

## Supporting information

### **Recyclable, Adhesive and Fast Self-Healable Ionic Conducting Elastomer Based on Poly-Zwitterionic Liquid for Soft Iontronics**

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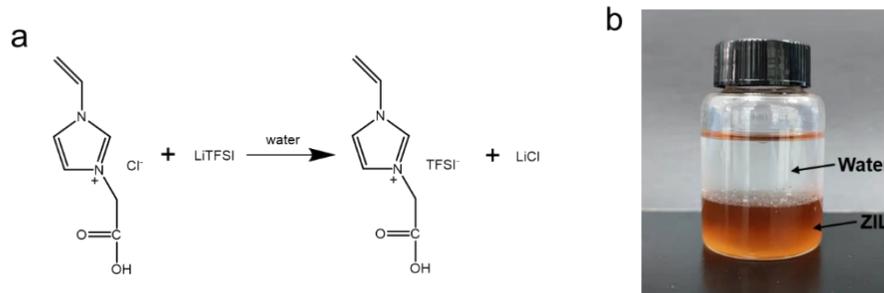
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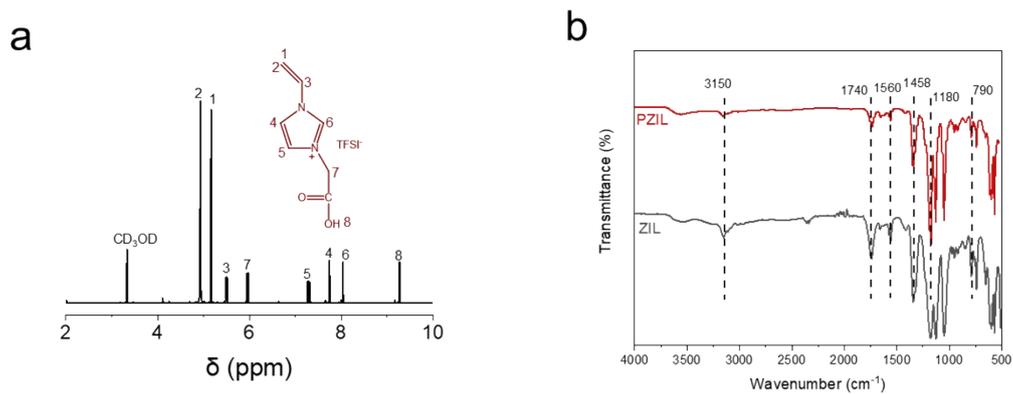
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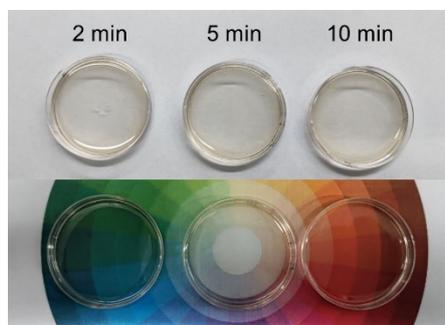
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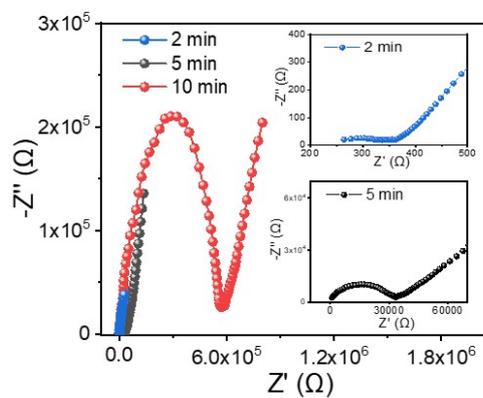
**Fig. S1.** (a) The synthesis route of ZIL monomer. (b) Photo shows the hydrophobic ZIL monomer.



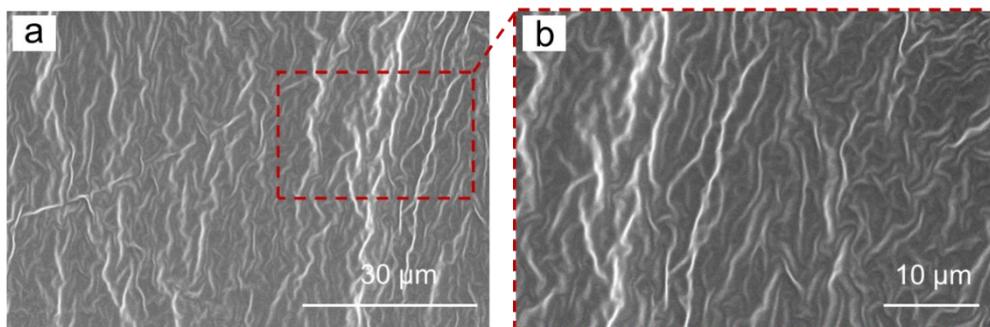
**Fig. S2.** (a)  $^1\text{H-NMR}$  spectra of ZIL monomer. (b) FT-IR spectra of ZIL monomer and PZIL.



