Supporting Information

Dynamic Thiourea Networks Enable Self-Healing Chromic Films for Visual Detection of Light and Acidic Vapors

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Table S1. Comparison of reported self-healing chromic polymer systems

Material	Healing condition	Healing time	Healing efficiency	Chromic response	Key limitation	Reference
PTU/TPU/SPCOOH	50 °C, RT	87%, 72%	12 h	Yes (60-75 s)	Trade-off between healing & chromism	This work
PU+PMA	70 °C	97%	24 h	Yes (15 min)	Thermally activated disulfide exchange	(27)
PDMS+Spiropyran	60 °C	73.5%	16 h	Yes (10-20 s)	Single functinality	(28)
Spiropyran-grafted AAO sensor	-	-	-	Yes (seconds–minutes)	Irreversible after damage	(22)
PS/PAzo	RT	N/A	minutes–hours	Yes (20-60min)	Requires external trigger	(18)
Upcycled TPEE / Pazo fibers	RT	~50%	~2 h	Yes (~20 min)	Incomplete mechanical recovery; light-dependent activation	(29)

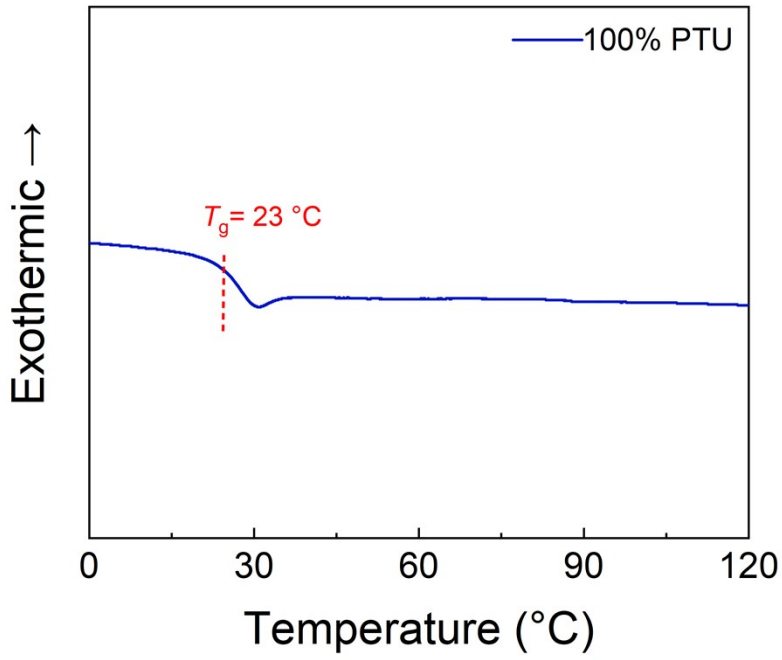

Figure S1. DSC curve of pure PTU.

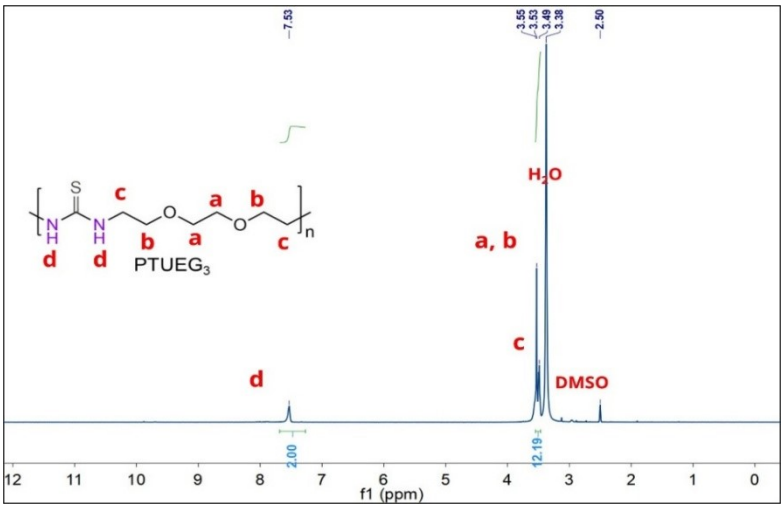

Figure S2. ^{1}H-NMR spectrum of pure PTU.

