Supplementary Information (SI) for Green Chemistry.
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Supplemental Information

Development of Degradable Epoxy-Acid Thermosetting Polymers and Recyclable Composites by Dual-functional Liquid Hardeners Derived from Solid Carboxylic Acids

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Supplemental Tables

Sample	**Flexural Stress (Mpa)**	**Flexural Strain (%)**	**Flexural Modulus (Gpa)**
SuA	86.55±31.53	2.45±0.69	3.97±0.49
SeA	163.71±27.61	4.79±1.11	4.03±0.42
AzA	117.26±48.06	3.37±1.64	3.79±0.56
DdA	88.35±49.07	3.59±2.40	2.80±0.30
tChA	44.94±4.50	1.13±0.14	3.17±0.58
oPA	46.72±5.8	1.18±0.14	3.59±0.14
iPA	34.93±13.88	0.99±0.30	3.23±0.56
cChA	59.12±12.04	1.37±0.15	4.85±0.52
Infusion Resin	58.88±4.60	10.97±1.83	0.76±0.04

Table S1. Flexural properties of neat polymer samples.

Table S2. Summary of prior work (Ref. 22) contrasted with the developments in the present work.

	Previous Work (J. Mater. Chem. A, 2025)	**Present Work**
Core concept	Established that DMAEMA forms a supramolecular ionic liquid complex with solid dicarboxylic acids creating low viscosity dual cure hardeners	Develops the established ionic-liquid hardener platform with a specific focus on enabling circular recovery of composite fibers through chemically recyclable network design
Tertiary amine (meth)acrylate	DMAEMA	DMAEMA and DMAEA
Epoxy monomer	Glycerol and sorbitol based	BADGE and TMPTGE
Mechanical testing	Tensile data on two acid systems	Flexural strength, viscosity, and DMA on 8 acids (aromatic, cyclic, linear)
Recyclability	Not explored	Enabled through ethylene glycol transesterification at 170 ºC
Composite application	Listed as future work	Glass fiber composites manufactured via VARTM enabling closed loop fiber recovery with 2nd life UTS within 4% of virgin
Nucleophilic catalyst	Not explored	Both EMI-2,4 and TPP explored to tame etherification in the form of epoxy photopolymerization and improve degradability

Table S3. Formulations of the polymers synthesized in this study, given in mass and based on 0.01 mol of acid and (meth)acrylate functional groups.

Sample name	DMAEMA (g)	DMAEA (g)	Acid (g)	BADGE (g)	TMPTGE (g)	Catalyst (g)	BHT (g)	TPOL (g)
iPA	0.942	0.573	0.830, iPA	0.851	0.504	0	0.025	0.037
oPA	0.942	0.573	0.830, oPA	0.851	0.504	0	0.025	0.037
DdA	0.942	0.573	1.152, DdA	0.851	0.504	0	0.025	0.037
SeA	0.942	0.573	1.010, SeA	0.851	0.504	0	0.025	0.037
AzA	0.942	0.573	0.941, AzA	0.851	0.504	0	0.025	0.037
SuA	0.942	0.573	0.871, SuA	0.851	0.504	0	0.025	0.037
cChA	0.942	0.573	0.860, cChA	0.851	0.504	0	0.025	0.037
tChA	0.942	0.573	0.860, tChA	0.851	0.504	0	0.025	0.037
1% EMI-2,4	1.570	0	1.010, SeA	0.851	0.504	EMI-2,4, 0.039	0.025	0.037
5% EMI-2,4	1.570	0	1.010, SeA	0.851	0.504	EMI-2,4, 0.197	0.025	0.037
1% TPP	1.570	0	1.010, SeA	0.851	0.504	TPP, 0.039	0.025	0.037
5% TPP	1.570	0	1.010, SeA	0.851	0.504	TPP, 0.197	0.025	0.037
Control	1.570	0	1.010, SeA	0.851	0.504	0	0.025	0.037
0% Acrylate	1.570	0.000	0.860, cChA	0.851	0.504	0	0.025	0.037
10% Acrylate	1.413	0.143	0.860, cChA	0.851	0.504	0	0.025	0.037
20% Acrylate	1.256	0.246	0.860, cChA	0.851	0.504	0	0.025	0.037
30% Acrylate	1.099	0.430	0.860, cChA	0.851	0.504	0	0.025	0.037
40% Acrylate	0.942	0.573	0.860, cChA	0.851	0.504	0	0.025	0.037
Infusion Resin	0.942	0.573	1.010, SeA	0.851	0.504	EMI-2,4, 0.197	0.025	0.037

