Electronic Supplementary Information

Flame-retarding Nanoparticles as the Compatibilizers for Immiscible Polymer Blends: Simultaneously Enhanced Mechanical Performance and Flame Retardancy

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$$E_{PMMA} = \frac{n_{Actual\ PMMA}}{n_{Idea\ PMMA}}$$

$$= \frac{\bar{M}n_{GPS} \cdot f_{Boehmite} \cdot (f_{Boehmite-GPS} - f_{Boehmite-GPS-PMMA})}{\bar{M}n_{PMMA-COOH} \cdot f_{Boehmite-GPS-PMMA} \cdot f_{Boehmite} \cdot (f_{Boehmite} - f_{Boehmite-GPS})} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Formula S1. Formula for calculating the grafting ratio of PMMA with epoxy group on Boehmite nanorods surface. Where $E_{PMMA-COOH}$ is the grafting ratio of the grafted PMMA chain on the surface of Boehmite nanorods, which based on the GPS content on the Boehmite nanorods. $n_{actual\ PMMA}$is the actual number mole of grafting PMMA chain on the surface of Boehmite nanorods. $n_{Idea\ PMMA}$ is the number mole of theory obtained grafting PMMA chain on the surface of Boehmite nanorods, which calculated by the content of GPS on the Boehmite nanorods surface. $\bar{M}n_{GPS}$ and $\bar{M}n_{PMMA-COOH}$ is the molecular weight of 3-Glycidoxypropyl trimethoxysilane (GPS) and carboxyl-terminated polymethyl methacrylate (PMMA-COOH) respectively. $f_{Boehmite}$, $f_{Boehmite-GPS}$ and $f_{Boehmite-GPS-PMMA}$ represent the inorganic residual content of pristine Boehmite, Boehmite-GPS, and Boehmite-GPS-PMMA nanorods respectively after the TGA test respectively.

Table S1. Molecular parameter of PMMA-COOH and the surface modified Boehmite nanorods

Sample	Mn^a (g/mol)	PDI^a	d^b (nm)	l^b (nm)	$T_d{}^c$ (°C)	$f_{inorganic}{}^c$ (wt%)	$w_{GPS}{}^d$ (wt%)	$w_{PMMA}{}^d$ (wt%)	$E_{PMMA}{}^d$ (%)
PMMA-COOH	3850±60	2.24			398.8	0			
Boehmite			8.2±2.2	98±23	446.1	80.7±0.1			
Boehmite-GPS			8.1±1.9	86±19	472.3	79.3±0.1	1.8±0.2		
Boehmite-GPS -PMMA	3850±60	2.24	16.8±5.6	93±25	392.1 and 481.1	66.7±0.2	1.8±0.2	19.2±0.6	66.7±10.6

[a] Measure from GPC plots using THF as eluent and PS to linear calibration at 35 °C (Mn: number-averaged molecular weight of the single PMMA chains; PDI: polydispersity (Mw/Mn) of the single PMMA chains).

[b] Measured from TEM images (d: number-averaged diameter of nanorods; number-averaged length of nanorods).

[c] Measured from the TGA and DTG curves. (T_d: the TGA temperature with maximum loss rate; $f_{inorganic}$: the inorganic oxide residual content).

[d] Calculated on the basis of TGA data (w_{GPS} : the grafting content of the GPS on the surface of Boehmite nanorods; w_{PMMA} : the grafting content of the PMMA on the surface of Boehmite nanorods; E_{PMMA}: the grafting ratio of the grafted PMMA chain on the surface of Boehmite nanorods calculated by Formula S1, which is based on the GPS content on the Boehmite nanorods.).

Table S2. The work of fracture of the PVDF/PLLA blends with the Boehmite nanorods

Sample	Sample Composition	*Work of Fracture /J.m^{-2}*
1	PVDF/PLLA (50/50)	1.04×10^{5}
2	PVDF/PLLA/Boehmite (50/50/3)	1.07×10^{5}
3	PVDF/PLLA/Boehmite-GPS (50/50/3)	1.48×10^{5}
4	PVDF/PLLA/Boehmite-GPS-PMMA (50/50/1)	1.47×10^{5}
5	PVDF/PLLA/Boehmite-GPS-PMMA (50/50/3)	4.47×10^{5}
6	PVDF/PLLA/Boehmite-GPS-PMMA (50/50/5)	1.08×10^{6}
7	PVDF/PLLA(70/30)	2.40×10^{4}
8	PVDF/PLLA/Boehmite-GPS-PMMA (70/30/1)	2.34×10^{5}
9	PVDF/PLLA/Boehmite-GPS-PMMA (70/30/3)	7.14×10^{5}
10	PVDF/PLLA/Boehmite-GPS-PMMA (70/30/5)	1.15×10^{6}

