

Xida Zhang¹, Yuan Yu², Qingwu Zhang², Tingting Chen, Juncheng Jiang²

¹ College of Safety Science and Engineering, Nanjing Tech University, Nanjing, 211800, China;

² Jiangsu Key Laboratory of Hazardous Chemicals Safety and Control, Nanjing Tech University, Nanjing, 211800, China.

Introduction

- ◆ Epoxy resin (EP) is widely used in a series of fields such as coatings, adhesives, electronics, aerospace technology and so on, attributable to their superior properties.
- ◆ By adding DOPO@GPO@SiO₂ brings good smoke suppression and flame retardance to EP.
- ◆ A flame retardant with phosphorus and silicon co-coating metal oxide microspheres was prepared.

Method

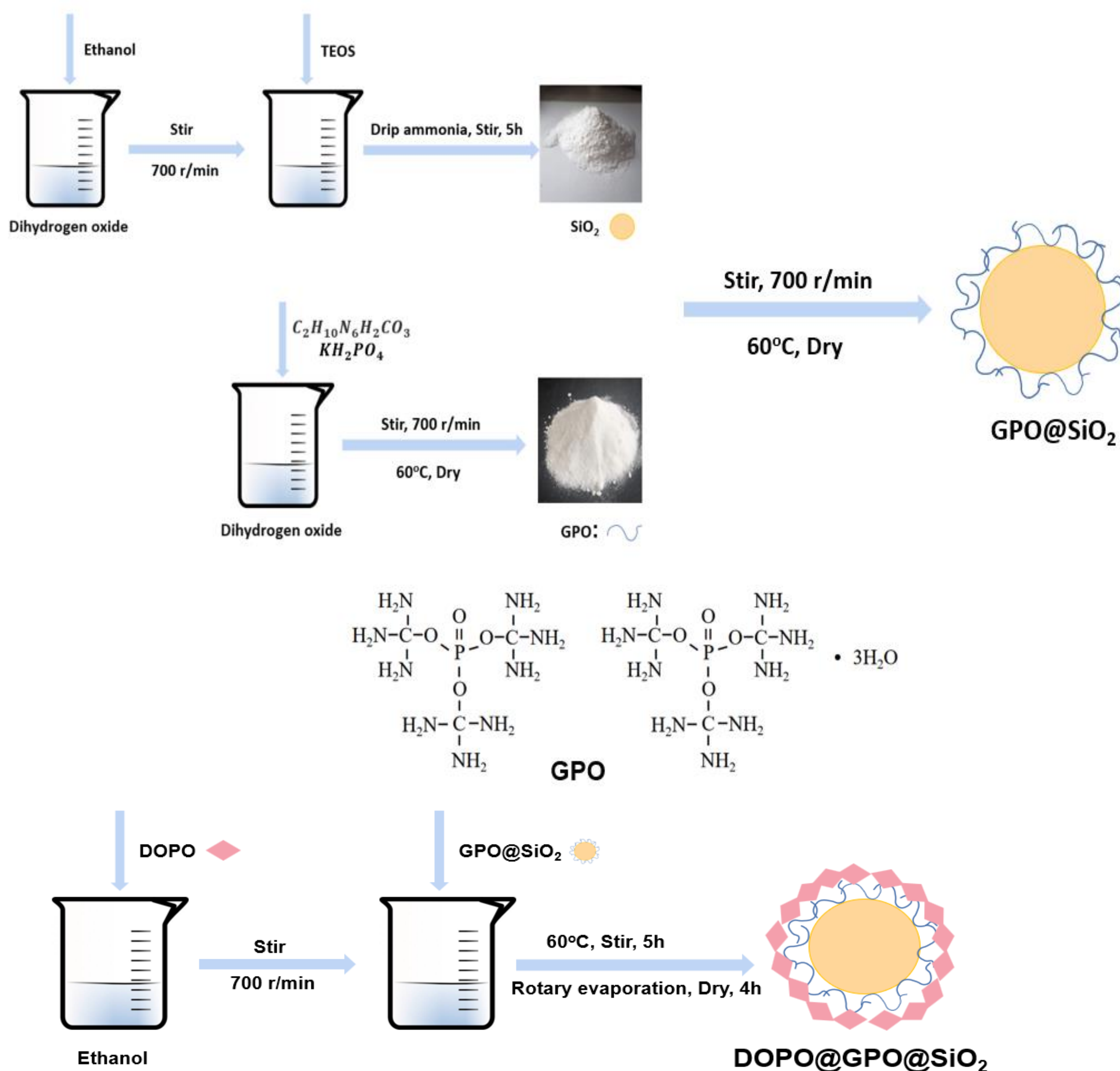


Figure 1. The preparation process of DOPO@GPO@SiO₂

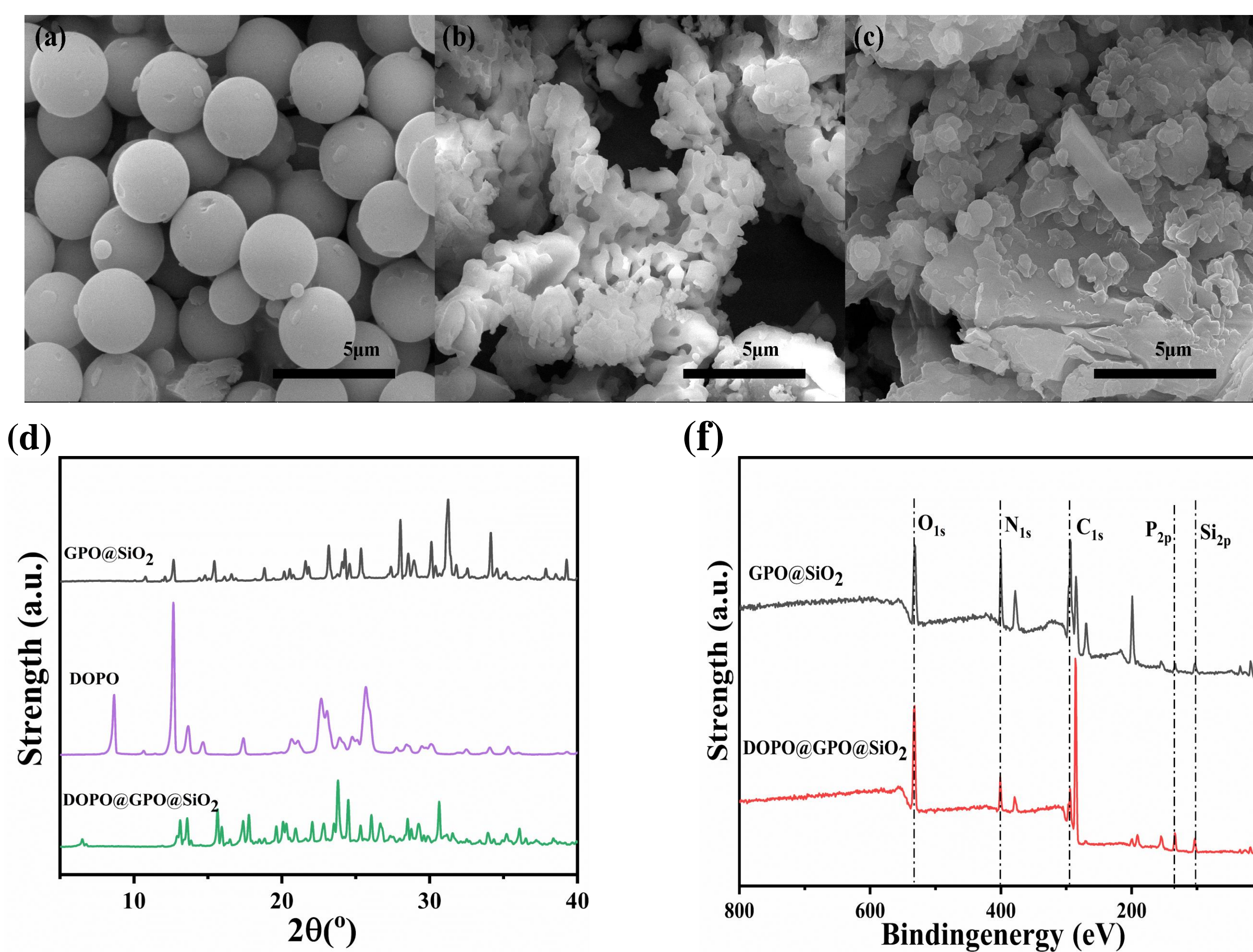


Figure 2. The SEM of SiO₂ (a), GPO@SiO₂ (b) and DOPO@GPO@SiO₂ (c), XRD (d), XPS (f).