Supplemental Figures

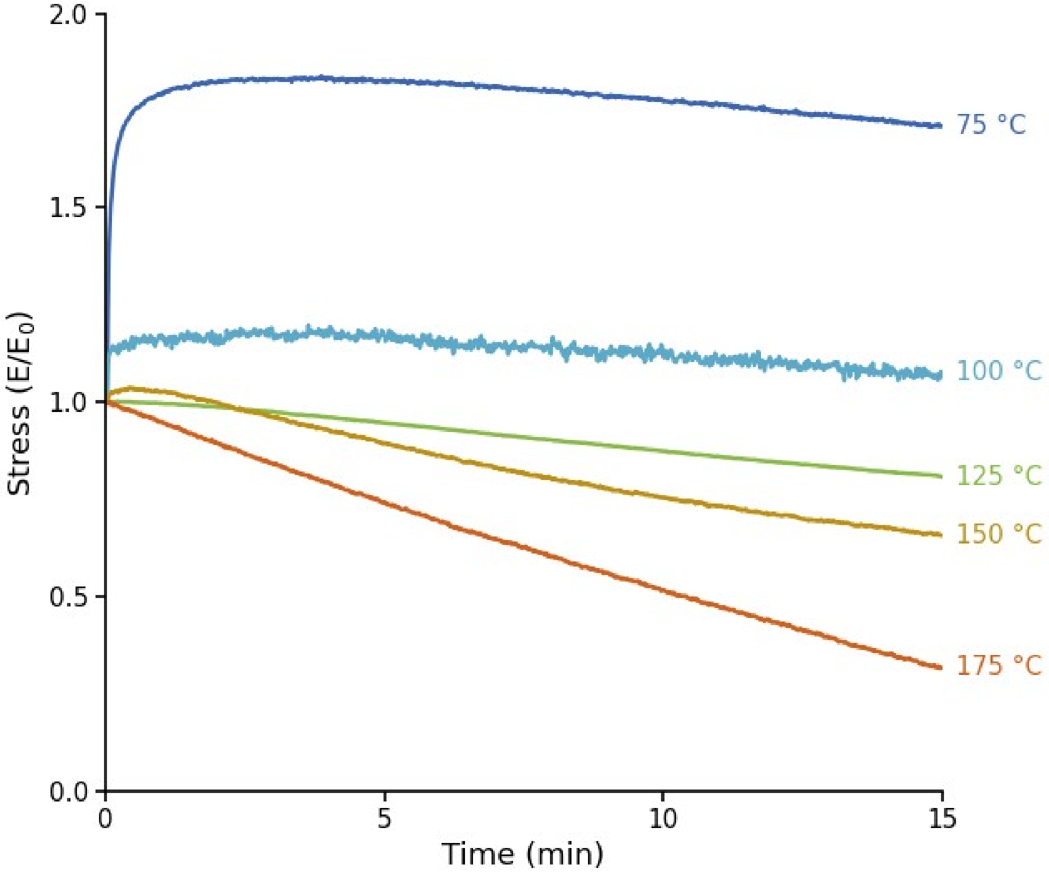

Figure S1. Stress relaxation behavior of 5wt.% EMI-2,4 polymer sample with 1% tensile strain on a rectangular specimen.

Figure S2. Photo of the sample produced with non-reactive tertiary amine catalyst, Dimethylethanolamine (DMAE) at 23 ºC.

