

## Supporting information

**Effects of  $\alpha$ -zirconium phosphate and zirconium organophosphonate on the thermal, mechanical and flame retardant properties of intumescent flame retardant high density polyethylene composites**

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## 1. Composition analysis of Zr-PA and Zr-ATMP

The compositional analysis of the Zr-PA and Zr-ATMP was performed by ICP-OES and conventional elemental analyzer and the results are shown in Table S1.

Table S1: Elemental analysis of the Zr-PA and Zr-ATMP

| Samples | C (%) | H (%) | N (%) | P/Zr (mole ratio) | C/P (mole ratio) |
|---------|-------|-------|-------|-------------------|------------------|
| Zr-ATMP | 11.48 | 3.71  | 2.78  | 3.12              | 5.54             |
| Zr-PA   | 15.78 | 4.51  | -     | 1.86              | 3.31             |

The molar ratio of Zr/P is 1:3 and 1:2 in Zr-ATMP and Zr-PA respectively, suggesting that mole ratio of zirconium/ATMP and Zirconium/PA are in 1:1 and 3:1, respectively. A higher percentage of carbon suggests that residual oxalic acid is present in zirconium hybrid structure.

## 2. Thermogravimetric analysis of zirconium-based compounds

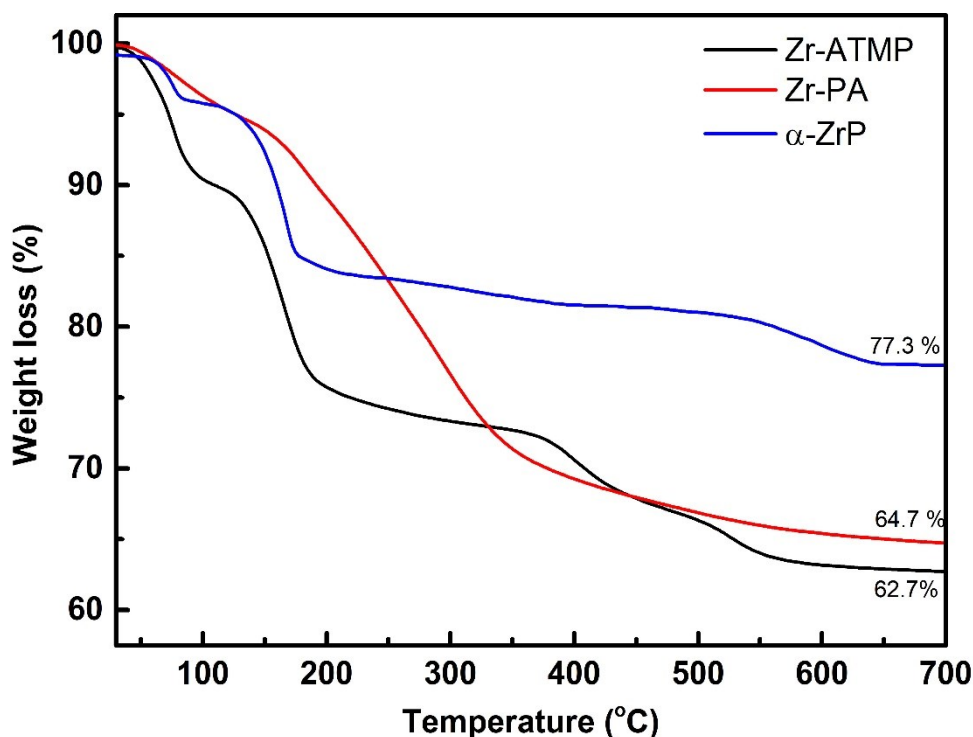


Figure S1: TGA curves for zirconium-based compounds in nitrogen atmosphere

The TGA curves for the zirconium based compounds in nitrogen are given in Fig S1.

The early weight loss in zirconium-based compounds is due to removal of surface adsorbed water. The residual oxalic acid present in Zr-PA and Zr-ATMP is also decomposed at lower temperature. The mass of residues are 77.3 %, 64.7 % and 62.7 % at 700 °C for  $\alpha$ -ZrP, Zr-PA and Zr-ATMP respectively.