- ◆ Through the analysis of XRD and XPS, the appearance of new crystallization peaks and the appearance of P=O and P-O binding energy further confirmed that DOPO successfully protected GPO@SiO₂.

Performance of thermal stability

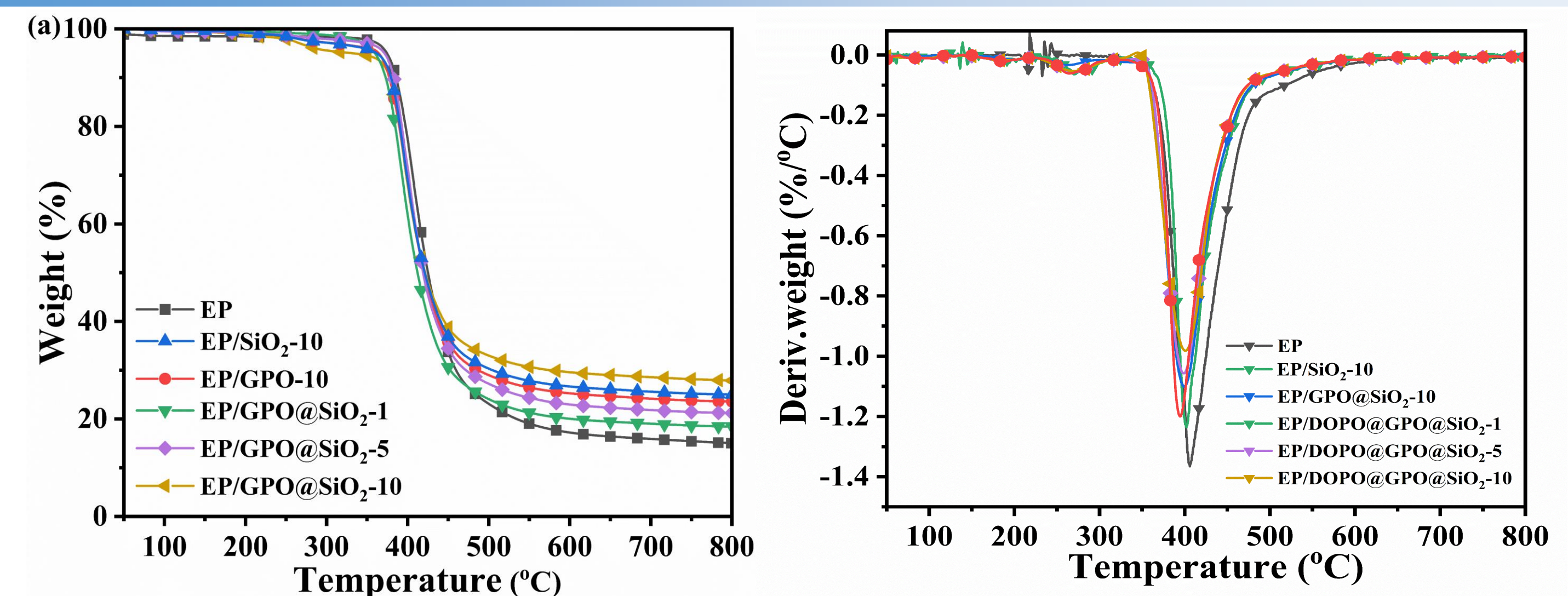


Figure 3. TG (a) and DTG (b) curves of EP/SiO₂, EP/GPO@SiO₂, EP/ and DOPO@GPO@SiO₂ composites under N₂

- ◆ It can be seen from the figure that DOPO@GPO@SiO₂ can significantly improve the thermal stability of EP and achieve the flame-retardant effect.