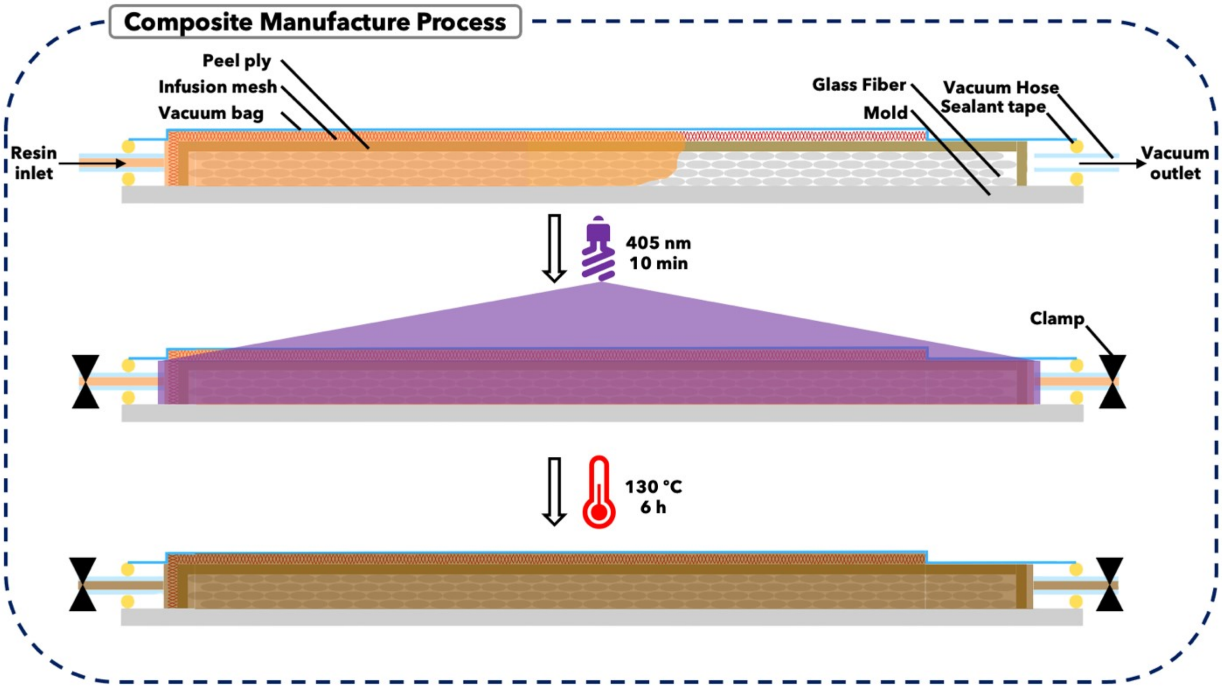

Figure S3. Scheme showing the photo-heat composite manufacturing process.

