4	93.4±2.4

Note: a, thermo-induced shape memory properties; b, NIR light-induced shape memory properties.

Table S3 property comparison of hydrogel based TENG reported in recent years

Materials	Self-healing	Self-adhesive	Voltage	Power density	Year	Ref.
PVA/agarose/MWCNT hydrogel	Yes	N/A	95V	0.75 W/m^2 (500MΩ)	2019	[1]
PVA hydrogel	Yes	N/A	20V	5 mW/m^2 (110MΩ)	2019	[2]
Chitosan/AgNW hydrogel	N/A	N/A	182V	2 W/m^2	2019	[3]

				(10.5MΩ)		
PAM/HEC/LiCl hydrogel	N/A	N/A	285V	0.626W/m^2 (30MΩ)	2020	[4]
PNA/PMA hydrogel fiber	Yes	N/A	36V	88 mW/m^2 (200MΩ)	2020	[5]
PVA/PAM hydrogel	N/A	N/A	345V	1.81 W/m^2 (10MΩ)	2021	[6]
PAM/Clay hydrogel	Yes	N/A	157V	0.71 W/m^2 (20MΩ)	2021	[7]
PAM/SA/Ca^{2+} hydrogel	N/A	N/A	22V	6.79 mW/m^2 (700 kΩ)	2022	[8]
PHAM/PAA hydrogel	Yes	Yes	123V	0.209 W/m^2 (30MΩ)	2022	[9]
PVA/PAM/EG hydrogel	N/A	N/A	200V	0.943 W/m^2 (100 MΩ)	2022	[10]
PAA/PA hydrogel	N/A	N/A	201V	1.33 W/m^2 (500 MΩ)	2022	[11]
ECTFE hydrogel	N/A	N/A	332V	1.85 W/m^2 (1.8 MΩ)	2022	[12]
PAM/alginate hydrogel	N/A	N/A	380V	5.7 mW/m^2 (2400 MΩ)	2022	[13]
PAMPSA/GO hydrogel	Yes	Yes	162V	2 W/m^2 (80MΩ)	This work	

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