Performance of combustion

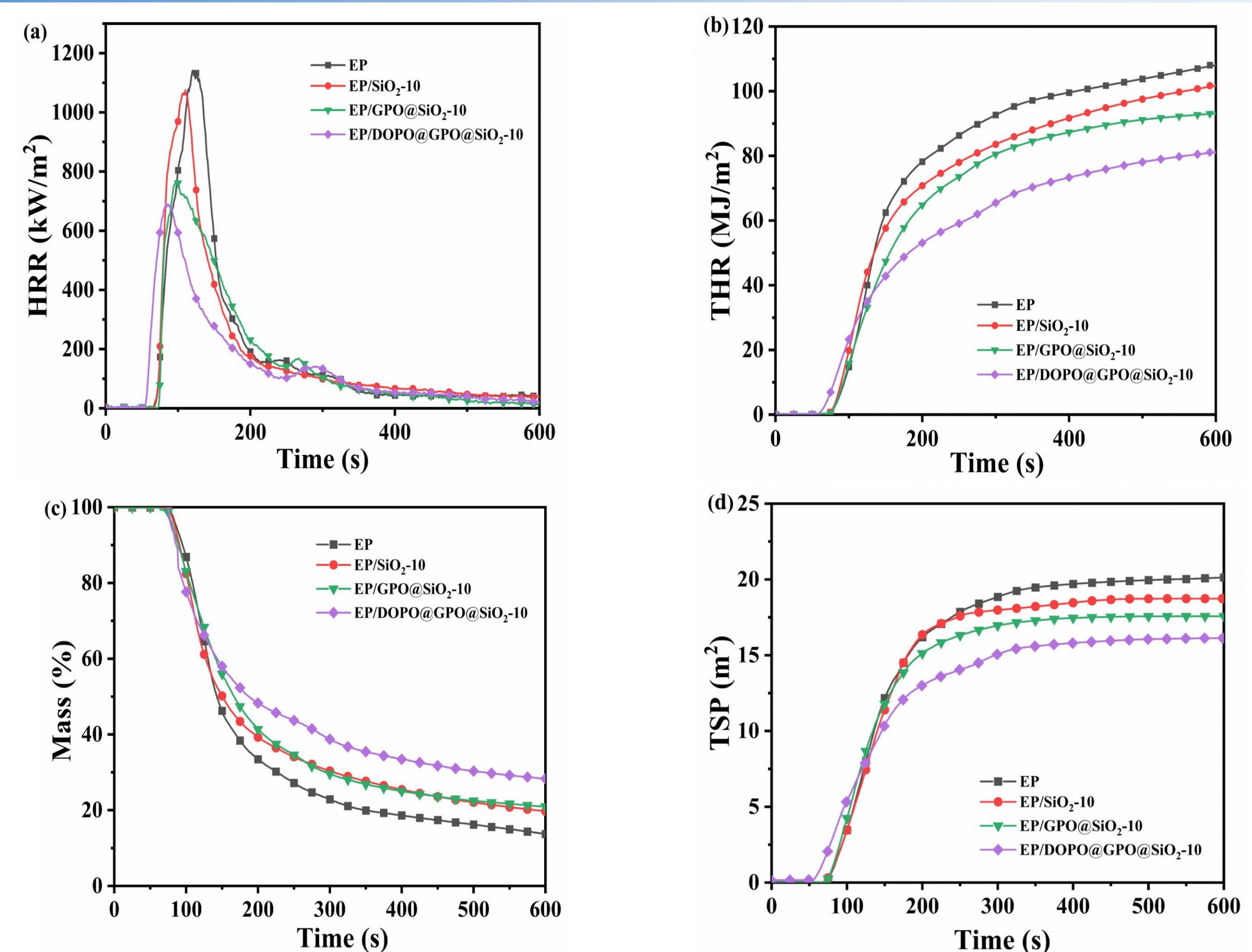


Figure 4. (a) HRR, (b) THR, (c) Mass, (d) TSP of EP, EP/SiO₂, EP/GPO@SiO₂, EP/ and DOPO@GPO@SiO₂ composites.

- ◆ The addition of DOPO@GPO@SiO₂ makes the carbon residue, smoke suppression and flame retardance of EP more outstanding.