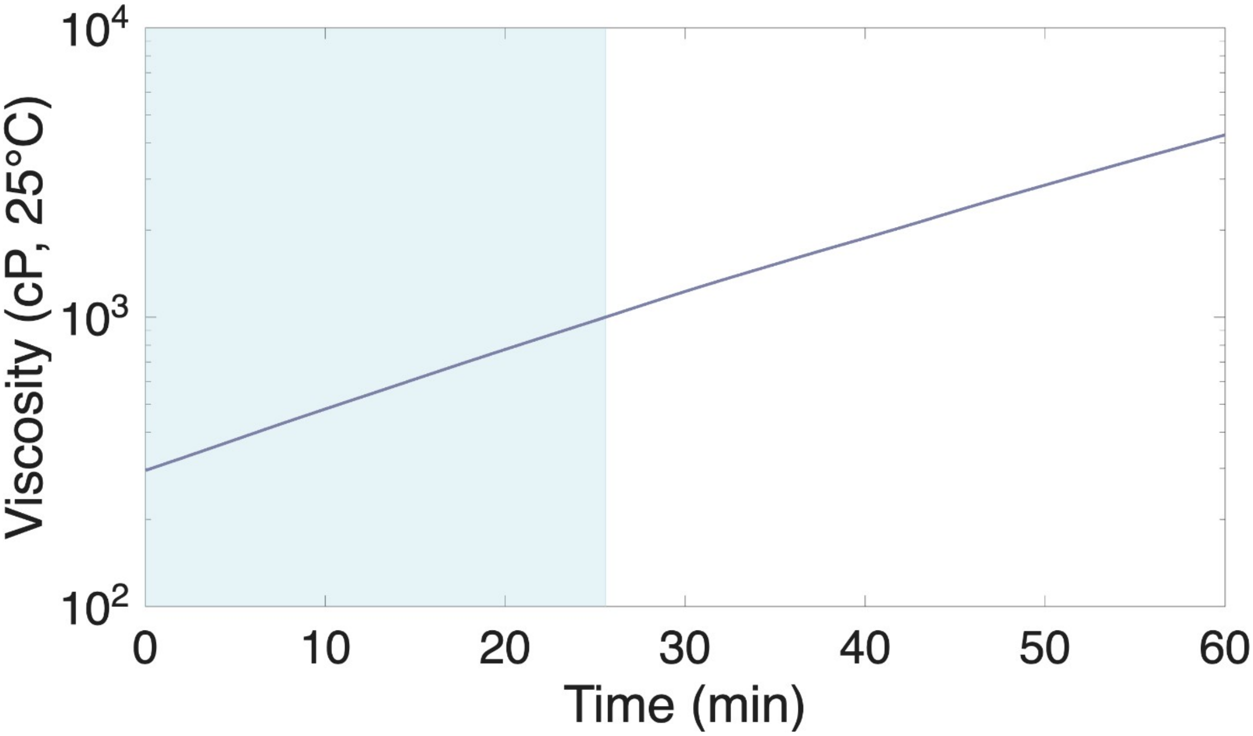

Figure S4. Viscosity of 5wt.% EMI-2,4 resin over time with infusible time highlighted in blue, denoting time till viscosity exceeds 1000 cP.

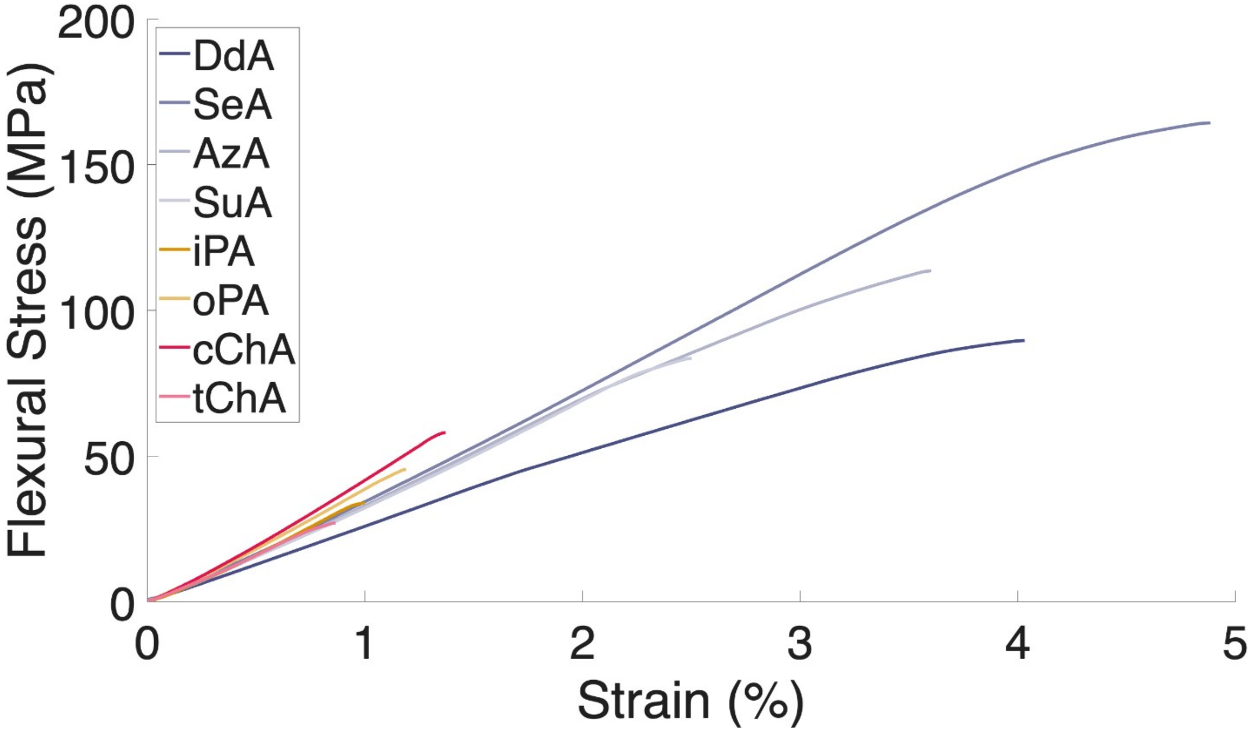

Figure S5. Flexural strength of neat polymer samples.