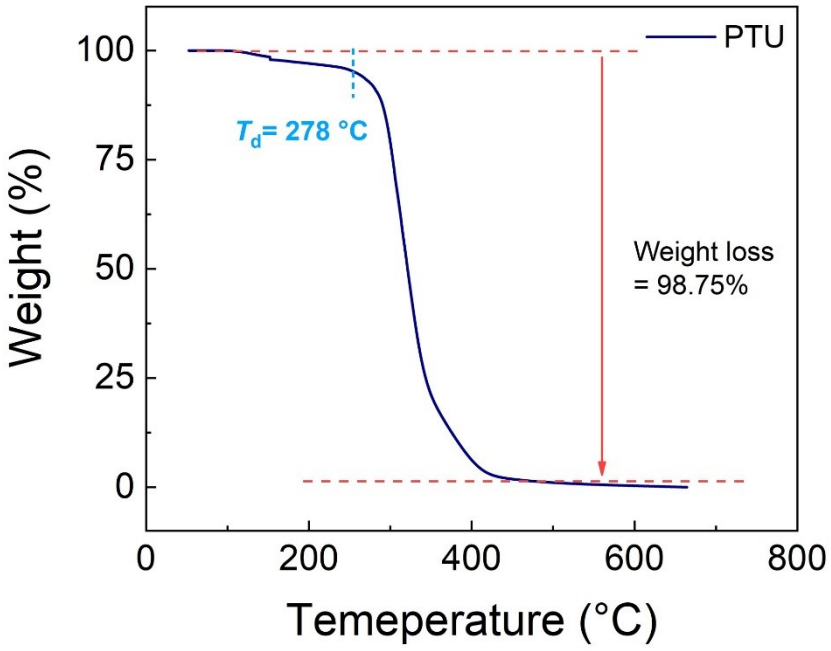

Figure S3. TGA curve of PTU.

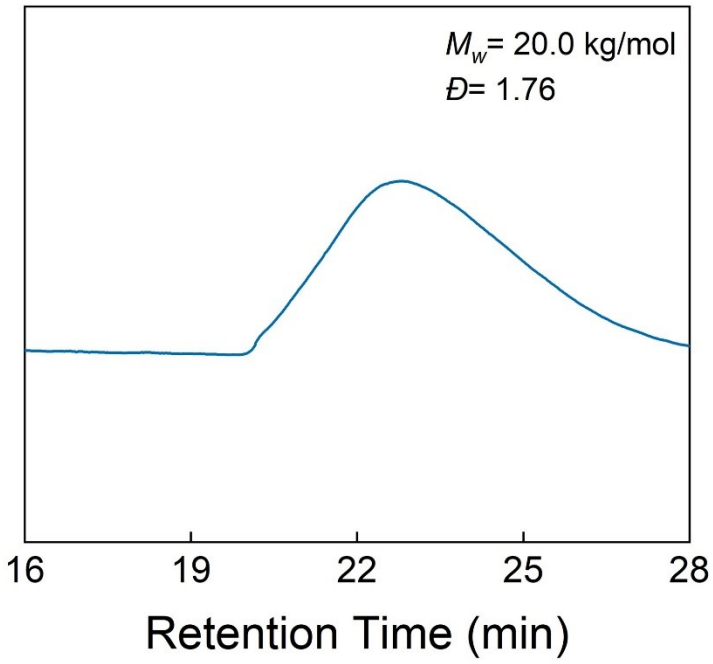

Figure S4. GPC analysis of PTU.

