Supporting Information

Preparation of environment-friendly solid epoxy resin with high-toughness via one-step banburying

Gaobo Lou, Qing Li, Qian Jin, Qingqing Rao, Shenyuan Fu*, Jinfeng Dai**

School of Chemistry and Materials Engineering, Zhejiang A&F University, Hangzhou 311300, China.

Corresponding author:

E-mail: qqrao@zafu.edu.cn (Q.Q. Rao)

E-mail: jinfengdai0601@gmail.com (J.F. Dai)

Email: fshenyuan@sina.com (S.Y. Fu)

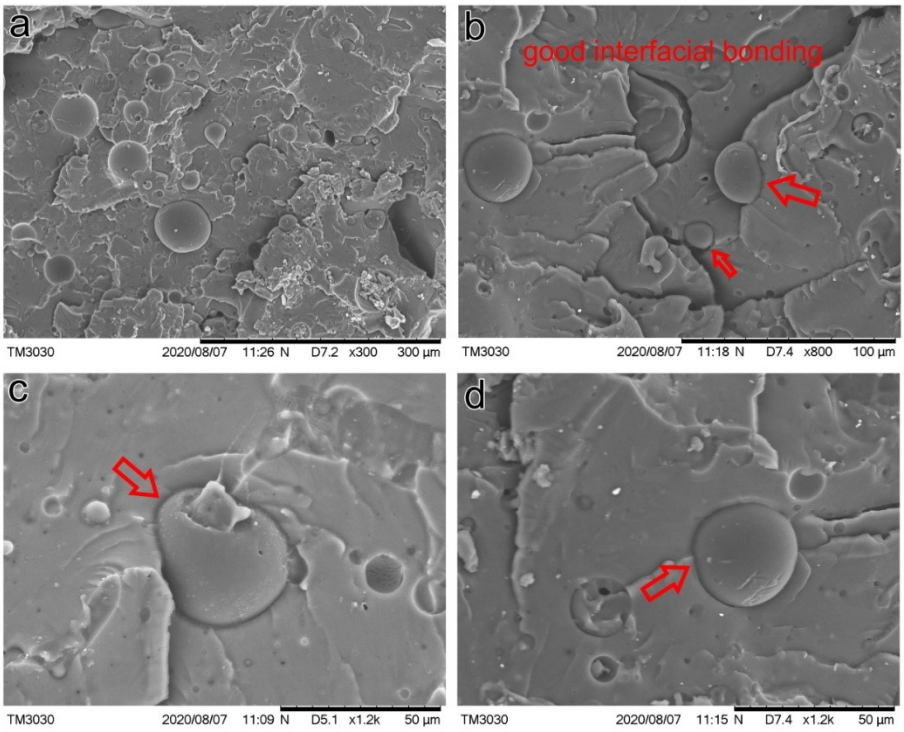

Fig. S1. The SEM micrographs of impact fracture surface of R-EM10.

