Supporting information

Tuning electromechanical properties of dielectric elastomers via dynamic ionic crosslinks

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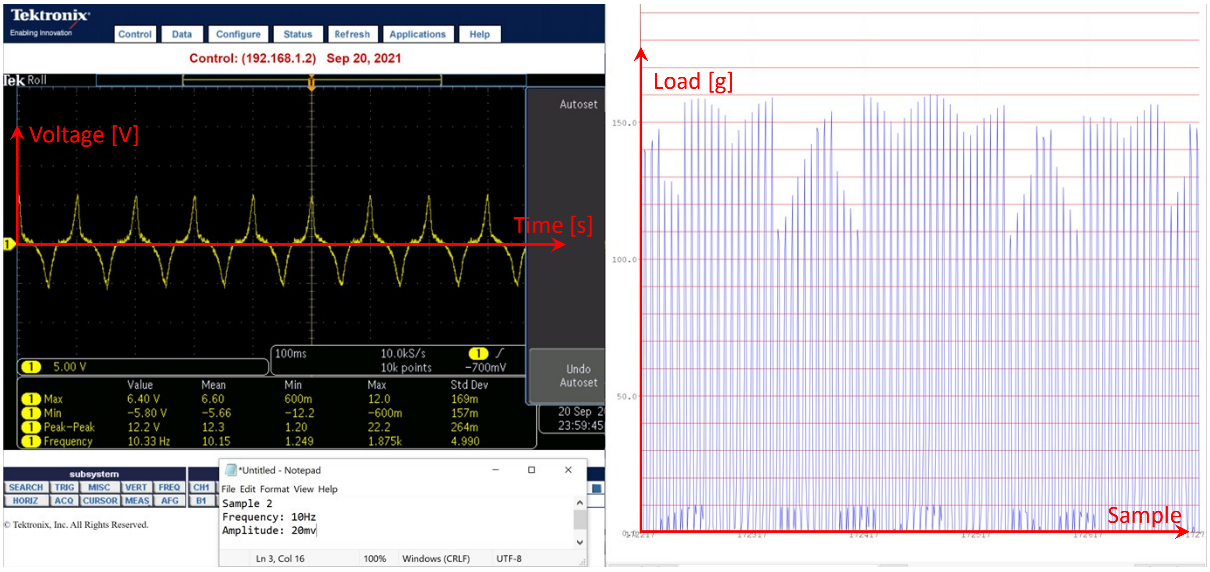

Control: (192.168.1.2) Sep 20, 2021

1 5.00 V

100ms 10.0kS/s 10k points 1 −700mV

	Value	Mean	Min	Max	Std Dev
1 Max	6.40 V	6.60	600m	12.0	169m
1 Min	−5.80 V	−5.66	−12.2	−600m	157m
1 Peak−Peak	12.2 V	12.3	1.20	22.2	264m
1 Frequency	10.33 Hz	10.15	1.249	1.875k	4.990

20 Sep 2
23:59:45

*Untitled - Notepad

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Sample 2
Frequency: 10Hz
Amplitude: 20mv
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Figure S1 Example of the output of the oscilloscope and Arduino