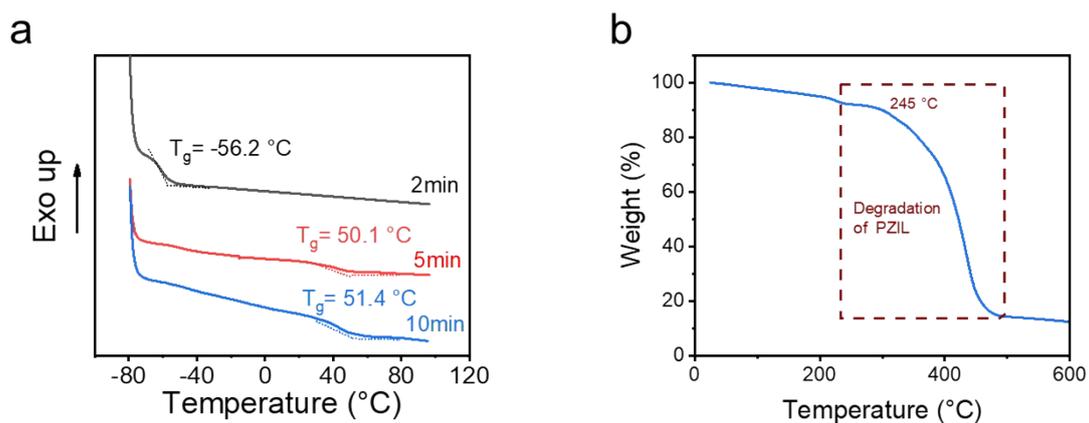
**Fig. S3.** Images of PZIL samples with different photoinitiation time.



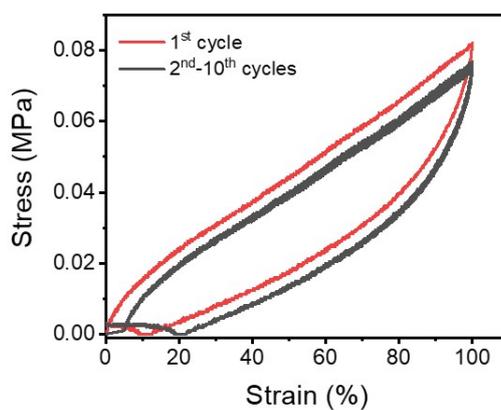
**Fig. S4.** EIS of PZIL with different photoinitiation time.



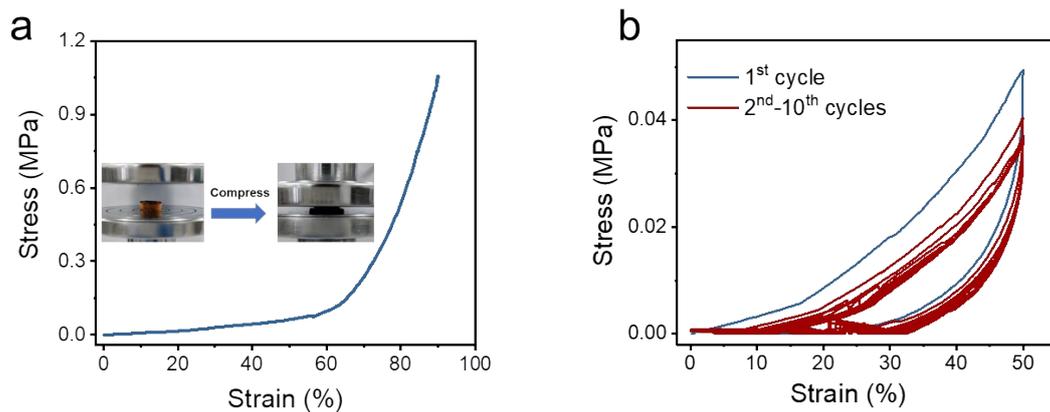
**Fig. S5.** (a-b) SEM images of cross profile of PZIL with different magnification.