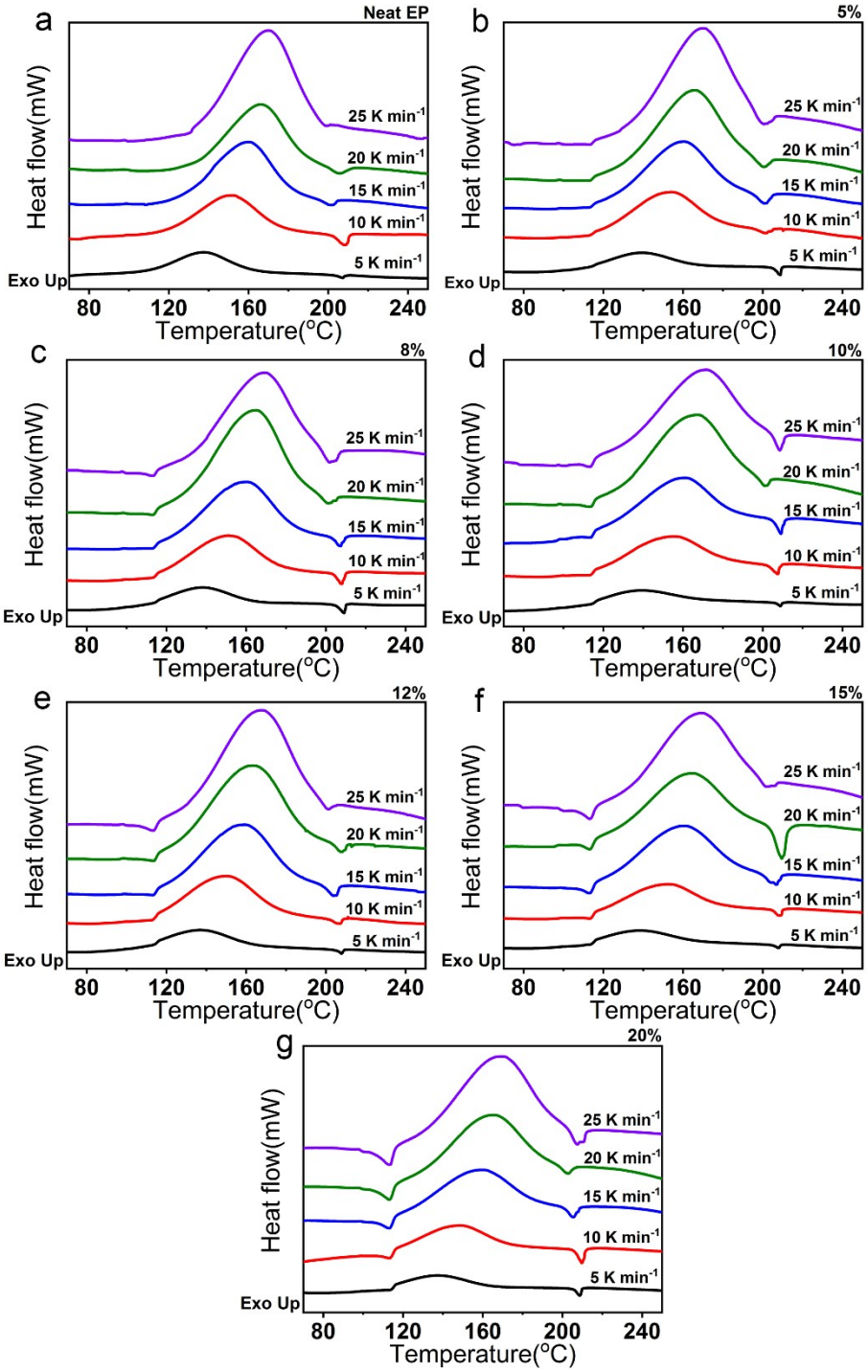

Fig. S2. DSC curves of epoxy systems with heat rates of 5, 10, 15, 20, 25 K min^{-1}: EVA-g-MAH addition amount of (a) 0 wt%, (b) 5 wt%, (c) 8 wt %, (d) 10 wt %, (e) 12 wt %, (f) 15 wt % and (g) 20 wt %, respectively.