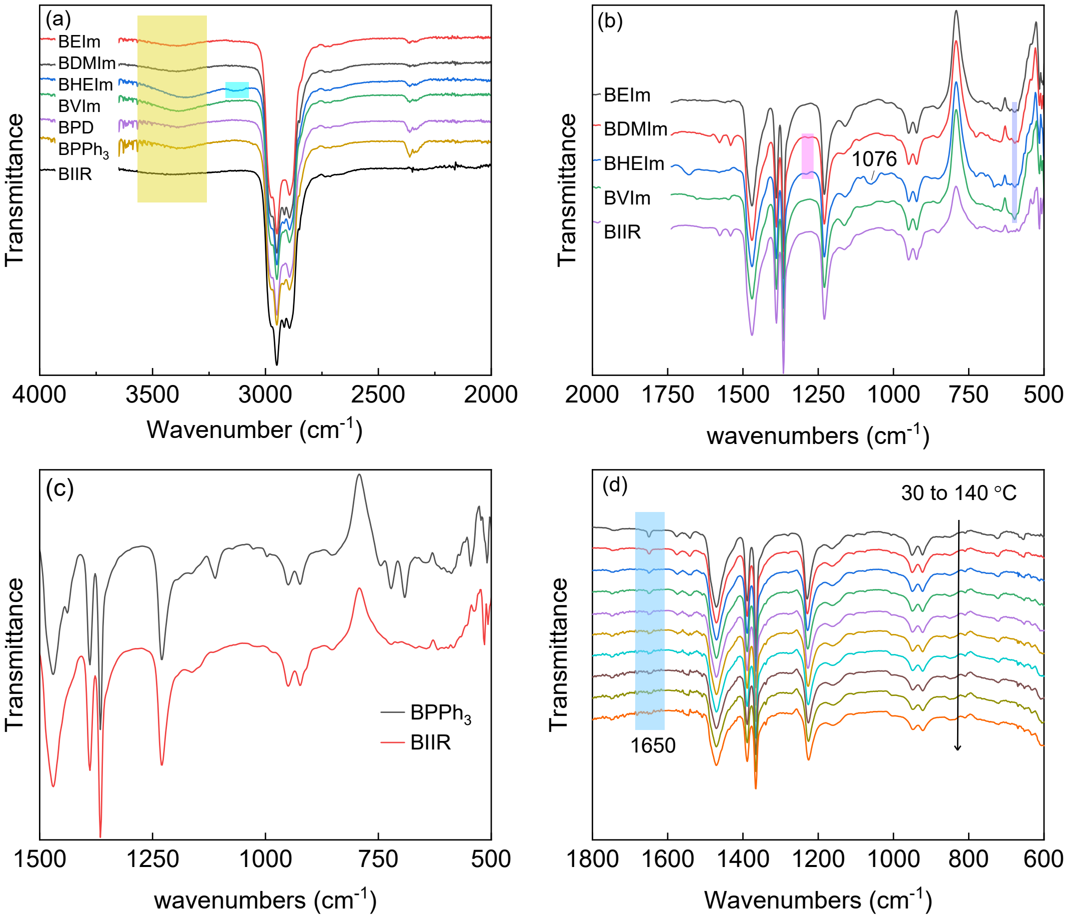

Figure S2 (a) FTIR spectra (measured at 30 °C) of BIIR and BEIm, BDMIm, BHEIm, BVIm, BPD and $BPPh_3$ gels after dissolving in toluene for 96 h and drying in 50 °C vacuum for 96h at 4000 ~2000 cm^{-1}, (b) FTIR spectra (measured at 30 °C) of BIIR and BEIm, BDMIm, BHEIm and BVIm gels after dissolving in toluene for 96h and drying in 50 °C vacuum for 96h at 2000 ~500 cm^{-1}, (c) FTIR spectra (measured at 30 °C) of BIIR and $BPPh_3$ gel after dissolving in toluene for 96h and drying in 50 °C vacuum for 96 h at 1500 ~500 cm^{-1}, (d) the temperature dependent FTIR spectra of BVIm mixture at 1800 ~600 cm^{-1} from 30 to 140 °C

As shown in Figure S2 (a) to (c), the alkylation of nucleophiles on the molecule of BIIR can be confirmed by following peaks:

(1) BEIm: the peaks at 3580 to 3250 cm^{-1} (assigned to the N-H vibration), the peak at 662 cm^{-1} (assigned to out-of-plane deformation of the imidazole ring);
(2) BDMIm: the peaks at 3580 to 3250 cm^{-1} and 662 cm^{-1}, and the weak peak at 1286 cm^{-1} (assigned to the combination of C-H stretching and out-of-plane bending of C-N on the imidazole ring).
(3) BHEIm: the peaks at 3580 to 3250 cm^{-1}, 1286 cm^{-1} and 662 cm^{-1}, and the peak 3132 cm^{-1} (attributed to C-H vibration of the imidazole ring).
(4) BVIm: the peak at 3580 to 3250 cm^{-1} and 662 cm^{-1}
(5) BPD: the peak at 3580 to 3250 cm^{-1}
(6) $BPPh_3$: the peak at 3580 to 3250 cm^{-}1, the peaks at 1439, 1111 and 692cm^{-1} (assigned to C-C out-of-plane vibration on the benzene ring), and the peak at 746 cm^{-1} (attributed to out-of-plane C-H vibration on the benzene ring).

As shown in Figure S3 (d), the peak at 1650 cm^{-1} of BVIm is assigned to C=C vibration of BIIR molecules, which becomes weak due to the free radical polymerization triggered during the heat process, indicating the decrease of C=C caused by covalent crosslinking.

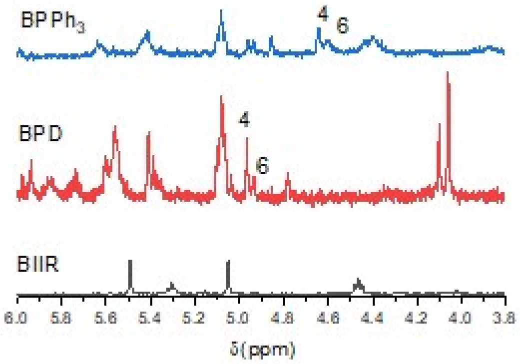

Figure S3. The olefin region of ^{1}HNMR spectra of pure BIIR, BPD and $BPPh_3$.

