Supporting information

Itaconic acid-based hyperbranched polymer toughened epoxy resins with rapid stress relaxation, superb solvent resistance and closed-loop recyclability

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SUMMARY

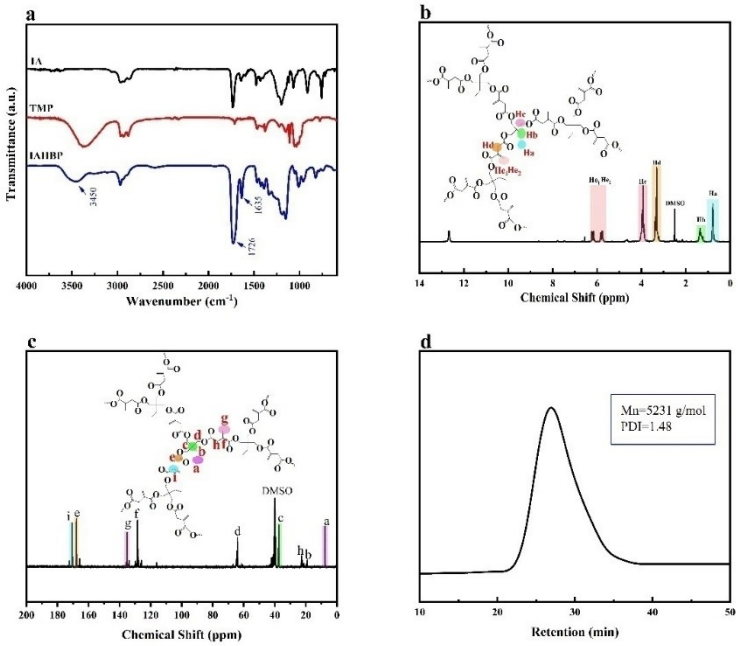

Figure S1. FTIR spectra (a), ^{1}H NMR spectra (b), ^{13}C NMR spectra (c), and GPC trace (d) of IAHBP.

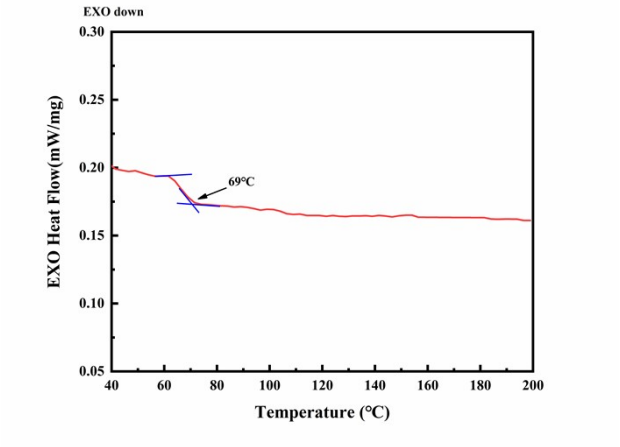

Figure S2. DSC curves of DGEBA/IAHBP after curing at 120 °C for 2 h.

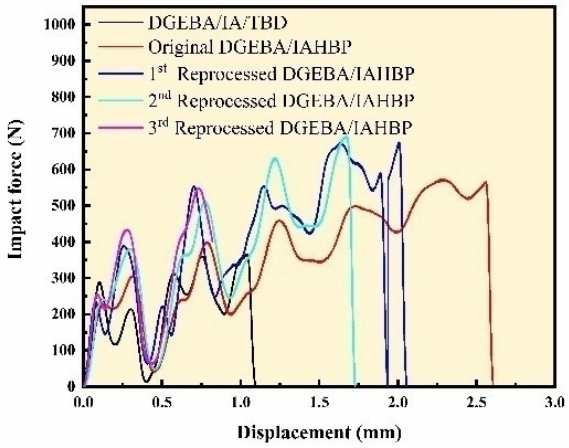

Figure S3. The impact force-displacement curves of DGEBA/IAHBP before and after reprocessed.

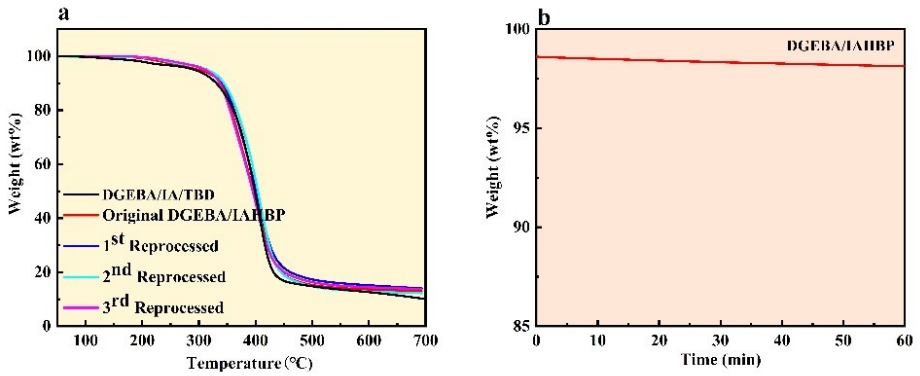

Figure S4. The TGA curves of different epoxy vitrimers (a) and DGEBA/IAHBP at 150℃.