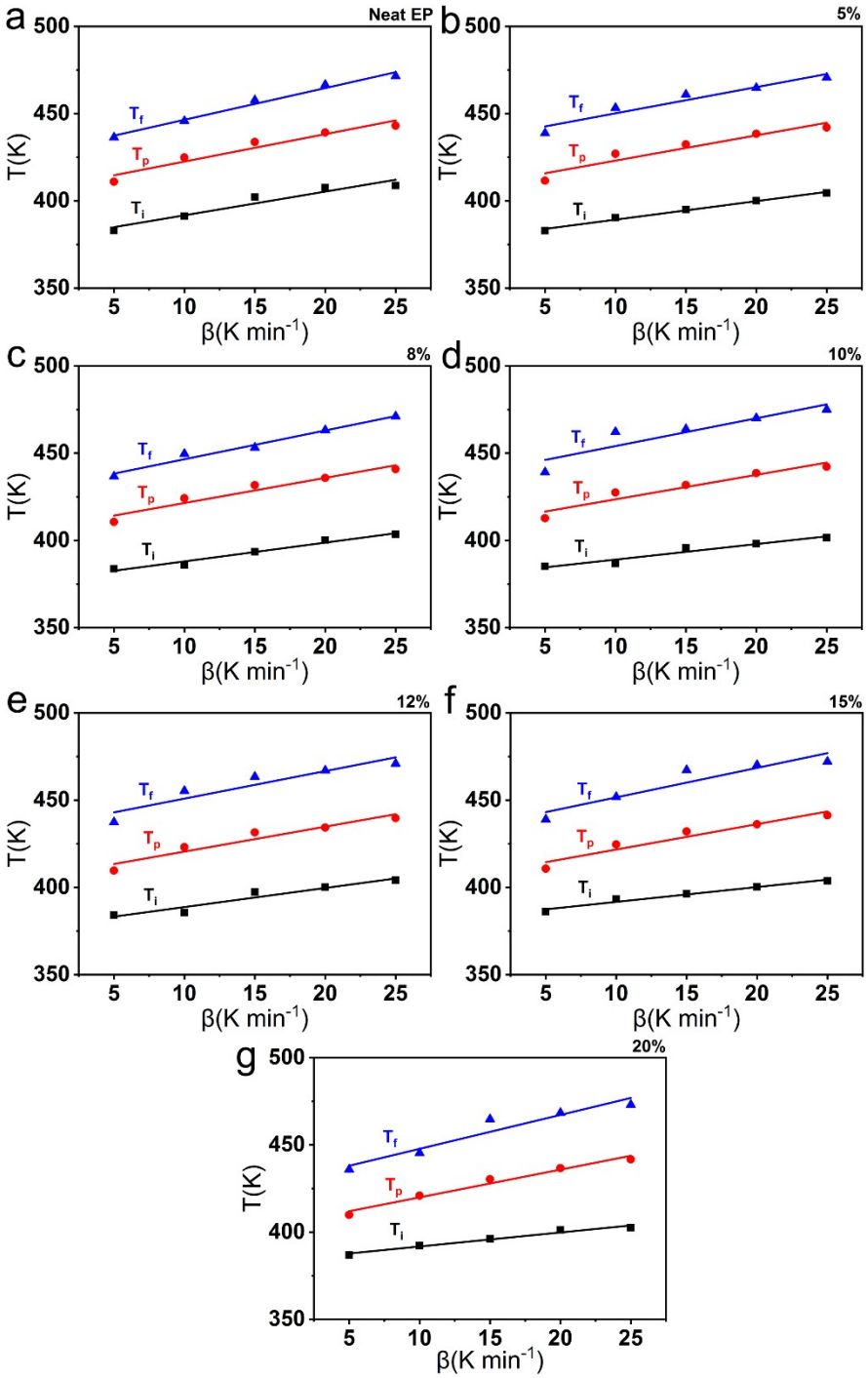

Fig. S3. T-β diagram of epoxy systems with different content EVA-g-MAH: (a) 0 wt%, (b) 5 wt%, (c) 8 wt %, (d) 10 wt %, (e) 12 wt %, (f) 15 wt % and (g) 20 wt %, respectively.

