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A straightforward, eco-friendly and cost-effective approach towards flame retardant epoxy resins

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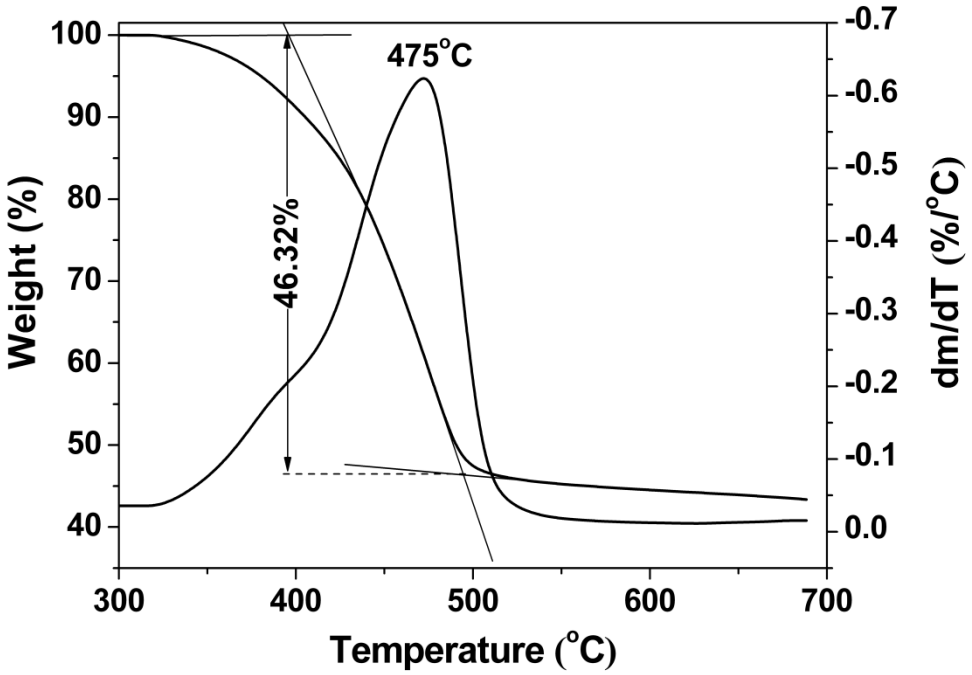

Fig. 1 TG and DTG curves of the oligophosphonate **PFR**.

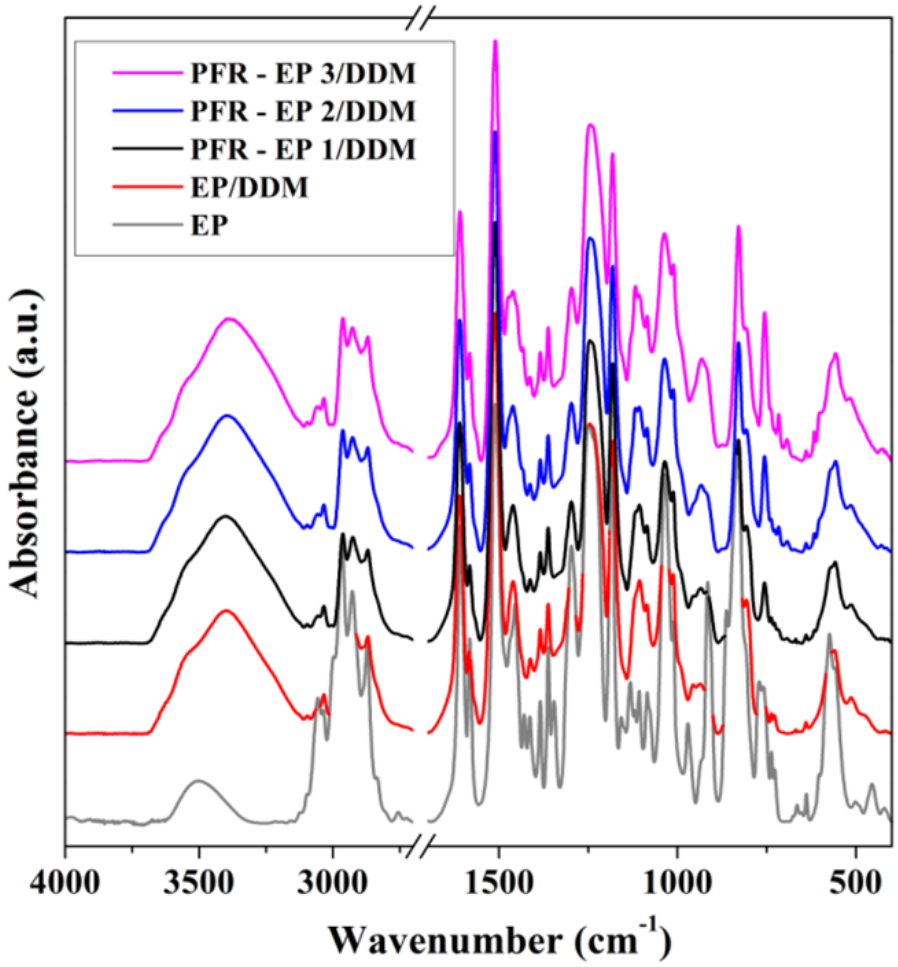

Fig. 2 FTIR spectra of the pristine **EP**, neat **EP/DDM** system and **PFR–EP/DDM** SIPNs.