Flame retardant mechanism

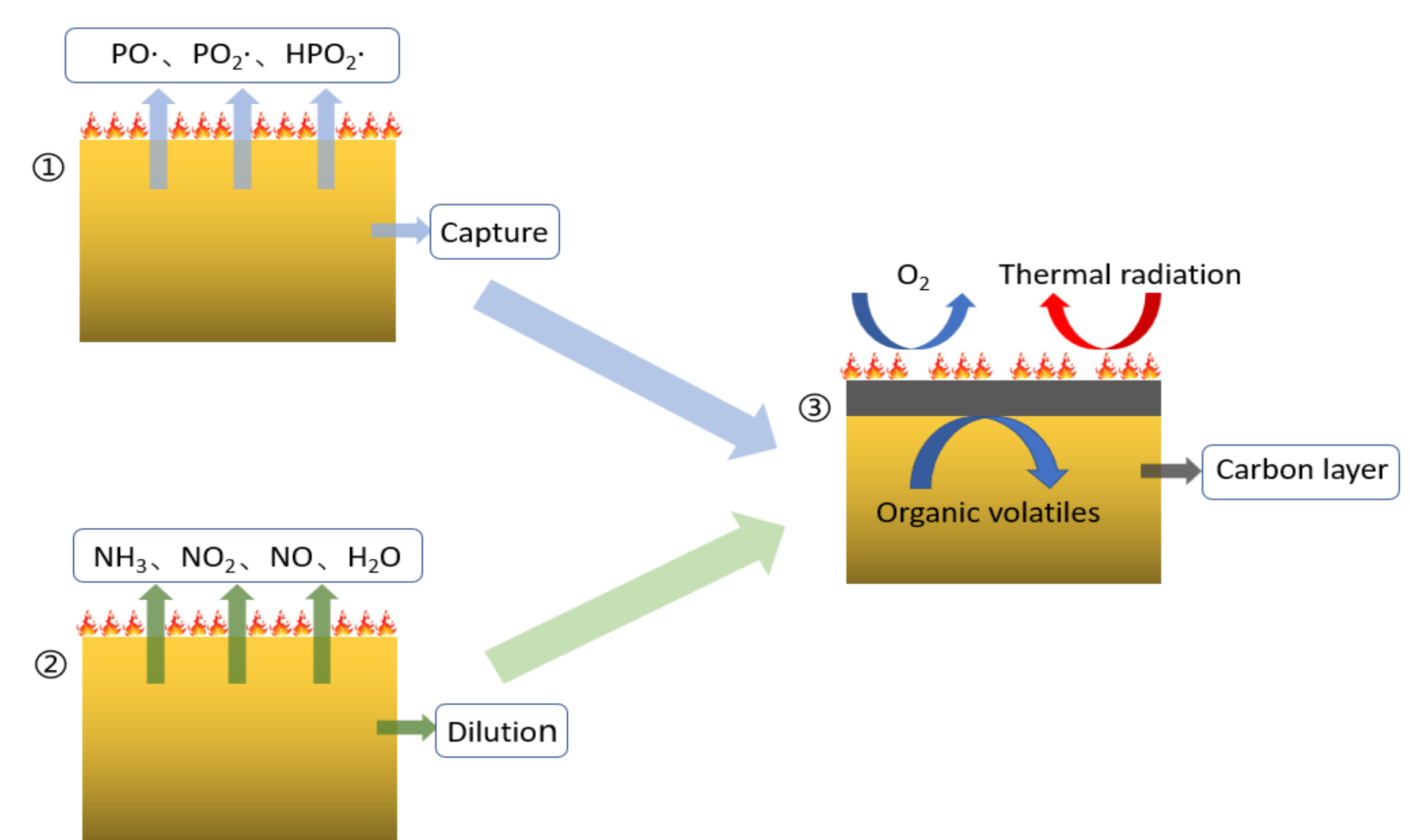


Figure 5. DOPO@GPO@SiO₂ flame retardant mechanism.

Conclusion

- ◆ The phosphorus free radicals such as PO·, PO₂· and HPO₂· produced by the pyrolysis of DOPO and GPO will capture the unstable free radicals ·H and ·OH in the flame zone, and end the chain reaction of flame combustion free radicals.
- ◆ The pyrolysis of GPO will produce H₂O, NO, NO₂, NH₃, which can dilute flammable gases and oxygen, and take away heat during the combustion process.

[1] Hamad K, *et al.* Polymer degradation and stability, 2013, 98(12): 2801-2812.

[2] Lyu M Y, *et al.* International journal of precision engineering and manufacturing, 2015, 16(1): 213-220.

[3] Pietroluongo M, *et al.* Sustainable Materials and Technologies, 2020, 23: e00143.