Electronic Supporting Information

Dynamic nanoconfinement strategy towards self-healing soft electronics with superstretchability, ultrahigh strength and reliably high conductivity

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Keywords: bioinspired nanoconfinement, self-healing electronics, superstretchability, ultrahigh strength, reliably high conductivity

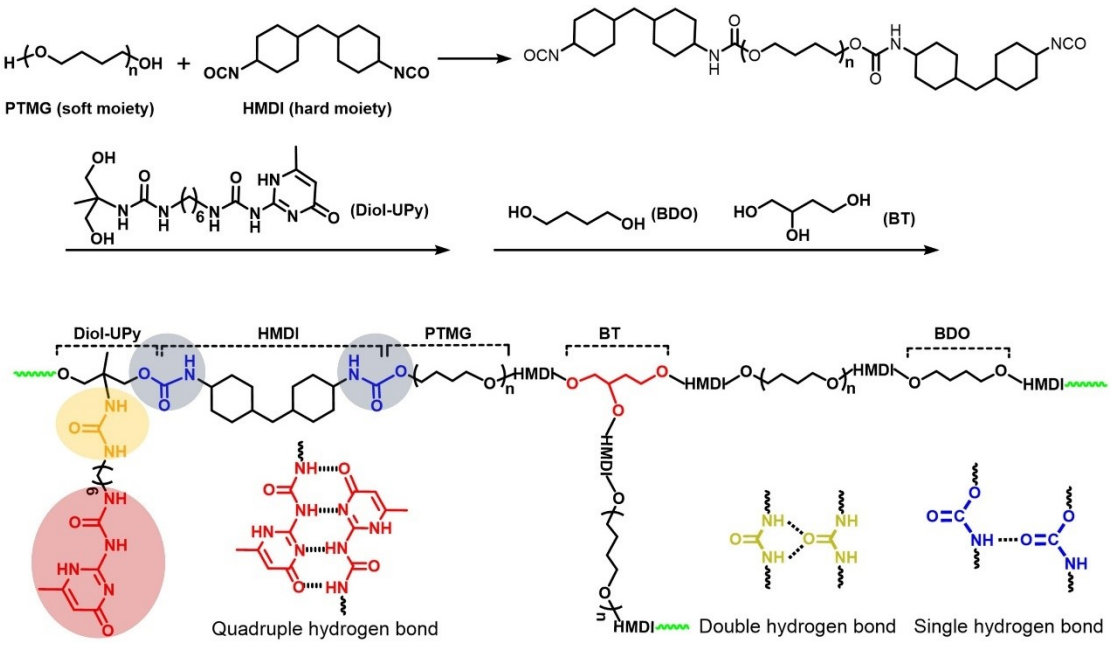

Figure S1. The synthesis route of TSPU polymer. In the final self-healing polymer matrix, there existed hierarchical (single, double, quadruple) hydrogen bonding interactions, which induced the aggregation of H-bonds from hard moieties forming nanoconfined phase.

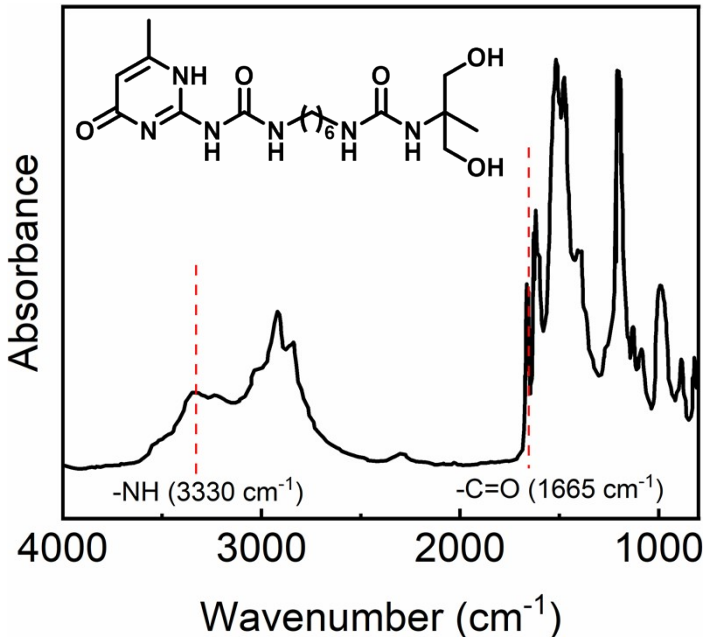

Figure S2. The FTIR spectrum of Diol-UPy.