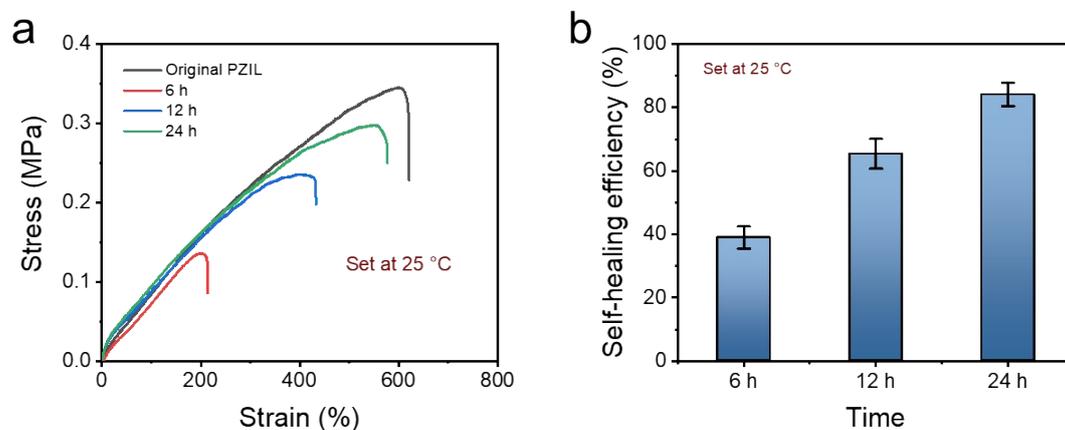
**Fig. S6.** (a) DSC curves of PZIL with different photoinitiation time. (b) TG curve of PZIL.



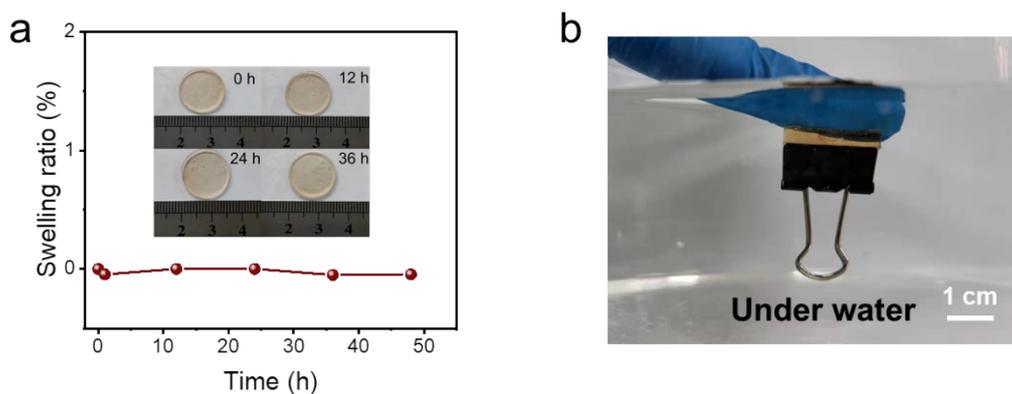
**Fig. S7.** Tensile curves of PZIL from 0-100% strain with 10 cycles.



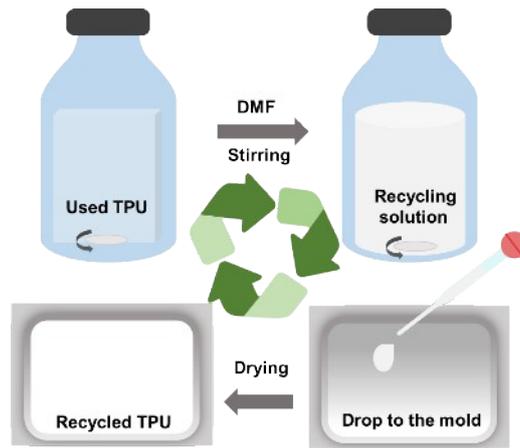
**Fig. S8.** (a) Compress curves of PZIL from 0-90% strain. (b) Cyclic compress curves of PZIL from 0-50% strain with 10 cycles.