Table S3. The LOI of PVDF/PLLA blends with different phase size

Sample	Sample Composition	*LOI*[a](%)
1	PVDF/PLLA (50/50)	24.1%
2	PVDF/PLLA/PS-g-GMA-g-PMMA (50/50/3)	24.3%
3	PVDF/PLLA/Boehmite-GPS-PMMA (50/50/3)	28.6%

[a] Limited oxygen index was measured by Oxygen index instrument

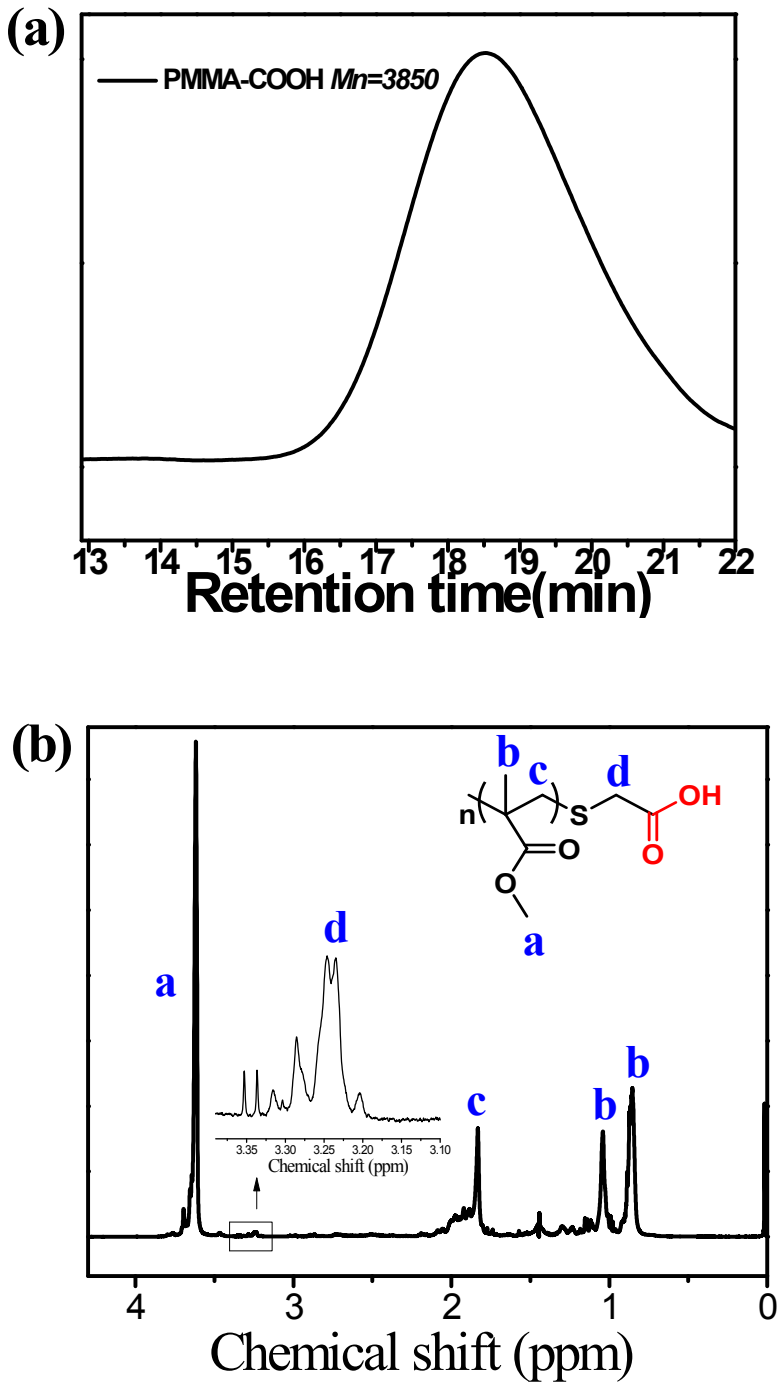


Figure S1. GPC curve (a) and ^{1}H-NMR (b) spectrum of PMMA-COOH, which number-average molecular weight (M_n) is 3850.