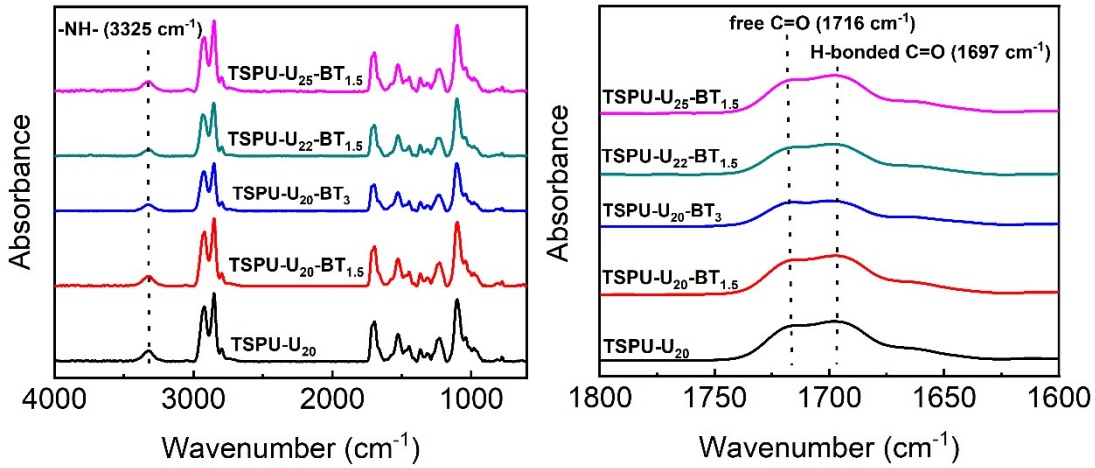

Figure S3. FTIR spectra of TSPU elastomers. The absorption peaks at 3325 cm^{-1}, 1716 cm^{-1} and 1697 cm^{-1} were attributed to the absorbance of -NH-, free C=O and H-bonded C=O, respectively.

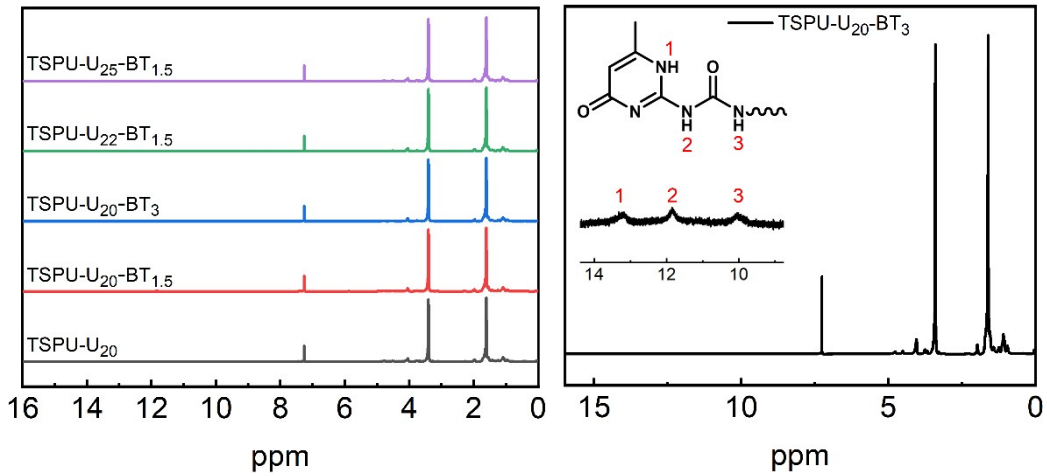

Figure S4. [1]HNMR spectra of TSPU elastomers. The chemical shifts at 13.21 ppm, 11.85 ppm, and 10.06 ppm demonstrated the existence of UPy groups.

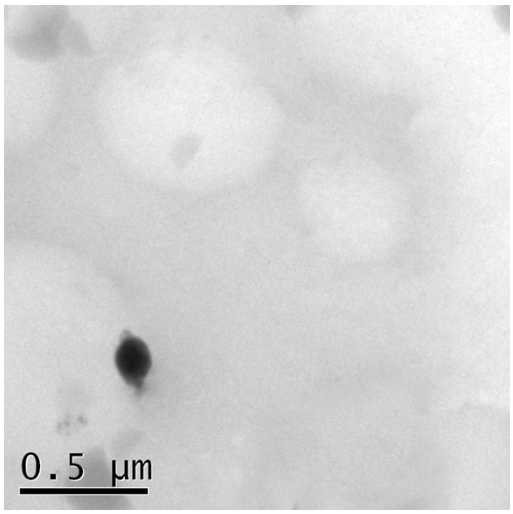

Figure S5. Characterization of TSPU-U_{25}-$BT_{1.5}$ polymer with TEM.

