Chemically Recyclable Poly(Thiol-Ene) Elastomers

Connor Williamson, Chemical Engineering
Mentor: Kailong Jin, Dr.
School for Engineering of Matter, Transport, and Energy

Research question: How can crosslinked elastic polymers be synthesized such that they may be chemically reprocessed into their original form and be crosslinked once again?

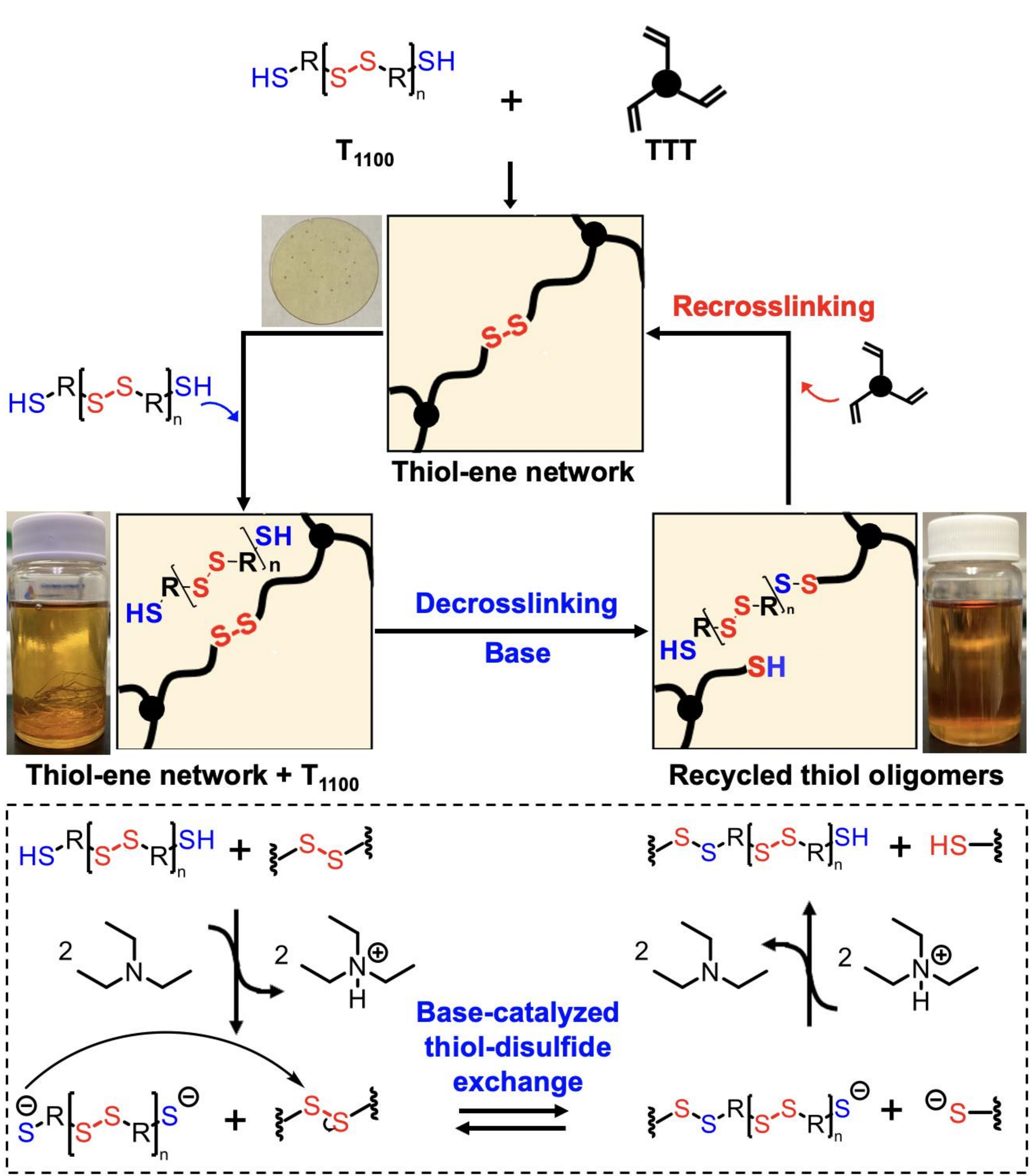

Fig. 1. Schematic overview of crosslinking/decrosslinking process

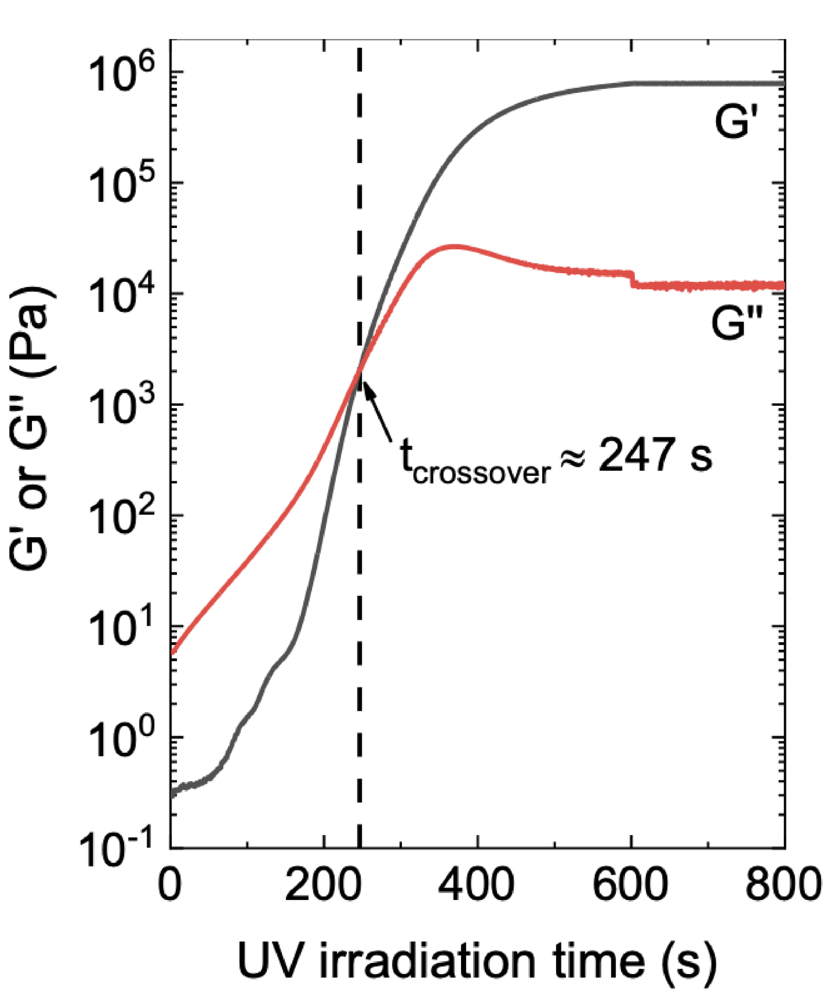

Fig. 2. Photorheological data indicates UV exposure time required to crosslink a sample at 10 mW cm^{-2} . Crossover between storage (G') and loss (G'') modulus indicates crosslinking.