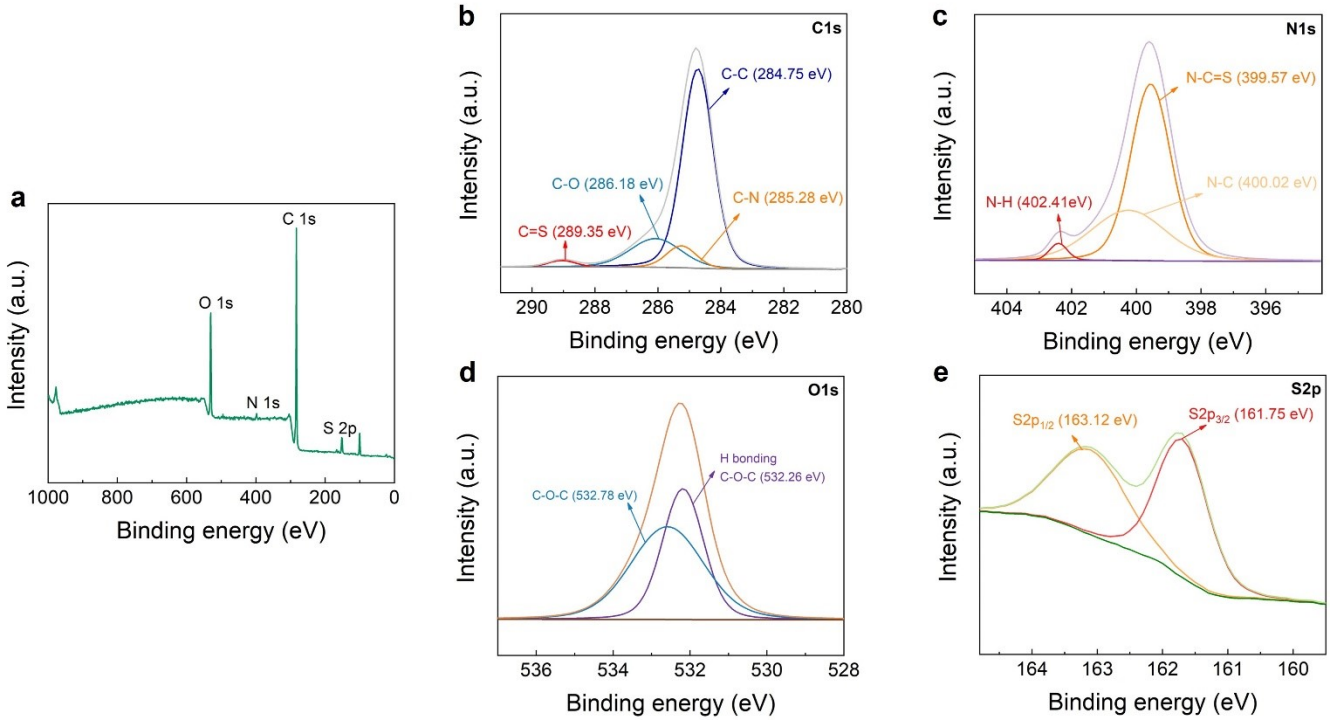

Figure S5. XPS spectra of the elemental compositions in the TPU/PTU film with a 50:50 weight ratio. (a) Full survey spectrum. (b–e) C1s, N1s, O1s, and S2p spectra.

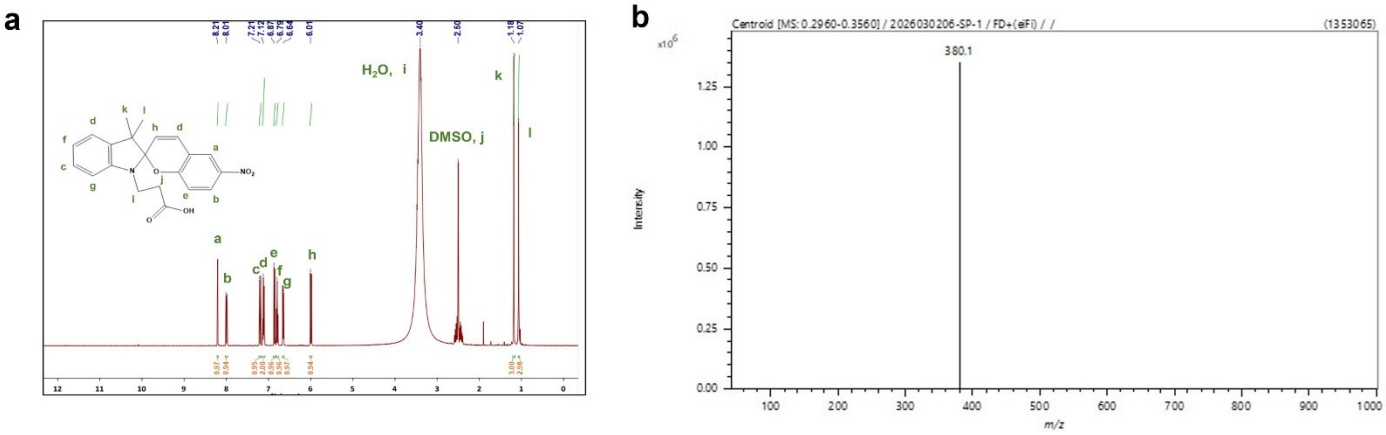

Figure S6. Characterization of spiropyran-COOH. (a.) ^{1}H-NMR spectrum. (b.) LR-MS spectrum.