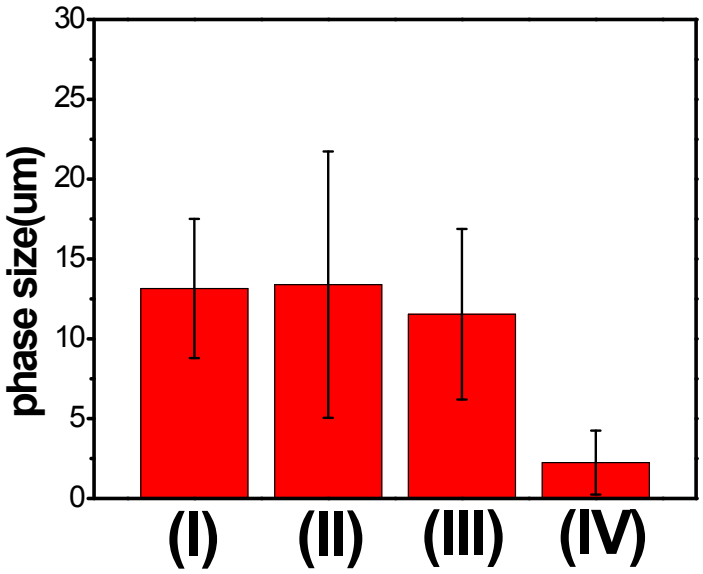


Figure S2. The particles distribution diagram of PVDF/PLLA (50/50, w/w) blends (I) melt mixing with 3wt% pristine Boehmite (II), Boehmite-GPS (III) and Boehmite-GPS-PMMA (IV) nanorods respectively.

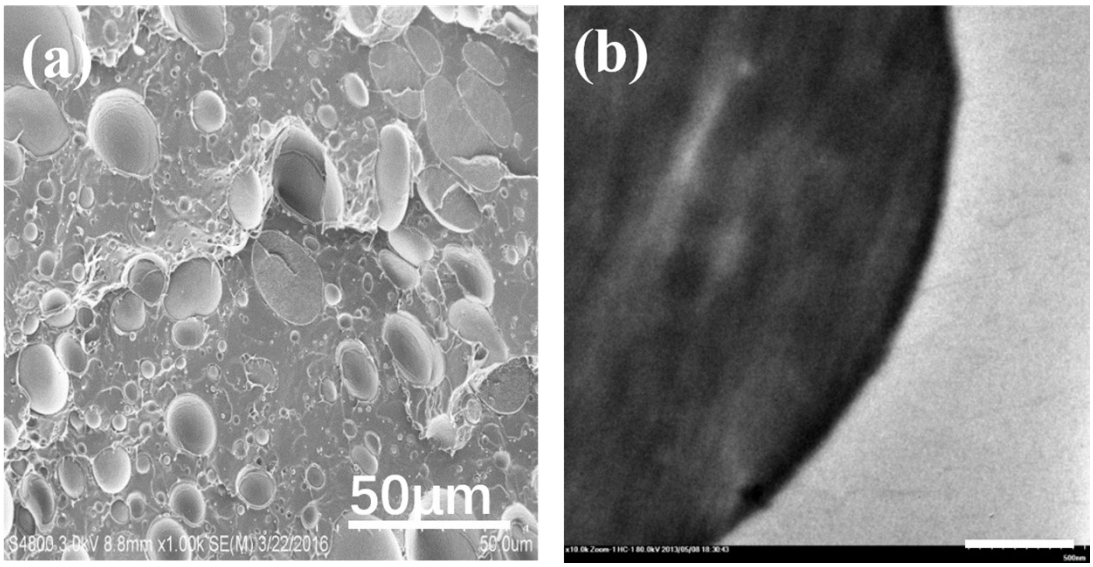


Figure S3. SEM (a) and TEM (b) image of PVDF/PLLA (50/50) blends.