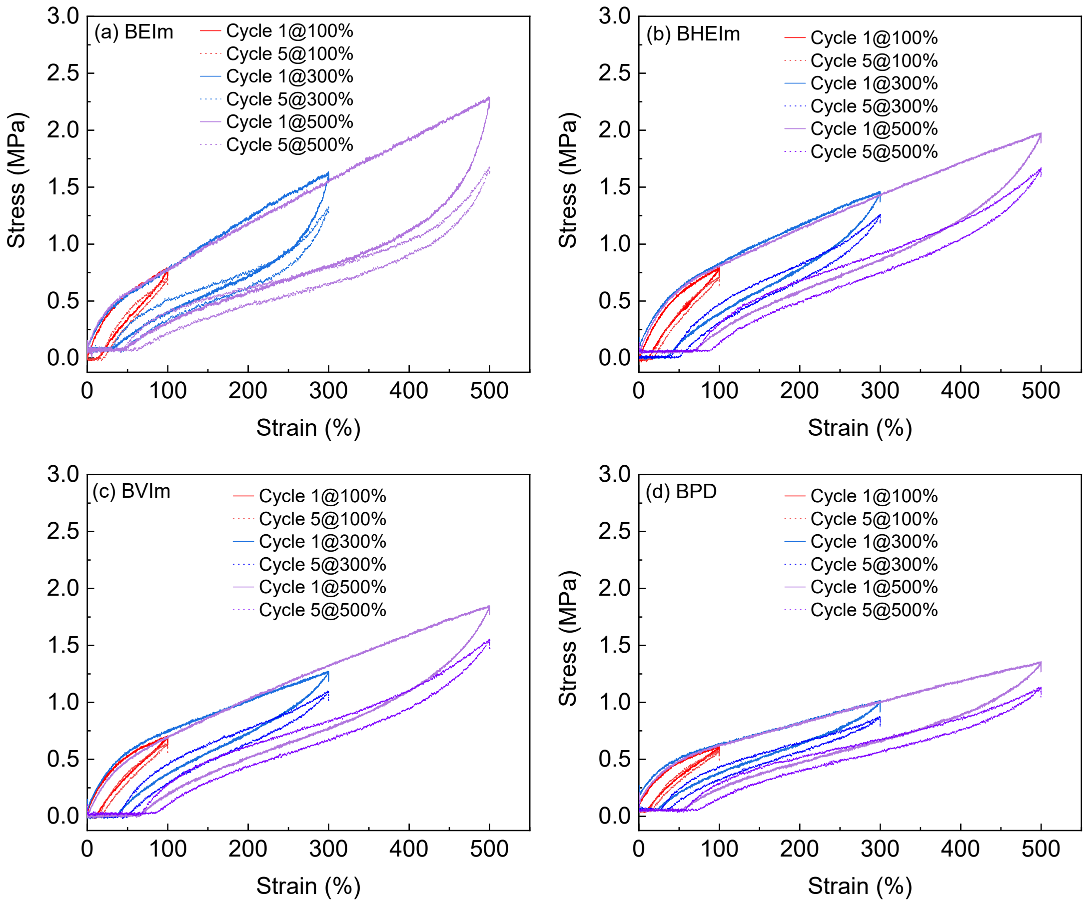

Figure S4 Cyclic tensile curve of (a) BEIm, (b) BHEIm, (c) BVIm, and (d) BPD with the maximum strain at 100%, 300% and 500%

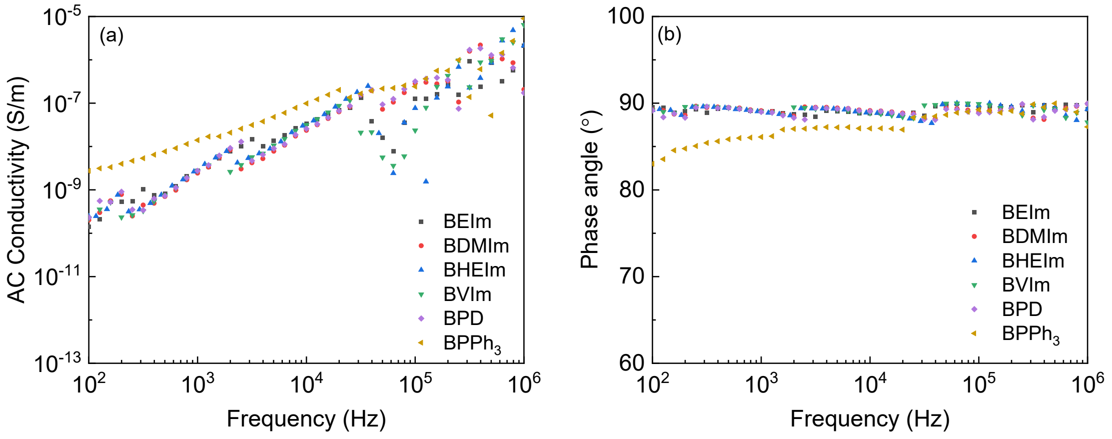

Figure S5 (a) Conductivity and (b) phase angle vs frequency curves of BIIR ionomers.