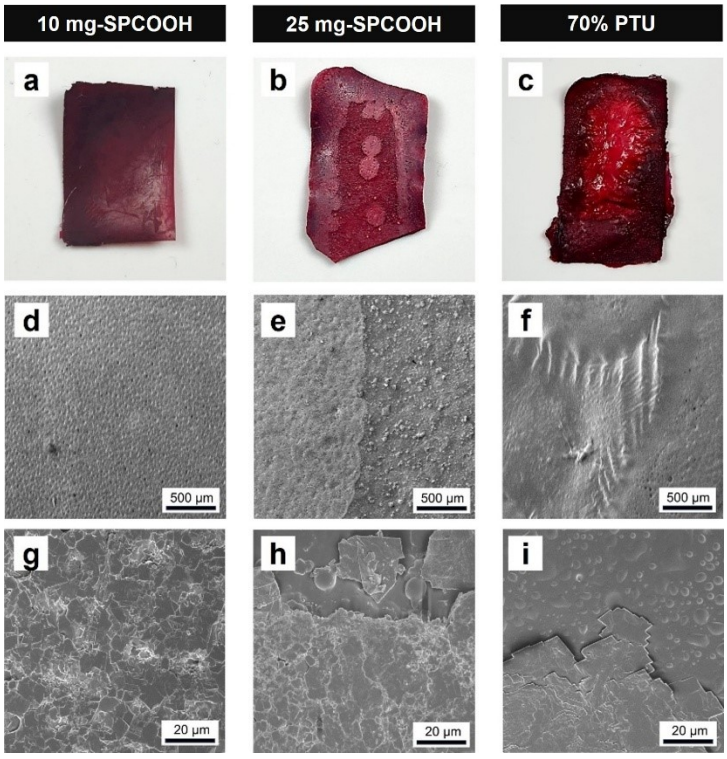

Figure S7. Composition-dependent morphological evolution of PTU/TPU/SPCOOH composite films. (a–c) Optical images of films containing (a) 10 mg-SPCOOH/50% PTU., (b) 25 mg-SPCOOH/50% PTU, and (c) 10 mg-SPCOOH/70% PTU, respectively. (d–f) Low-magnification SEM images corresponding to panels (a–c). (g–i) High-magnification SEM images corresponding to panels (a–c).