Table S1. DSC curing data of modified epoxy systems with different content EVA-g-MAH

Systems	β (K min^{-1})	T_i (K)	T_p (K)	T_f (K)	△H (J g^{-1})
Neat EP	5	382.93	410.97	436.36	96.60
	10	391.24	424.87	445.80	100.00
	15	402.09	433.71	457.61	103.20
	20	407.51	439.22	466.47	82.79
	25	408.75	443.09	471.47	118.6
R-EM5	5	382.84	411.6	438.80	65.88
	10	390.26	426.97	453.26	84.62
	15	395.02	432.35	460.89	90.26
	20	400.07	438.45	464.75	77.58
	25	404.46	442.05	470.60	95.05
R-EM8	5	383.75	410.67	436.67	74.67
	10	385.91	424.19	449.66	84.64
	15	393.51	431.67	453.22	89.69
	20	400.24	435.86	463.22	100.10
	25	403.46	440.88	471.10	79.90
R-EM10	5	385.14	412.72	439.14	63.14
	10	386.63	427.52	462.18	92.75
	15	395.86	431.77	463.81	73.34
	20	398.15	438.63	470.08	107.97
	25	401.57	442.22	475.00	70.59
R-EM12	5	384.05	409.59	437.32	82.70
	10	385.46	423.12	455.25	97.62
	15	397.34	431.56	463.36	95.14
	20	400.04	434.35	467.03	93.09
	25	404.1	439.67	470.85	85.01
R-EM15	5	386.05	410.71	438.95	64.56
	10	393.21	424.61	451.84	65.16
	15	396.37	432.07	467.24	78.88
	20	400.32	436.18	470.1	65.37

	25	403.78	441.26	472.08	66.65
R-EM20	5	386.82	409.84	435.92	50.55
	10	392.35	420.89	445.34	57.44
	15	396.12	430.34	464.75	57.64
	20	401.25	436.64	468.32	66.09
	25	402.48	441.69	473.01	67.43

Table S2. Kinetic parameters of the curing reaction for epoxy systems with different content EVA-g-MAH

Systems	**Kissinger**			**Ozawa**		**n**
	E_a**(KJ/mol)**	**A(s^{-1})**	R^2	E_a**(KJ/mol)**	R^2	
Neat EP	67.8	9.81×10^4	0.997	71.2	0.998	0.9053
R-EM5	73.0	4.50×10^5	0.985	76.1	0.988	0.9115
R-EM8	73.9	6.54×10^5	0.995	77.0	0.996	0.9128
R-EM10	76.0	1.10×10^6	0.982	79.4	0.985	0.9147
R-EM12	73.5	6.02×10^5	0.987	76.5	0.989	0.9125
R-EM15	73.2	5.11×10^6	0.994	76.3	0.995	0.9119
R-EM20	67.9	1.14×10^6	0.992	71.2	0.994	0.9056

Table S3. Gelation, curing and post-treatment temperature of epoxy systems with different content EVA-g-MAH

Systems	T_{gel}**(K)**	T_{cure}**(K)**	T_{treat}**(K)**
Neat EP	378.1	406.8	428.3
R-EM5	378.6	408.6	435.1
R-EM8	377.2	407.0	430.0
R-EM10	380.2	409.5	438.2
R-EM12	377.8	406.2	435.1
R-EM15	383.2	407.2	434.7
R-EM20	383.7	404.0	428.3

Table S4. DMA parameters of epoxy systems with different content EVA-g-MAH

Systems	T_g(°C)	E′ at T_g +30 °C (MPa)	v_e (*10^3 mol/m^3)
Neat EP	111.09	1.68	0.163
R-EM5	113.45	3.51	0.338
R-EM8	112.66	3.62	0.349
R-EM10	111.48	1.95	0.189
R-EM12	110.10	2.76	0.268
R-EM15	112.52	6.00	0.579
R-EM20	114.24	4.44	0.426

Table S5. Characteristic parameters of the neat epoxy and EVA-g-MAH modified epoxy systems from the thermogravimetric plots.

Systems	$T_{5\%}$ (°C)	T_{max} (°C)	Char yield at 800 °C (%)
Neat EP	368.1	444.1	1.5
R-EM5	365.6	445.6	0.4
R-EM8	372.2	446.3	4.0
R-EM10	380.7	449.1	8.5
R-EM12	378.4	445.9	6.5
R-EM15	375.8	447.1	7.7
R-EM20	376.9	449.5	6.4