Figure S6. Optical photographs of TSPU elastomer at 0% (left) and 2000% (right) strains.

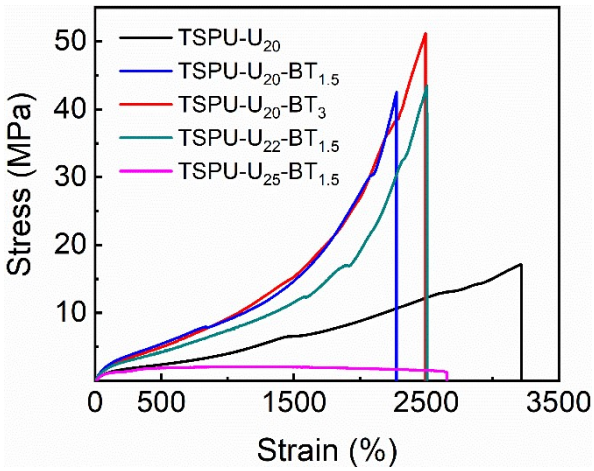

Figure S7. The engineering stress-strain curves of as-synthesized TSPU elastomers.

Figure S8. The weights of dumbbell and TSPU sample used to lift up dumbbell.

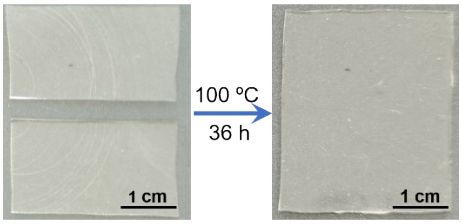

Figure S9. The cut-off sample was self-healed after handled at 100 °C for 36 h.

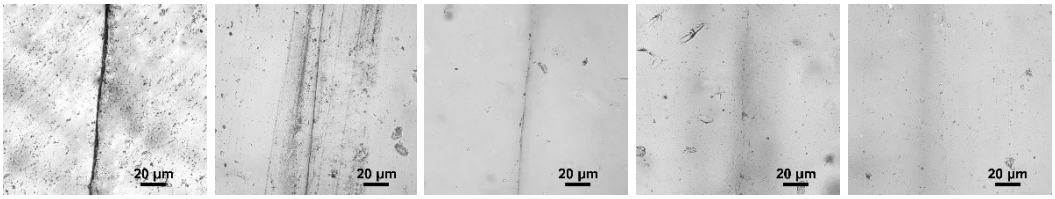

Figure S10. The microscopy images of self-healing process for reattached two cut-off pieces at 100 °C for 0 h, 4 h, 12 h, 24 h, 36 h (from left to right).

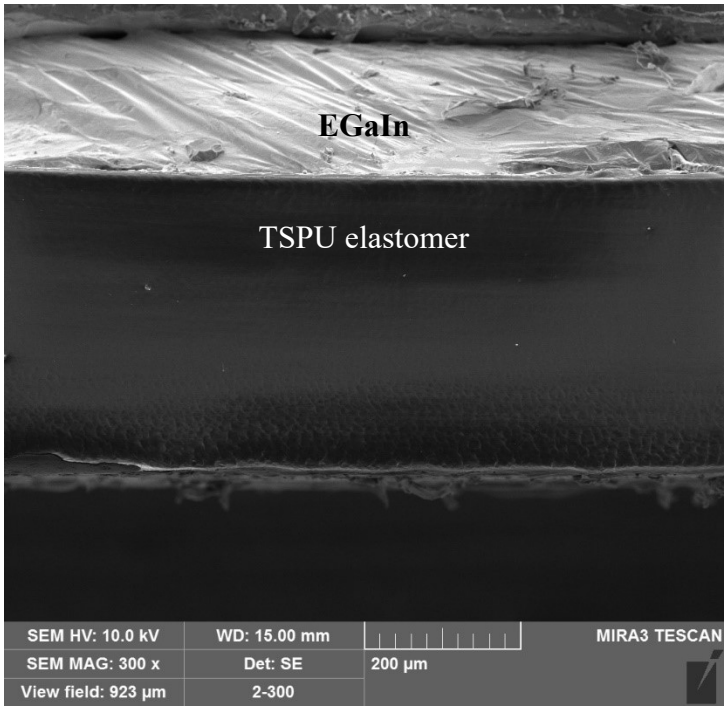

Figure S11. Cross-profile image of electrode characterized by SEM. It is shown that EGaIn liquid metal spreads on TSPU elastomer and the thickness of EGaIn is ca. 170 μm.