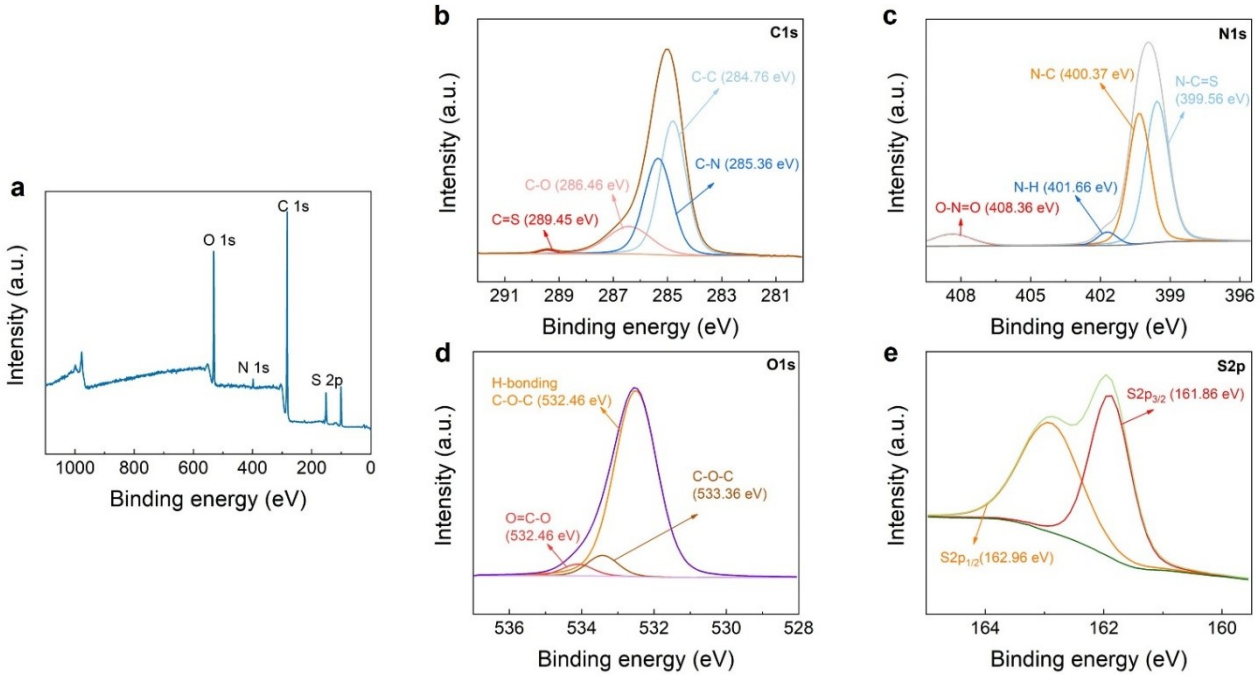

Figure S8. XPS spectra of the elemental compositions in the10 mg-SPCOOH/PTU film. (a) Full survey spectrum. (b–e) C1s, N1s, O1s, and S2p spectra.

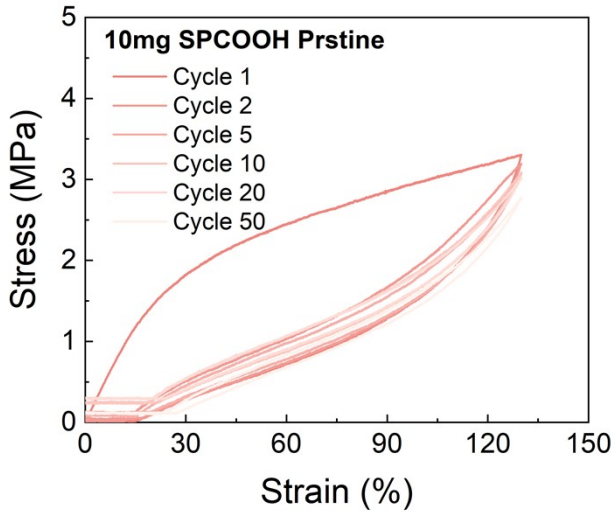

Figure S9. Cyclic tensile tests of the pristine 10mg-SPCOOH/PTU film.

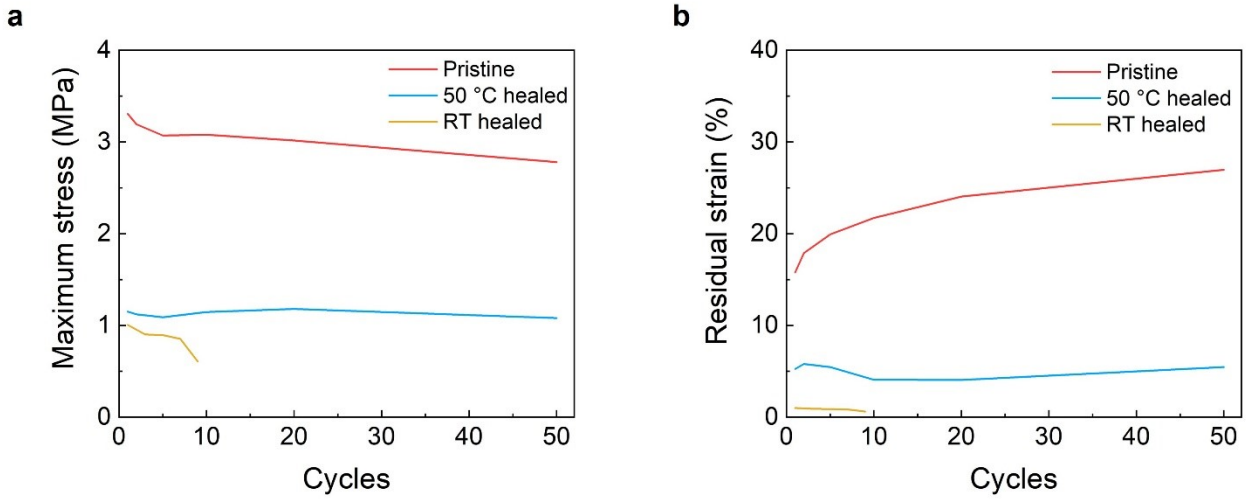

Figure S10. Evolution curves of the cyclic tensile tests for pristine, RT-healed, and 50 °C-healed specimens. (a) Maximum stress. (b) Residual strain.