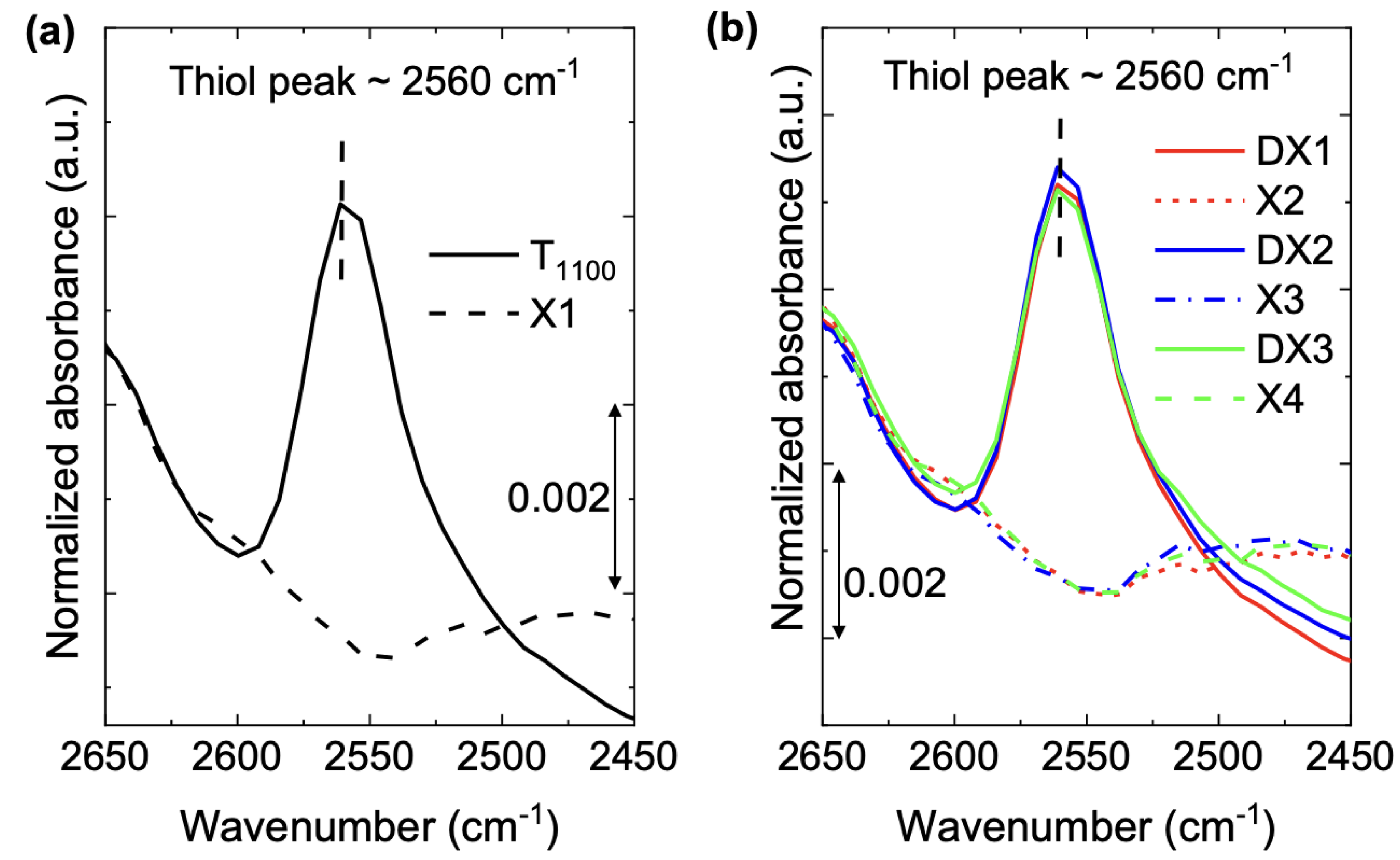

Fig. 3. IR spectra of **(a)** T_{1100} and X1; **(b)** decrosslinked and recrosslinked materials with increasing generation count.