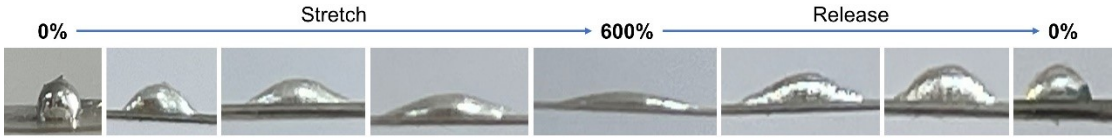

Figure S12. (a) Photographs of EGaIn droplet illustrating a well surface reconciliation on a TSPU-U_{20}-BT_3 specimen during stretching and releasing process.

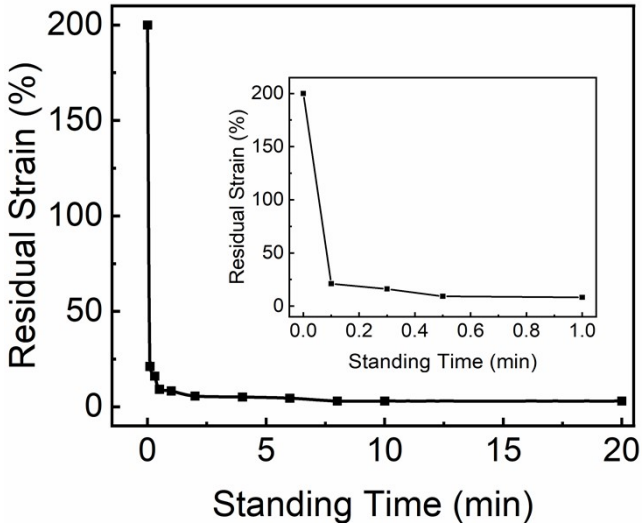

Figure S13. The dependence of residual strain on standing time of relaxed TSPU after being stretched to 300% strain.

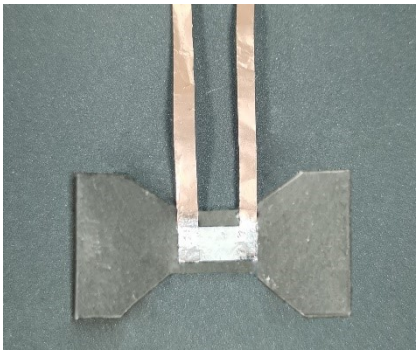

Figure S14. Soft electrode used for measuring its conductivity.

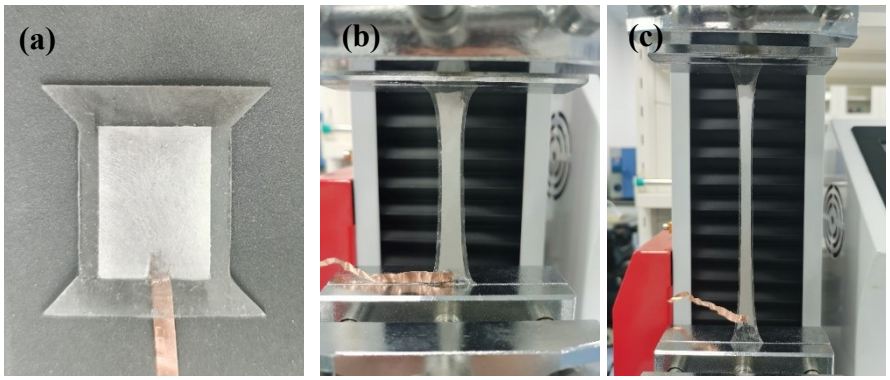

Figure S15. The photography images of supertough self-healing triboelectric nanogenerator (TS-TENG, working area: 3 cm × 2 cm) (a) and its tensile states at 500% (b) and 900% (c) strains.