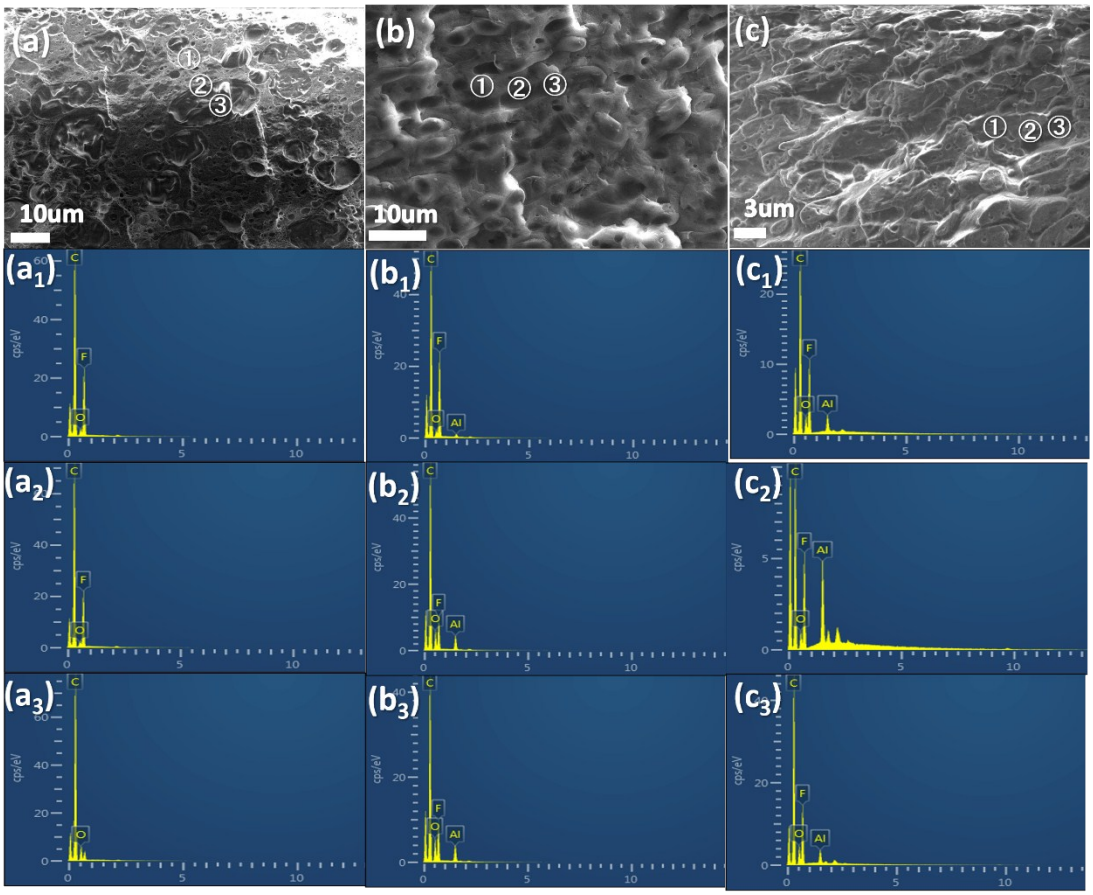


Figure S4. SEM images and EDS scan of the PVDF/PLLA (70/30) (a), PVDF/PLLA/Boehmite-GPS (70/30/3) (b) and PVDF/PLLA/Boehmite-GPS-PMMA (70/30/3) (c) blends. The mark of 1, 2 and 3 in SEM are correspond to the subscript in the EDS.

