Electronic Supplementary Material (ESI) for RSC Advances.

Electronic Supplementary Information

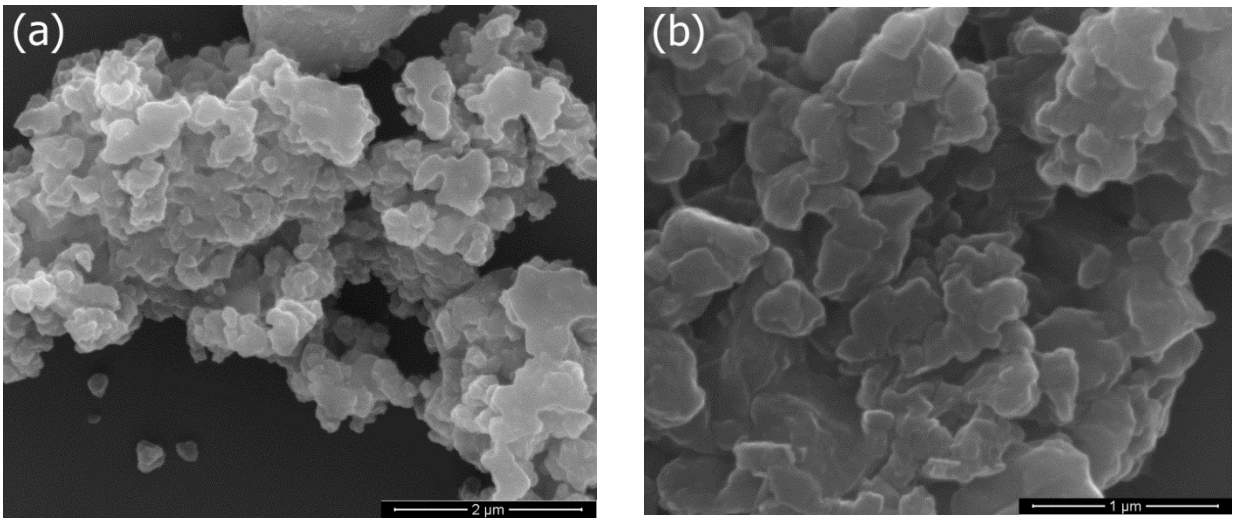
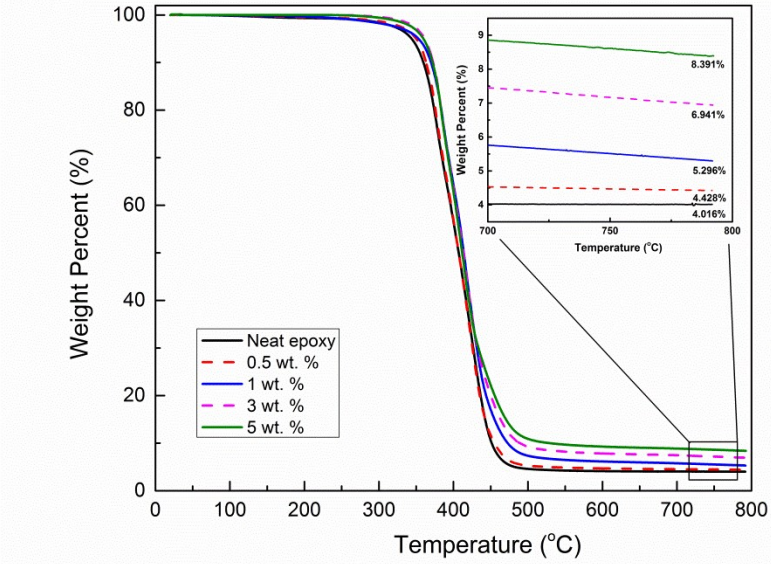


Figure S1. SEM images of asphaltene particles at (a) 20,000 ×; (b) 40,000 ×

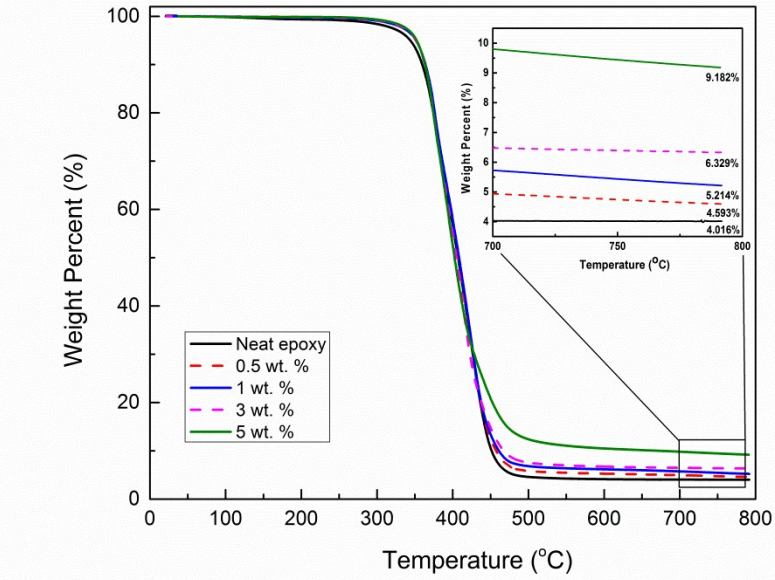
Table S1. Deconvoluted peak data of high-resolution spectra of elements in functionalized asphaltene