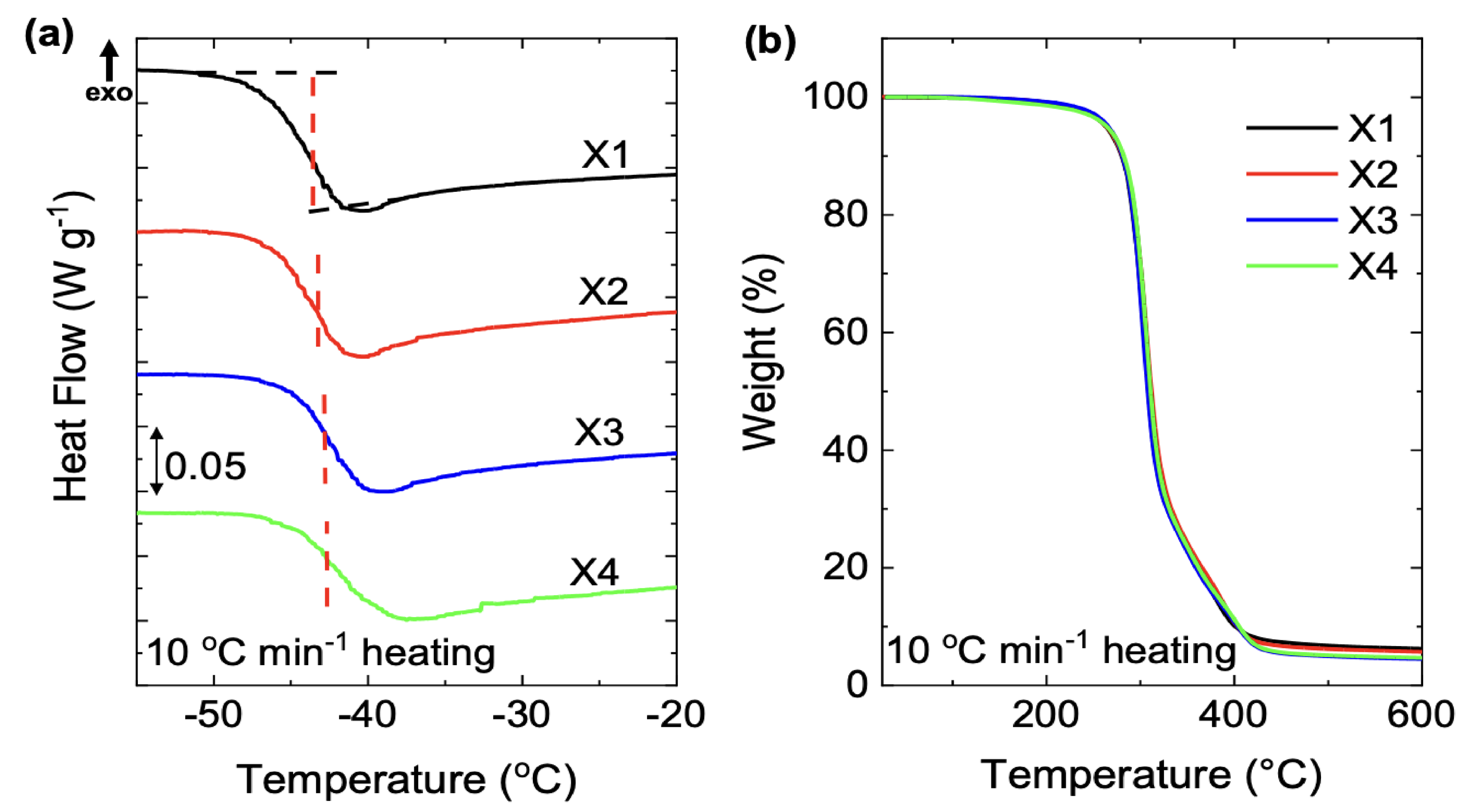

Fig. 4. a) DSC and **b)** TGA analysis of crosslinked X1, X2, X3, and X4 samples

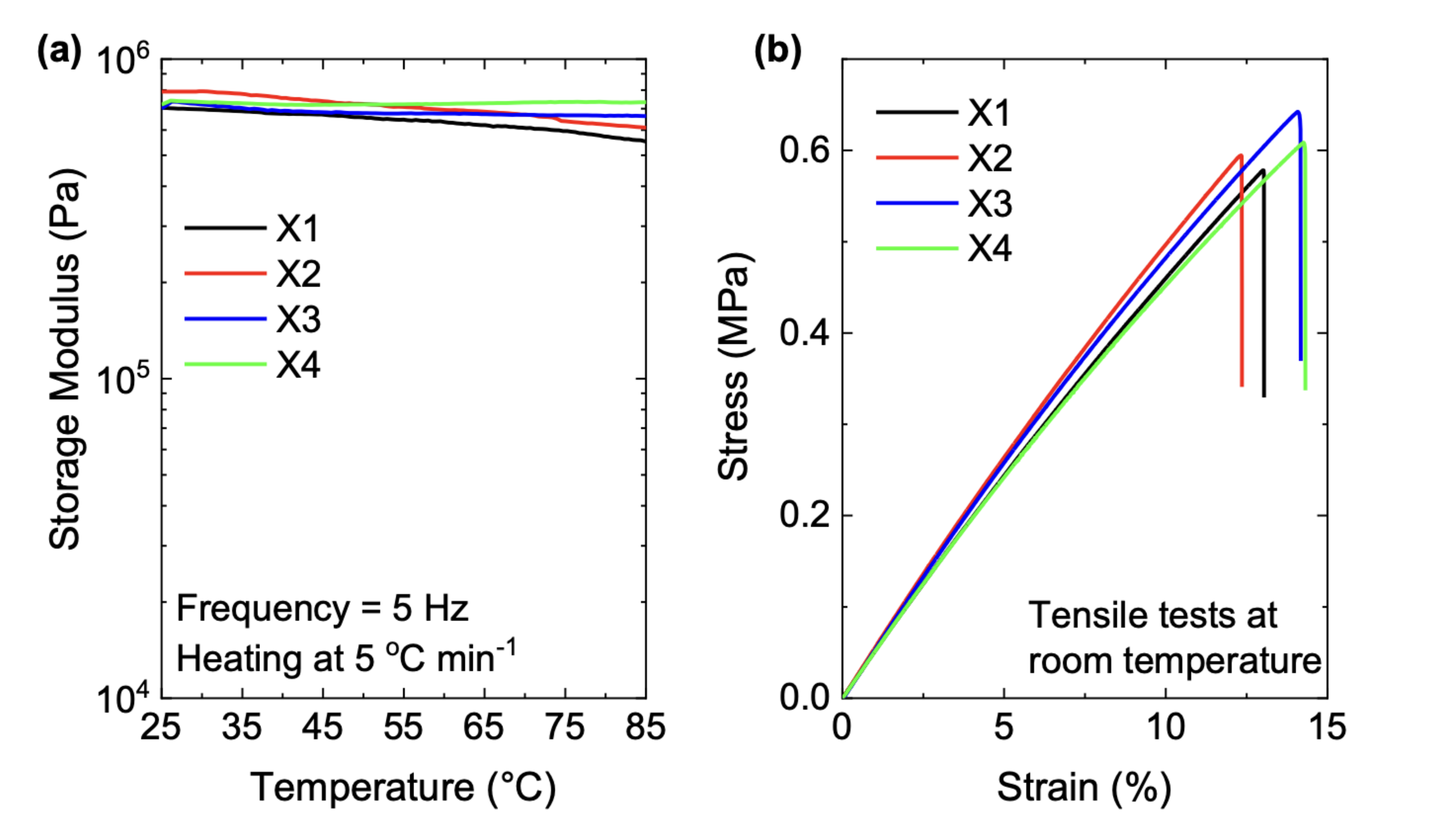

Fig. 5. a) G' vs T and **b)** destructive tensile testing data of crosslinked samples

Sample[a]	X1	X2	X3	X4
Gel fraction (%)	94.4 ± 0.4	94.2 ± 0.3	94.0 ± 0.7	94.8 ± 0.2
T_g (°C)	-43.3 ± 0.5	-43.0 ± 0.8	-42.8 ± 0.4	-42.7 ± 0.2
$T_{d \text{ at } 5wt\% \text{ loss}}$ (°C)	263.4 ± 0.1	263.7 ± 0.1	265.9 ± 1.1	264.3 ± 4.7
Storage modulus[b] [MPa]	0.61 ± 0.10	0.67 ± 0.10	0.67 ± 0.02	0.73 ± 0.10
Young's modulus[c] [MPa]	5.0 ± 0.1	5.5 ± 0.3	5.4 ± 0.2	5.1 ± 0.1
Elongation at break[c] [%]	12.4 ± 1.6	12.1 ± 2.2	14.0 ± 1.8	14.3 ± 1.5
Tensile strength[c] [MPa]	0.54 ± 0.10	0.58 ± 0.10	0.64 ± 0.10	0.61 ± 0.10

a) Reported errors are standard deviations from multiple measurements.
b) Storage modulus measured at 70 °C
c) Tensile properties measured at 25 °C

Fig. 6. Compiled physical property table for 4 generations of crosslinked samples

Findings thus far: Polymers produced with the goal of recycling in mind maintain physical Properties even after several generations of decrosslinking and recrosslinking.

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