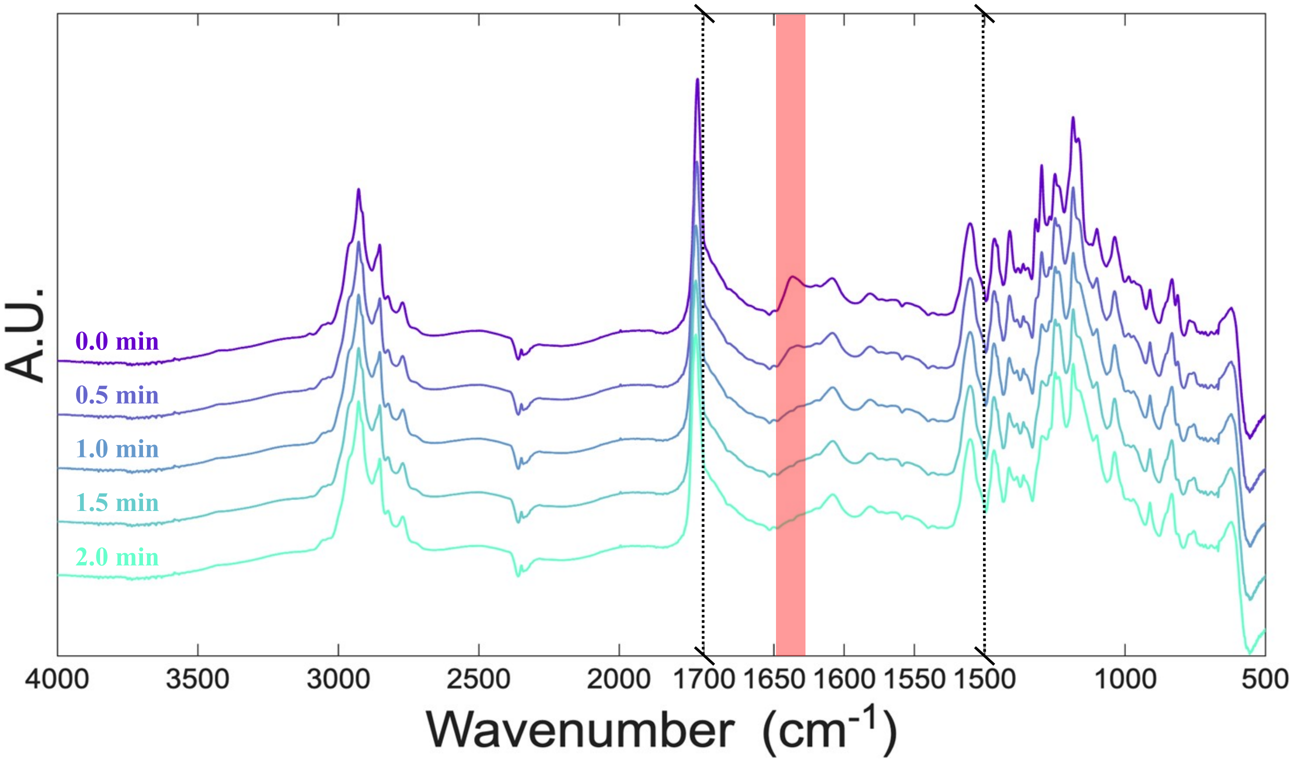

Figure S6. UV time series FTIR of SeA neat resin system at 5mW/cm^2 showing conversion of (meth)acrylate peak.

