Supporting Information

Synergistic flame retardant effect of an intumescent flame retardant containing boron and magnesium hydroxide

Lianghui Ai\textsuperscript{a}, Shanshan Chen\textsuperscript{a}, Jinming Zeng\textsuperscript{a}, Liu Yang\textsuperscript{a}, Ping Liu\textsuperscript{a}* 

\textsuperscript{a} State Key Laboratory of Luminescent Materials and Devices, Research Institute of Materials Science, South China University of Technology, Guangzhou 510640, China

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* Corresponding author. E-mail address: mcpliu@scut.edu.cn (P. Liu).
\textsuperscript{a} State Key Laboratory of Luminescent Materials and Devices, Research Institute of Materials Science, South China University of Technology, Guangzhou 510640, China
Table S1. The characteristic thermal performance data of EP samples

| Samples                | $T_{\text{onset}}^a$ ($°C$) | $T_{\text{max1}}^b$ ($°C$) | $T_{\text{max2}}$ ($°C$) | $W_{\text{800°C}}^c$ (%) |
|------------------------|-------------------------------|-----------------------------|--------------------------|--------------------------|
| EP                     | 318.9                         | 395.7                       | –                        | 9.7                      |
| EP/3%MH                | 321.8                         | 352.5                       | –                        | 16.1                     |
| EP/3%CP-6B             | 279.5                         | 388.8                       | 522.4                    | 18.0                     |
| EP/3%CP-6B/0.5%MH      | 337.4                         | 387.9                       | –                        | 21.8                     |
| EP/3%CP-6B/1.0%MH      | 335.0                         | 376.8                       | –                        | 18.8                     |
| EP/3%CP-6B/1.5%MH      | 330.4                         | 364.2                       | –                        | 18.4                     |

$a$Initial temperature at 5% mass loss; $b$Temperature at maximum mass loss rate; $c$Residual char yield at 800 °C.

The maximum decomposition rate was at 395.7 °C, and the residual char yield of pure EP at 800 °C ($W_{\text{800°C}}$) was 9.7%. The initial decomposition temperatures ($T_{\text{onset}}$) of EP/3%CP-6B were lower than those of pure EP, and the carbon residue of EP/3%CP-6B at 800 °C was higher than that of pure EP. The initial decomposition temperatures of EP/CP-6B/MH were higher than those of EP/3%CP-6B. Thus, MH could improve the thermal stability of CP-6B. The residual char yield of EP/CP-6B/MH at 800 °C ($W_{\text{800°C}}$) was higher than that of pure EP. This result showed the formation of a stable carbon layer containing MgO when CP-6B and MH were added together.
Table S2. Elemental analysis of the residual char

| Sample               | Element composition (wt.%) |  
|----------------------|---------------------------|
|                      | C    | O    | N    | P    | Mg  |
| EP                   | 83.89 | 13.33 | 2.77 | 0    | 0   |
| EP/3%MH              | 26.74 | 49.73 | 1.21 | 0    | 22.32|
| EP/3%CP-6B           | 67.41 | 26.22 | 4.16 | 2.21 | 0   |
| EP/3%CP-6B/0.5%MH    | 77.75 | 16.71 | 4.88 | 0.34 | 0.32|

EP/3%MH sample showed higher oxygen and magnesium contents than pure EP. EP/3%CP-6B showed higher oxygen, phosphorus, and nitrogen contents compared with pure EP sample. EP/3%CP-6B/0.5%MH showed higher oxygen, magnesium, phosphorus, and nitrogen contents compared with pure EP. EP/3%CP-6B/0.5%MH formed a high thermal-oxidative stability carbon layer under heating and sufficient oxygen.
Table S3. Assignment of peaks in PY-GC-MS results of EP/3%CP-6B/0.5%MH

| Peak | m/z | Structure | Peak | m/z | Structure |
|------|-----|-----------|------|-----|-----------|
| A    | 44  | O=C=O     | I    | 94  |           |
| B    | 278 |           | J    | 108 |           |
| C    | 322 |           | K    | 107 |           |
| D    | 296 |           | L    | 108 |           |
| E    | 236 |           | M    | 121 |           |
| F    | 72  |           | N    | 121 |           |
| G    | 58  |           | O    | 135 |           |
| H    | 98  |           | P    | 136 |           |

In the process of combustion decomposition, EP produced active free radicals H· and ·OH, and H· and ·OH continued to promote the decomposition of EP and accelerate its combustion. The gas phase volatiles of EP/3%CP-6B/0.5%MH were alcohols, phenols, and amines. CP-6B decomposed to produce small-molecule radicals. These free radicals could capture H· and ·OH; produce stable alcohols, phenols, and amines.