		Atomic concentration (%)	**Position (eV)**	**FWHM (eV)**	**Area**	**%Area**	**Bond assignments**
GPTMS-treated	C 1s	88.05	284.86	2.0	69152	97.56	C-C / C-H
			286.47	1.6	1697	2.39	C=O / C-O-C
			290.14	1.6	30	0.04	O=C-O
	O 1s	6.22	532.61	2.22	11182	88.75	C-O-C
			534.31	2.46	1418	11.25	O=C-O
	N 1s	1.09	397.89	1.80	356	24.67	Pyridinic
			400.06	1.99	1086	75.33	Pyrrolic
	S 2p	1.89	164.02	2.18	2016	66.67	Thiophenic
			165.20	2.66	1008	33.33	Sulfite / sulfonyl
	Si 2p	2.75	102.31	1.96	2377	88.11	Si-O-C
			103.49	1.90	321	11.89	Si-O-Si
APTES-treated	C 1s	87.49	285.12	1.89	67343	89.43	C-C
			286.71	2.2	7171	9.52	C=O / C-O-C / C-N
			289.62	1.94	790	1.05	O=C-O
	O 1s	6.64	532.82	2.23	11169	78.96	C-O-C
			533.91	2.46	2976	21.04	O=C-O
	N 1s	1.83	398.46	2.80	710	25.92	Pyridinic
			400.18	2.22	2030	74.08	Pyrrolic
	S 2p	1.59	163.88	1.84	1893	66.67	Thiophenic
			165.06	2.04	947	33.33	Sulfite / sulfonyl
	Si 2p	2.45	102.25	1.78	1899	70.77	Si-O-C
			103.43	1.98	784	29.23	Si-O-Si

(a)


Weight Percent (%)
Temperature (°C)
Neat epoxy
0.5 wt. %
1 wt. %
3 wt. %
5 wt. %
8.391%
6.941%
5.296%
4.428%
4.016%

(b)


Weight Percent (%)
Temperature (°C)
Neat epoxy
0.5 wt. %
1 wt. %
3 wt. %
5 wt. %
9.182%
6.329%
5.214%
4.593%
4.016%

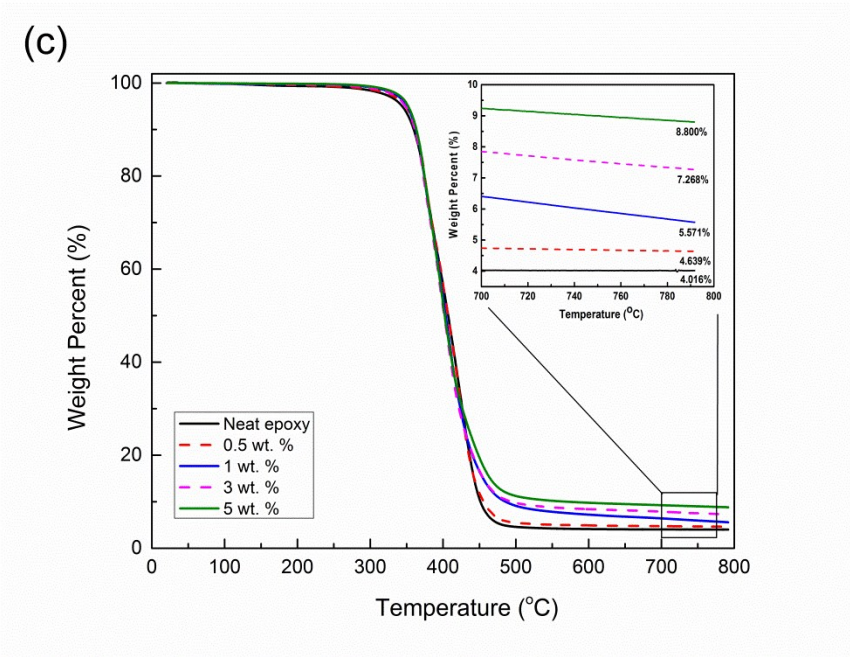


Figure S2. Thermal degradation of (a) pristine, (b) APTES-treated, (c) GPTMS-treated asphaltene reinforced epoxy composites at different loading levels in nitrogen atmosphere