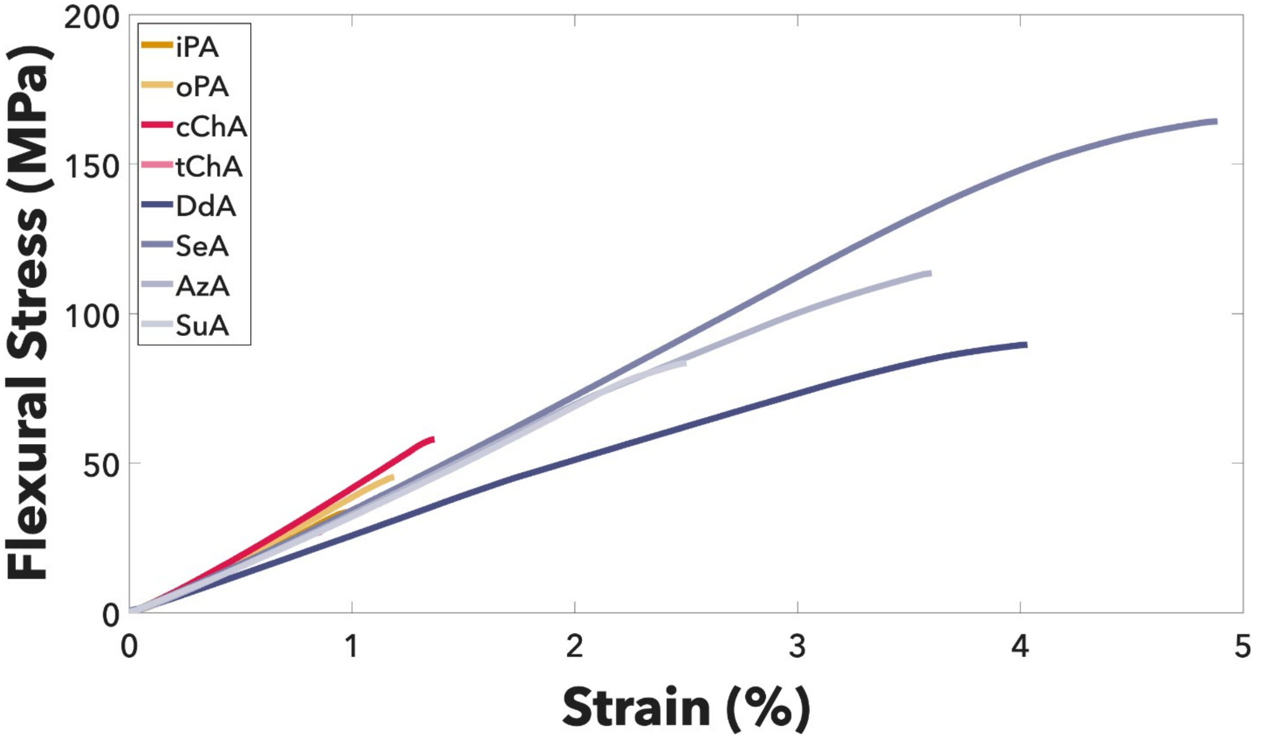

Figure S7. Flexural strength of neat polymer samples.