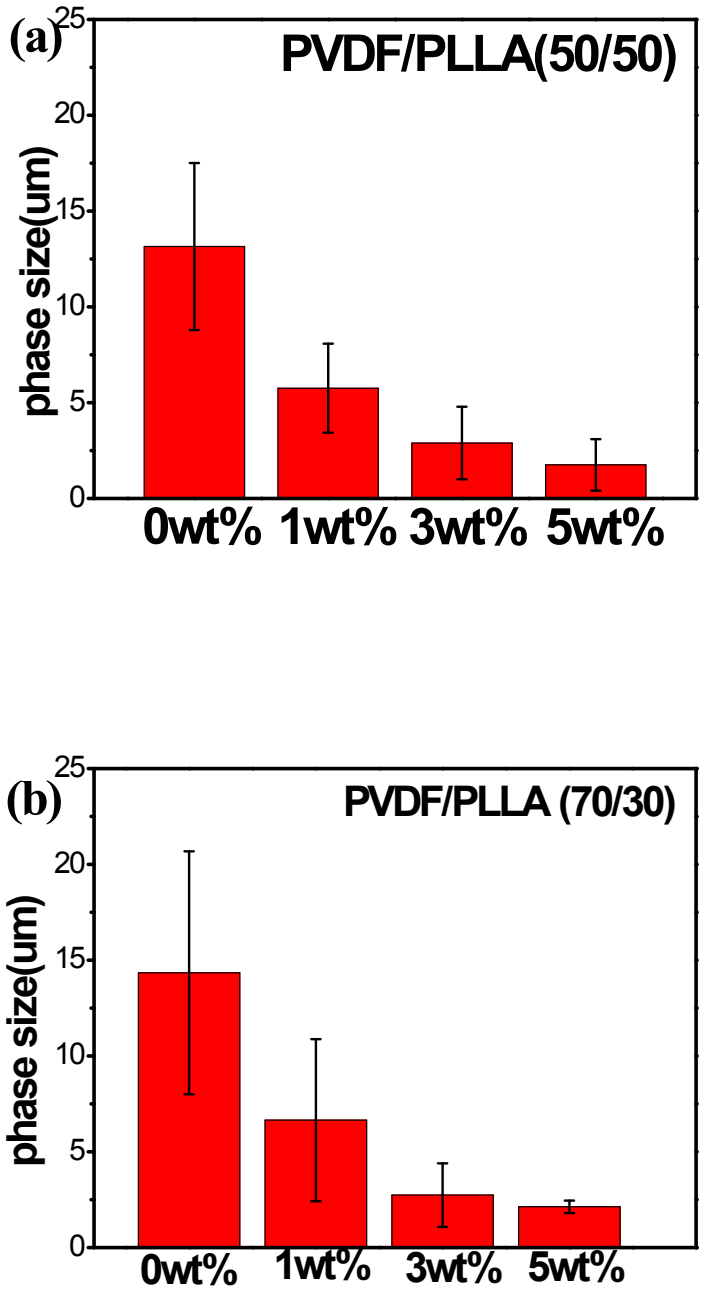


Figure S5. The particles distribution diagram of PVDF/PLLA (50/50, w/w) (a) and PVDF/PLLA (70/30, w/w) (b) blends melt mixing with 0 wt%,1 wt%, 3wt% and 5 wt% Boehmite-GPS-PMMA nanorods respectively.

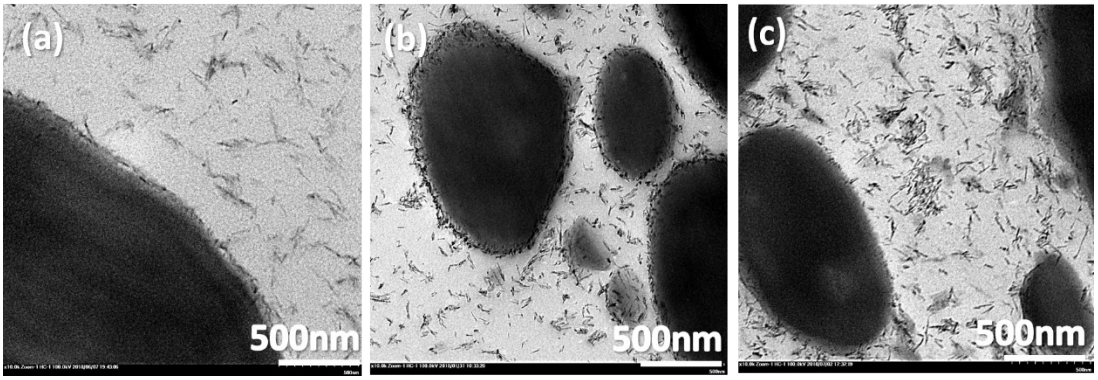


Figure S6. The TEM images of the PVDF/PLLA/Boehmite-GPS-PMMA (50/50/3). The number-average molecular weight of the PMMA chain grafted onto the Boehmite-GPS-PMMA is 2000 g/mol (a), 3850 g/mol (b) and 8600 g/mol (c) respectively.

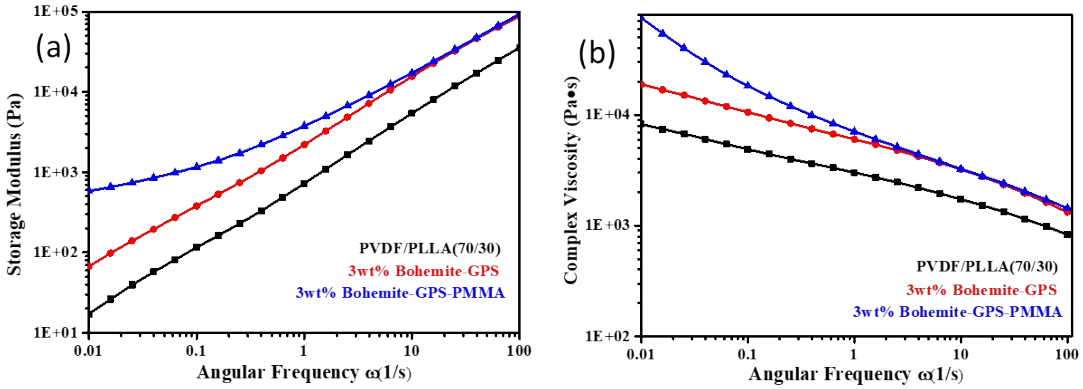
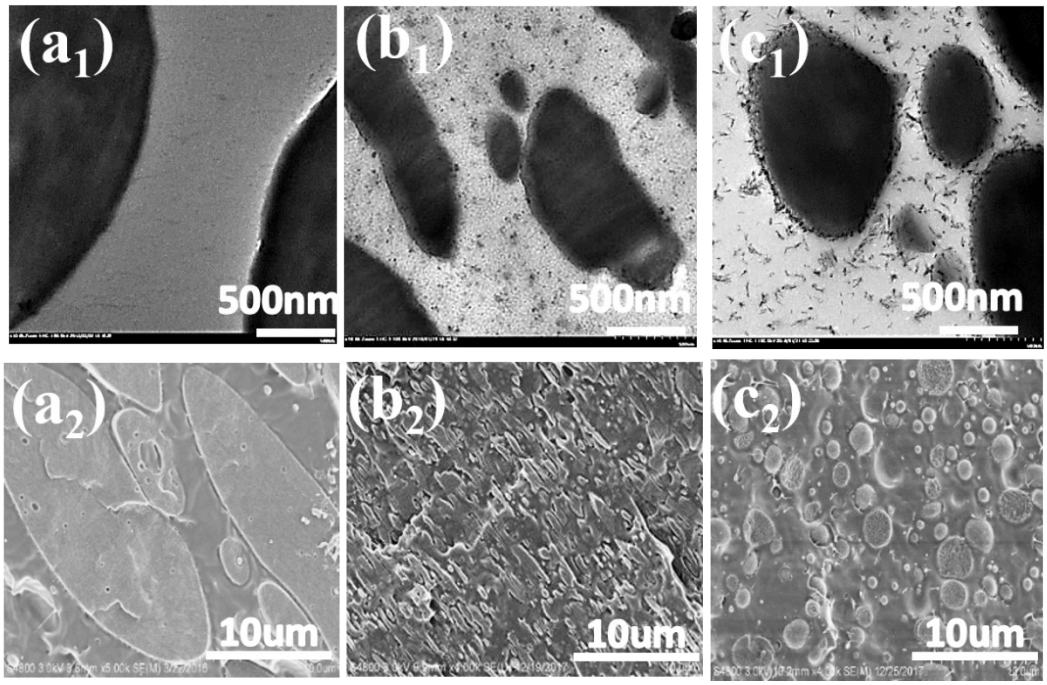


