Electronic Supplementary Information

Flame retardant epoxy resin based on the organic titanate and polyhedral oligomeric silsesquioxane-containing additives with synergistic effect

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Synthesis and characterization of POSS-bisDOPO

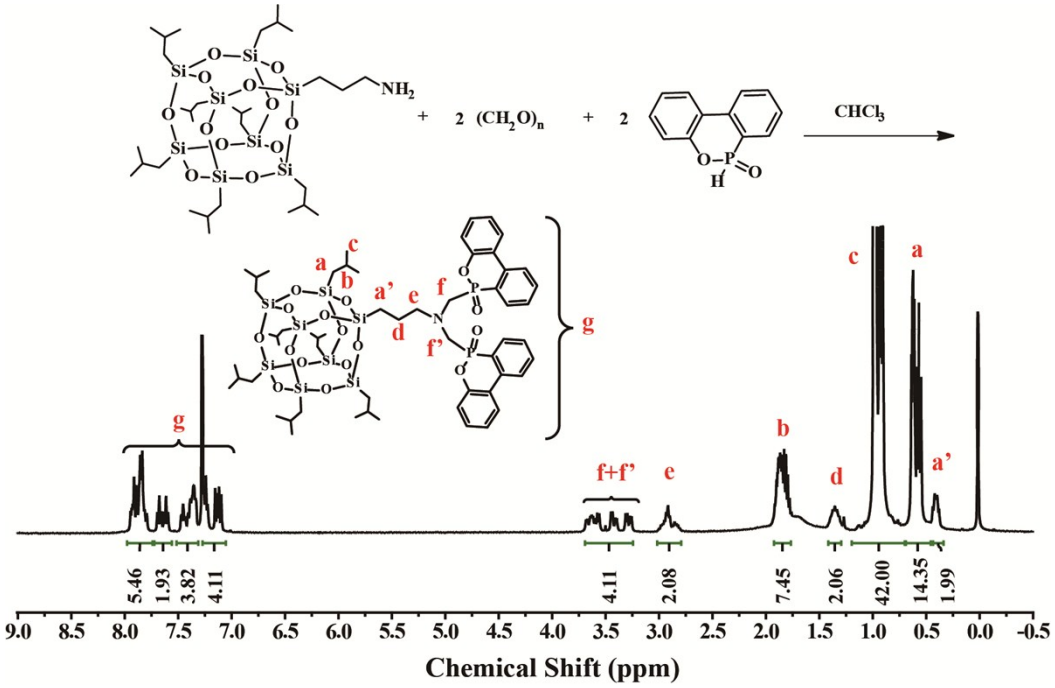

Figure S1. Synthetic route and ^{1}H NMR spectrum of POSS-bisDOPO

The synthesis route and ^{1}H NMR spectrum of POSS-bisDOPO was shown in Figure S1. The whole characterization data were listed as follows. ^{1}H NMR ($CDCl_3$,

400 MHz, δ, ppm): 7.95-7.10 (16H, Aromatic ring), 3.26-2.92 (4H, N–($C\underline{H}_2$–P)$_2$), 2.92-2.85(2H, N–$C\underline{H}_2$–CH_2–CH_2–Si), 1.92-1.76 (7H, Si–CH_2–$C\underline{H}$(–CH_3)$_2$), 1.41-1.24 (2H, Si–CH_2–$C\underline{H}_2$–CH_2–N), 1.12-0.76 (42H, Si–CH_2–CH(–$C\underline{H}_3$)$_2$), 0.66-0.52 (14H, Si–$C\underline{H}_2$–CH(–CH_3)$_2$), 0.45-0.36 (2H, Si–$C\underline{H}_2$–CH_2–CH_2–N). ^{31}P NMR ($CDCl_3$, 400 MHz, δ, ppm): 14.7 (DOPO), 34.57 (POSS-bisDOPO). MS spectrum: 1353.2 [M + Na]$^+$. FTIR (ATR, cm^{-1}): 3063 and 1600 (phenyl in DOPO), 2410 (P-H in DOPO), 1085 (Si-O-Si, P-O-P), 908 (P-O-phenyl).

Glass transition behavior

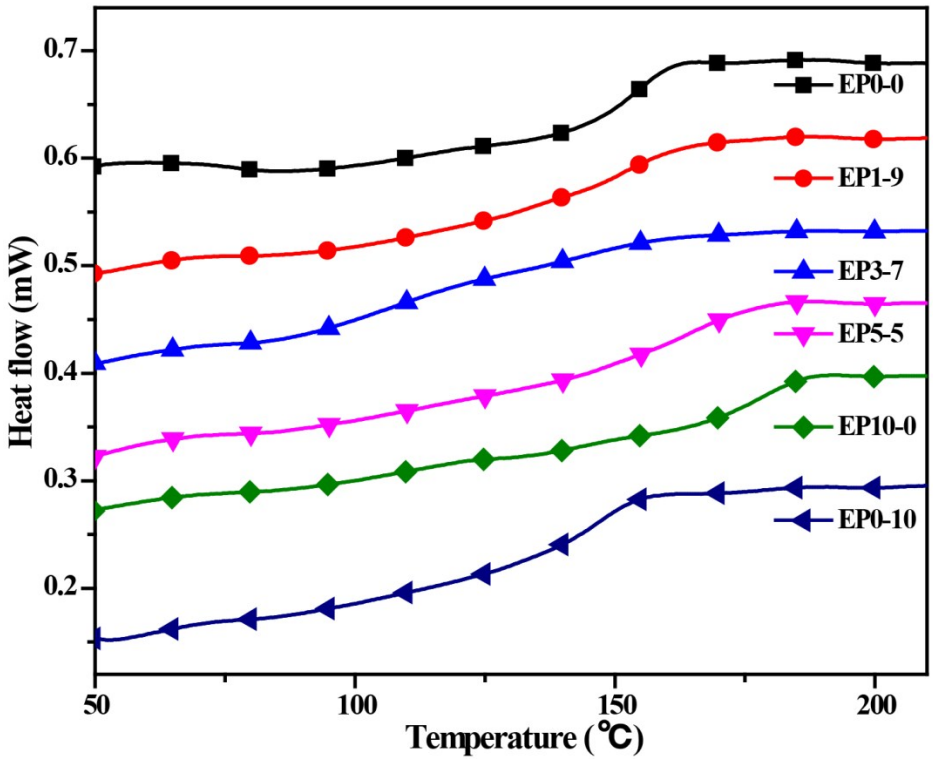

Figure S2. DSC curves of the cured EP composites

Mechanical property

Table S1 DMA data of the cured EP composites

Sample	E′-40℃/MPa	E′-190℃/MPa	tanδ
EP 0-0	1245	10.1	0.729
EP 1-9	1350	12.8	0.513
EP 3-7	1235	14.2	0.467
EP 5-5	1247	16.1	0.415
EP 10-0	1244	19.6	0.453
EP 0-10	1241	11.1	0.617

Flame retardancy

Table S2 Microscale combustion calorimeter data of the cured EP composites

Sample	EP0-0	EP5-5	EP10-0	EP0-10
PHRR (W/g)	430.2	28.4	255.6	369.2
THR (kJ/g)	22.7	1.7	17.9	20.1