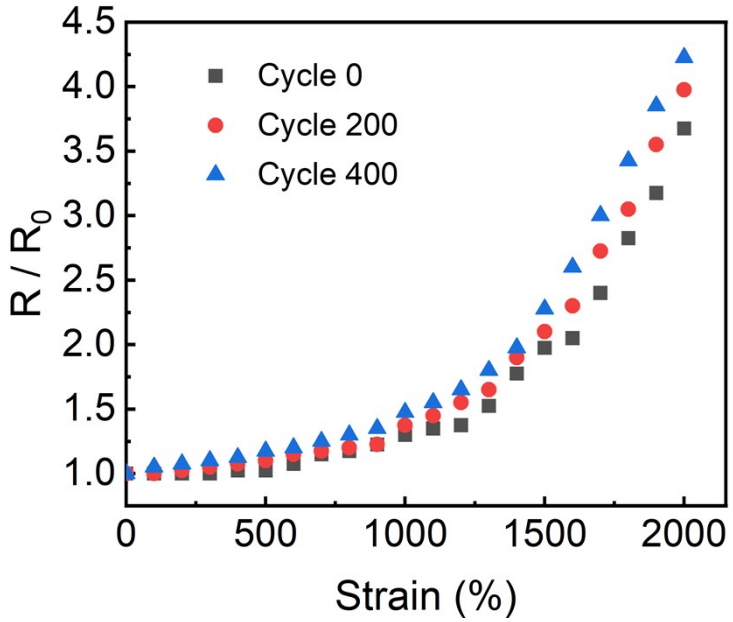

Figure S16. The dependence of R / R_0 on strain of healed electrode after varied stretch-release cycles. One stretch-release cycle is referred to the electrode stretched to 100% and then released.

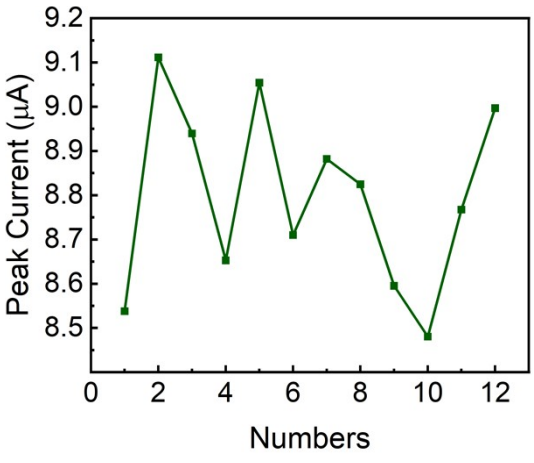

Figure S17. The varation of peak short circuit current of TS-TENG versus testing numbers. The standard deviation is 0.21 μA.

Entry	Electrodes	Strain (%)	Stress (MPa)	R/R_0	Healing efficiency (%)	Ref.
A	DMSO/PEDOT:PSS	32	11.5	9.5@40%	No	1
B	P(AAm-co-HEMA) /PANI	90	17.5	1.8@70%	No	2
C	F-PNIPAAm/PANI	187	0.042	5.5@120%	No	3
D	Ionic conductive cellulose hydrogel (CCH)	220	2	2.62@220%	No	4
E	P(AN/AANa)	425	23.17	3.5@425%	No	5
F	PVA_2PEI_1-75	500	0.6	14.5@460%	No	6
G	$PADL_3$ hydrogel	500	0.052	31@500%	93	7
H	PEDOT:PSS-PAAm organogels	525	0.03	17@300%	No	8
I	PVA-1% CNF	625	1.4	6.76@400%	No	9
J	PAA–rGO hydrogel	630	0.4	5.25@500%	75	10
K	SACP film	700	1.2	81@400%	No	11
L	PVA/GE/GL/NaCl gels	715	1.04	6@600%	No	12
M	$HPC/PVA_{16\%}$ hydrogel	800	1.3	9@400%	No	13
N	PAA/PANI/glycerol/ Fe^{3+}	991	0.0357	31@275%	90.8	14
O	GN-CNF@PVA hydrogel	1000	0.0037	21@500%	98.9	15
P	MXene/PVA/PAAm	1000	0.035	76@350%	85	16
Q	PAAm-oxCNTs	1044	0.71	21@700%	No	17
R	$Cel_{14}/PAA\text{-}Fe_{2.50}^{3+}$ hydrogel	1755	0.1	64@1100%	No	18
S	$VP/PP/ZP/Al^{3+}$ hydrogels	1769	0.46	23.5@700%	91.8	19
T	$PDMS\text{-}MPU_{0.4}\text{-}IU_{0.6}$	1842	1.5	6@500%	78	20
U	HPAAN/PDA	1845	0.438	1.3@200%	49	21
V	$AFPs_{50}\text{-}PAM/PVA_{0.5}$	2358	0.058	97@1000%	No	22
W	MGP	2700	0.3	41@2700%	No	23
X	LPBP hydrogel	2850	0.2	18@500%	98.6	24
Y	DAE-3	5100	1.9	301@100%	86	25
Z	This work	~2500	~50	3.63@2000%	82.9	

Table S1 Comparison of comprehensive performance of electrode herein to that of previously reported stretchable electrodes.

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