Figure S7. The storage modulus (a) and complex viscosity (b) of PVDF/PLLA (70/30), PVDF/PLLA/Boehmite-GPS (70/30/3) and PVDF/PLLA/Boehmite-GPS-PMMA (70/30/3)



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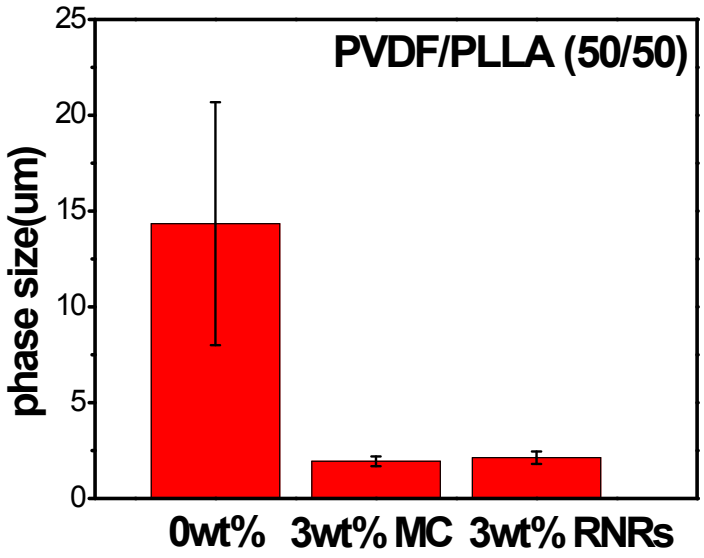
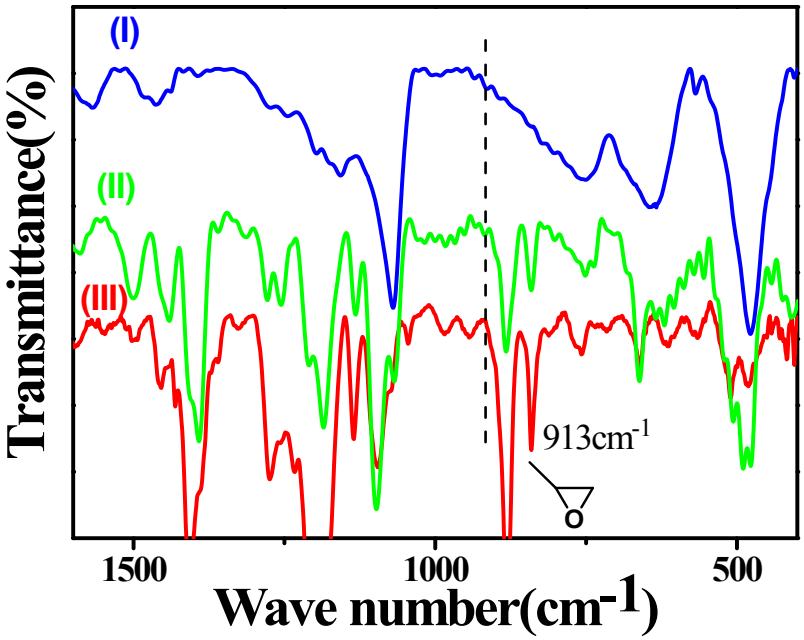


Figure S9. The particles distribution diagram of PVDF/PLLA (50/50, w/w) (a) blends with 3wt% PS-g-GMA-g-PMMA(b) and (c) Boehmite-GPS-PMMA nanorods respectively.