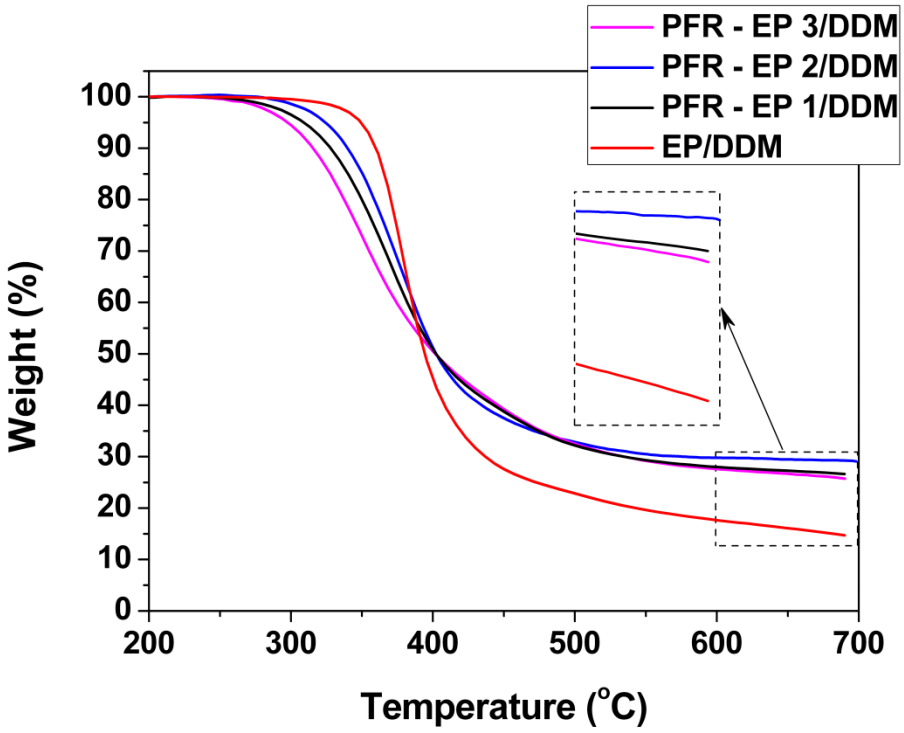

Fig. 3 TG curves in nitrogen atmosphere of neat **EP/DDM** system and **PFR–EP/DDM** SIPNs.

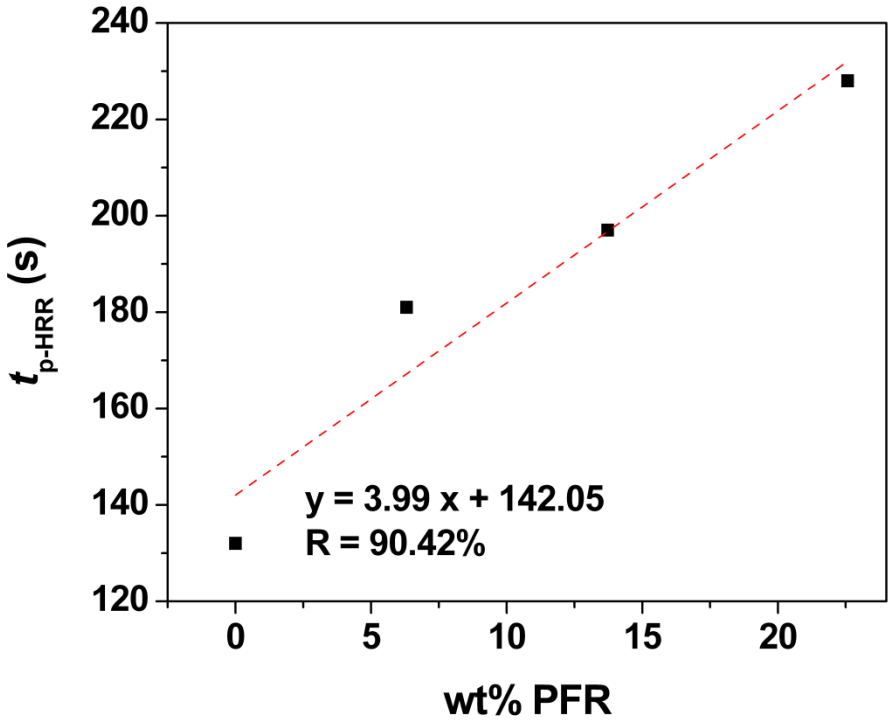

Fig. 4 The dependence of time to reach the peak of heat release rate ($t_{p\text{-}HRR}$) on the flame retardant additive (**PFR**) content.

Table 1 Decomposition results of the DTG curves of neat **EP/DDM** system and **PFR–EP/DDM** SIPNs.

Sample	Peak temperature (°C)	Peak aria (%)
EP/DDM	289; 317; 465; 528; 605	10.44; 9.73; 52.51; 24.37; 1.18
PFR–EP 1/DDM	282; 328; 479; 528	8.79; 10.23; 47.47; 24.59
PFR–EP 2/DDM	285; 315; 474; 526	9.12; 10.94; 51.17; 24.62
PFR–EP 3/DDM	281; 351; 492; 533	11.16; 9.76; 42.36; 22.34

Table 2 The surface element concentration of the residual char of neat **EP/DDM** system and **PFR–EP 3/DDM** SIPN.

Sample	Binding energy (eV)	Atomic concentration (%)
EP/DDM		
C1s	284.6; 285; 286.6; 288.3; 289.9	32.72; 44.61; 16.13; 3.77; 2.77
O1s	530.8; 532.2; 533.2	17.07; 35.79; 47.15
N1s	398.8; 400.5; 402.3	40.03; 46.60; 13.37
PFR–EP 3/DDM		
C1s	284.5; 285; 286.4; 287.6; 289.1; 290.8	24.40; 45.20; 18.97; 6.30; 3.12; 2.01
O1s	530.7; 532.3; 533.3	23.89; 53.18; 22.93
N1s	398.7; 400.5	27.32; 72.68
P2p	131.5; 132.4	58.25; 41.75