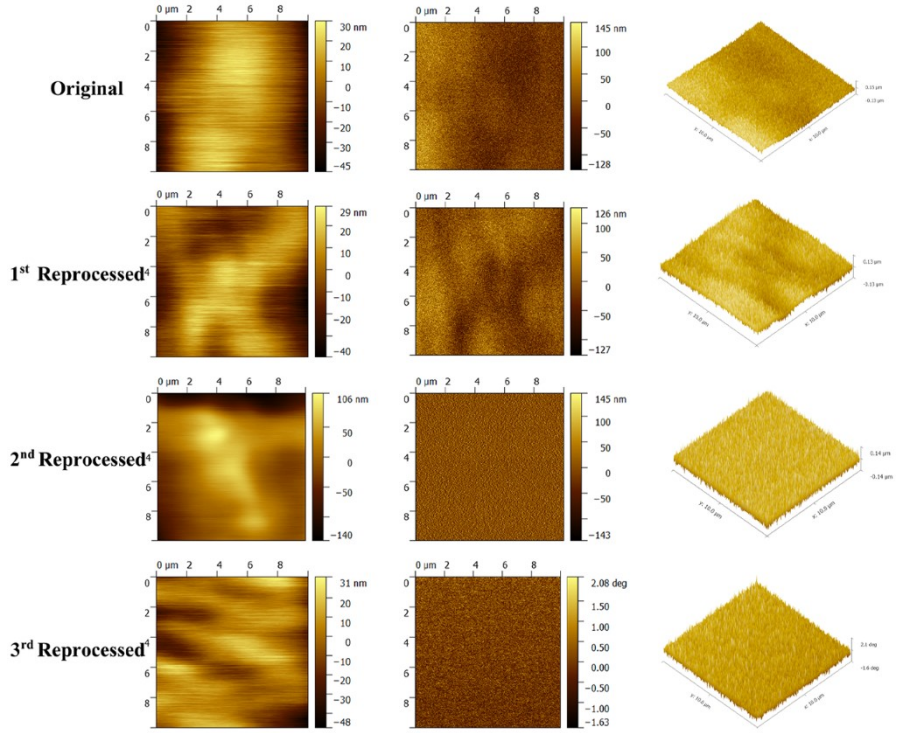

Figure S5. AFM images including height image, phase image and three-dimensional image of phase of DGEBA/IAHBP before and after reprocessed.

Table S1. The formations of different epoxy vitrimers.

Samples	DGEBA(g)	IAHBP(g)	IA(g)	TBD(g)
DGEBA/IAHBP	7.24	9.77	0.00	0.00
DGEBA/IA	10.01	0.00	3.32	0.00
DGEBA/IA/TBD	10.01	0.00	3.32	0.13

Table S2. Detailed results for DSC curves of DGEBA/ IAHBP, DGEBA/IA and DGEBA/IA/TBD mixtures.

Samples	T_i(℃)	T_p(℃)	ΔH(J/g)
DGEBA/IA/TBD	121.8	175.5	189.3
DGEBA/IA	133.0	181.1	145.9
DGEBA/IAHBP	110.1	154.8	187.3

Table S3. The mechanical properties of DGEBA/IA/TBD and DGEBA/IAHBP.

Samples	DGEBA/IA/TBD	DGEBA/IAHBP			
		Original	1st Reprocessed	2nd Reprocessed	3rdReprocessed
Tensile strength, MPa	60.8 ± 2.1	91.0±3.2	83.2±2.5	81.9±1.1	82.6±1.1
Impact strength, KJ/m^2	8.7±1.2	18.4±0.2	17.9±1.6	17.4±0.4	17.5±0.1
Flexural strength, MPa	85.9±1.1	121.8±3.8	116.2±1.9	115.5±0.1	114.4±0.2
Flexural modulus, GPa	2.6±0.2	3.7±0.1	3.5±0.2	3.3±0.2	3.1±0.2

Table S4. DMA data of original and reprocessed DGEBA/IAHBP.

Samples	*Tg*, ºC	*Ec*, MPa	*Ed*, MPa	ρ, $\times10^{-3}$ (mol/cm^3)
R0	67	2839.45	17.30	1.77
R1	68	2749.28	17.56	1.80
R2	66	2575.32	18.13	1.85
R3	66	2524.63	17.97	1.82

Table S5. Values of shape memory properties of the original and reprocessed of DGEBA/IAHBP.

Samples	R_f, %									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Original sample	98.1	97.9	97.7	97.6	97.3	96.9	96.5	96.1	95.8	95.1
1st Reprocessed	94.2	93.9	94.0	94.2	94.6	94.1	94.0	93.8	94.2	94.6
2nd Reprocessed	93.4	93.2	93.5	93.1	93.1	93.5	93.7	93.8	93.1	93.4
3rd Reprocessed	92.5	92.3	92.4	92.6	92.7	92.4	92.0	92.6	92.1	92.3
Samples	R_r, %									
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
Original sample	97.0	96.8	97.3	97.2	96.7	95.9	97.1	96.3	96.4	97.1
1st Reprocessed	97.3	96.8	98.3	97.5	97.3	98.0	96.7	97.4	98.2	97.7
2nd Reprocessed	97.2	97.9	97.3	97.5	97.9	97.3	96.6	97.7	96.2	96.3
3rd Reprocessed	97.8	97.4	98.2	97.9	97.4	98.3	97.5	97.8	96.2	97.3

Table S6. The gel contents and swelling ratios of epoxy vitrimers.

Samples	Gel contents, %	Swelling ratios					
		THF		DMSO		TCB	
		RT	40℃	RT	140℃	RT	140℃
DGEBA/IA/TBD	96.3	13.9	21.2	18.8	31.3	10.5	21.3
DGEBA/IAHBP	99.9	10.1	18.1	16.4	28.8	6.7	15.4

Table S7. Mechanical properties and DMA data of original and chemically recycled DGEBA/IAHBP.

Samples	Tensile strength (MPa)	Toughness (MJ/m^3)	T_g (℃)	E_c (MPa)	ρ ($\times10^{-3}mol/cm^3$)
Original DGEBA/IAHBP	91.0±3.2	2.5±2.1	67	2839.45	1.77
Chemically recycled DGEBA/IAHBP	81.8±1.5	2.6±1.9	65	2446.80	1.62