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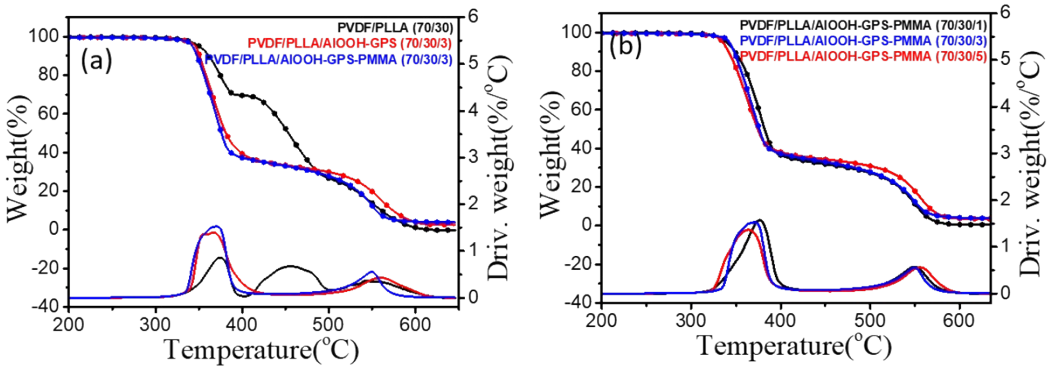

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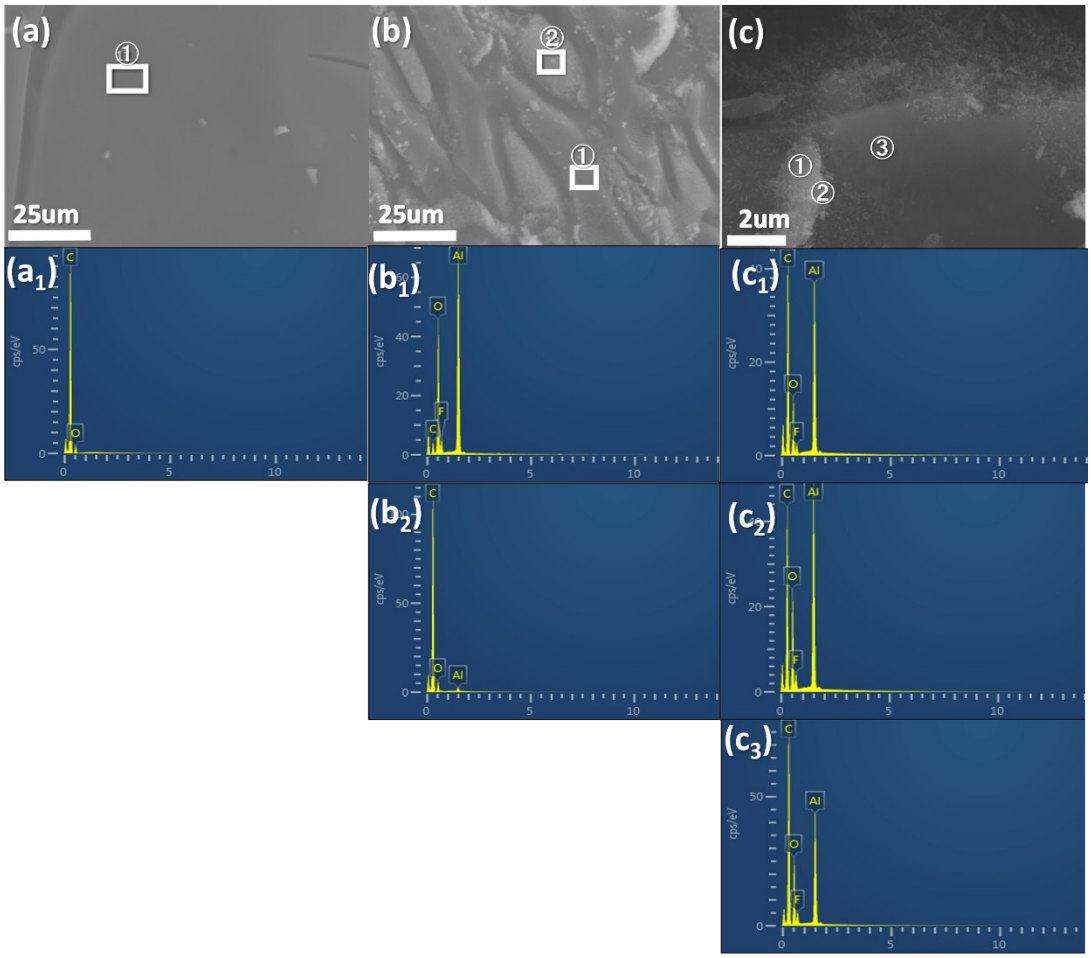