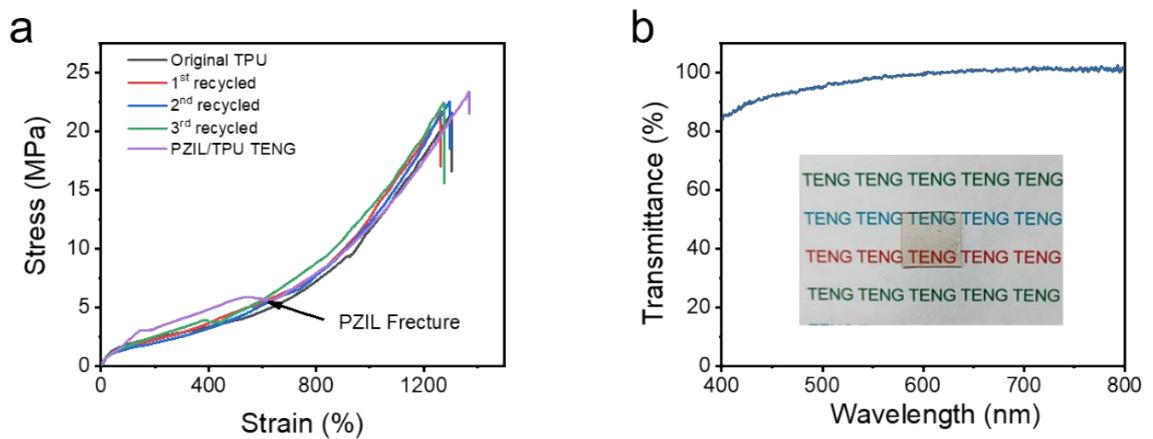
**Fig. S9.** (a) Tensile curves and (b) corresponding self-healing efficiency of PZIL with different time under 25 °C.



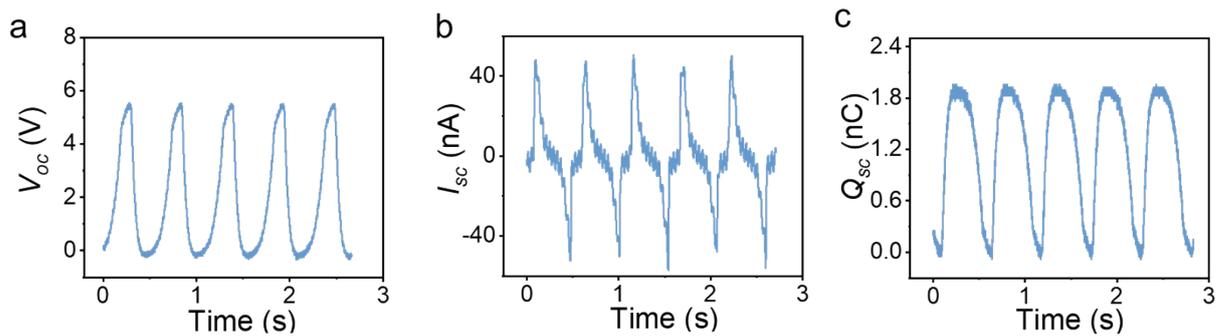
**Fig. S10.** (a) Anti-swelling performance of PZIL. (b) Photo shows the underwater adhesion behavior of PZIL.



**Fig. S11.** Schematic description of the recycle process of TPU.



**Fig. S12.** (a) Tensile curves of original, recycled TPU and PZIL/TPU TENG. (b) The UV-vis spectra of TENG.



**Fig. S13.** (a) The  $V_{oc}$ , (b)  $I_{sc}$  and (c)  $Q_{sc}$  output of TENG.

**Table S1.** Comparison of some important properties of various reported ionic conductors

Properties	Adhesion	Components	Recyclability	Transparenc y (%)	$\sigma$ (mS/cm)	Self- healing	Elongation (%)	Durability	References
ICE	Yes	Only PZIL without extra cross-linker	Yes	92	0.3	5 min at 60 °C	660	No dehydration	This work
Ionohydrogel	Yes	Poly(AA-co-DMAPS), [EMIM][OAc], MBA, Al <sup>3+</sup> and H <sub>2</sub> O	No	90	12	No	420	No dehydration	Ref 1
Ionogel	Yes	Poly(AA-co-DMAPS), EMIMEtSO <sub>4</sub> , HP	No	90	1.19	10 s	4000	No dehydration	Ref 3
Hydrogel	Yes	PSBMA, PDA, Iaponite XLG, DOPA and H <sub>2</sub> O	No	60	0.2	24 h	1100	With dehydration	Ref 5
Organohydroge l	No	PVA, CNF, NaCl, DMSO and H <sub>2</sub> O	No	90	32	No	660	No dehydration	Ref 2
Dry ICE	Yes	DC-PEO, LiTFSI	No	78	0.2	6 h at 60 °C	563	No dehydration	Ref 4

**Table S2.** GPC results of PZILs with different photoinitiation time

Photoinitiation time (min)	<i>Mn</i>	<i>Mw</i>	Polydispersity
2	5118	30462	5.95
5	26777	119042	4.44
10	37812	143428	3.79

## Reference

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