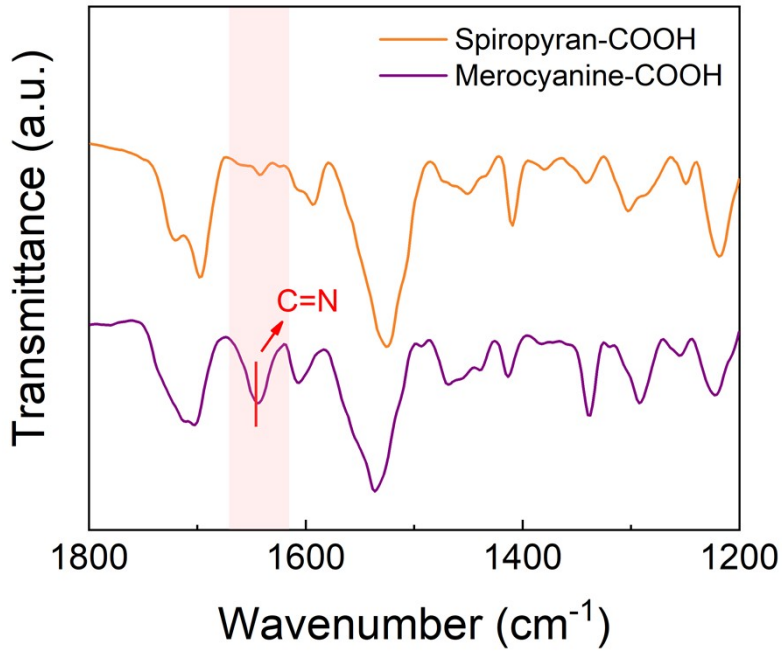

Figure S11. ATR-IR spectra of spiropyran-COOH and its merocyanine-COOH form.

Table S2. Summarized table of mechanical properties for 10 and 25 mg-SPCOOH/PTU films

PTU ratio	SPCOOH (mg)	Healing time (h)	Elongation at break (%)	Tensile stress at break (MPa)	Healing efficiency (%)
50%	10	0 (pristine)	204.17±0.80	3.77±0.14	-
50%	10	8	134.33±2.31	2.01±0.08	65.84±1.31
50%	25	0 (pristine)	204.11±.081	1.76±0.08	-
50%	25	8	76.37±4.97	0.73±0.07	37.38±2.61

Table S3. Summarized table of mechanical properties for 50 and 70% PTU/SPCOOH films

PTU ratio	SPCOOH (mg)	Healing time (h)	Elongation at break (%)	Tensile stress at break (MPa)	Healing efficiency (%)
50%	10	0 (pristine)	204.17±0.80	3.77±0.14	-
50%	10	24	160.75±3.05	2.33±0.20	78.53±1.28
70%	10	0 (pristine)	68.47±2.84	0.15±0.03	-
70%	10	24	52.67±4.16	0.10±0.01	77.74±9.22

Table S4. Summarized table of mechanical properties for 10 mg-SPCOOH/ PTU films at room temperature

PTU ratio	SPCOOH (mg)	Healing time (h)	Elongation at break (%)	Tensile stress at break (MPa)	Healing efficiency (%)	Young's modulus (MPa)
50%	10	0 (pristine)	204.17±0.80	3.77±0.14	-	9.59±0.11
50%	10	6	44.11±1.54	1.18±0.24	21.53±0.80	4.17±0.21
50%	10	8	56.03±1.19	1.67±0.12	27.50±0.57	6.31±0.92
50%	10	12	145.67±5.13	2.40±0.03	71.43±0.51	5.08±1.58
50%	10	24	160.75±3.05	2.33±0.20	78.53±1.28	5.92±0.72

Table S5. Summarized table of mechanical properties for 10 mg-SPCOOH/ PTU films at 50 °C

PTU ratio	SPCOOH (mg)	Healing time (h)	Elongation at break (%)	Tensile stress at break (MPa)	Healing efficiency (%)	Young's modulus (MPa)
50%	10	0 (pristine)	204.17±0.80	3.77±0.14	-	9.59±0.11
50%	10	6	109.18±7.89	1.86±0.28	53.42±3.74	7.27±1.17
50%	10	8	134.33±2.31	2.01±0.08	65.84±1.31	7.79±0.55
50%	10	12	177.20±3.40	2.70±0.22	86.85±1.79	9.22±0.85