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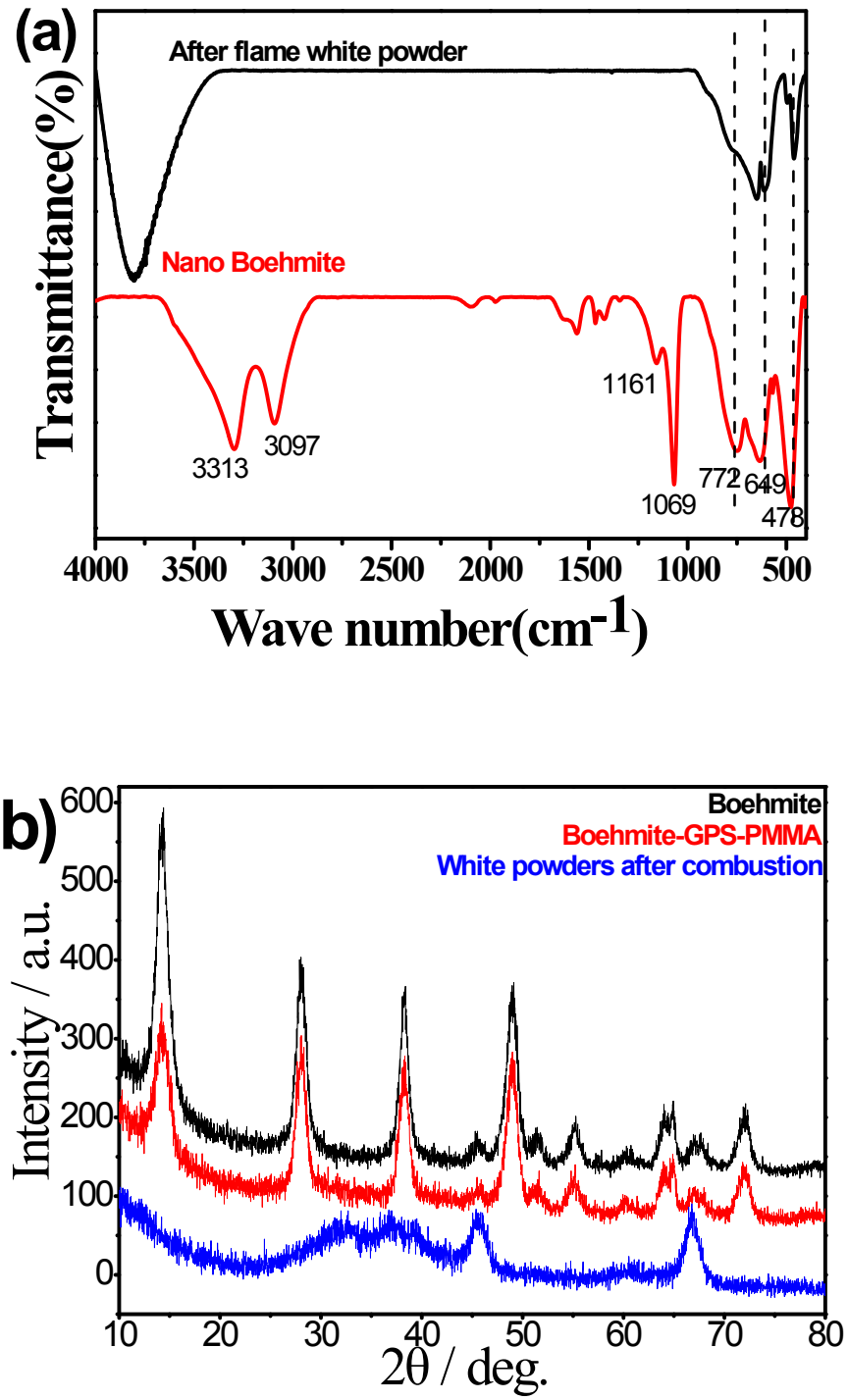

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