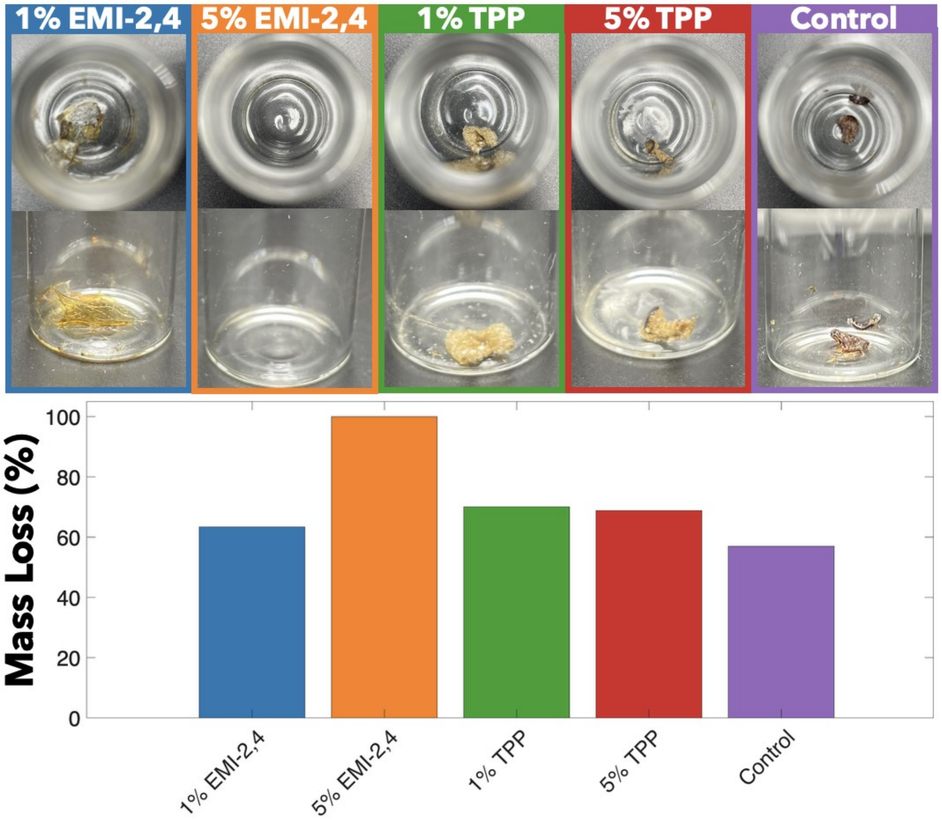

Figure S8. Degradation of methacrylate SeA polymer with varying catalyst loading.

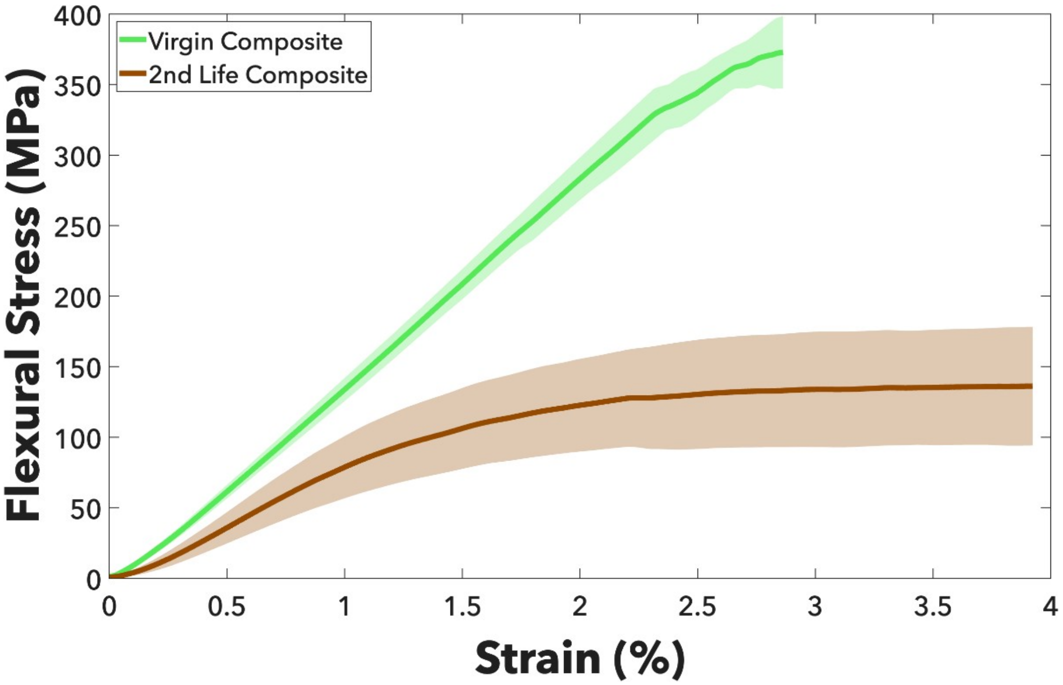

Figure S9. Stress-strain curve of virgin vs second life composite parts using SeA resin without the inclusion of 5wt% EMI-2,4