Cooperative Flame Retardancy of Ammonium Polyphosphate and Magnesium-Aluminum-Layered Double Hydroxide (LDH) in EVA Blends

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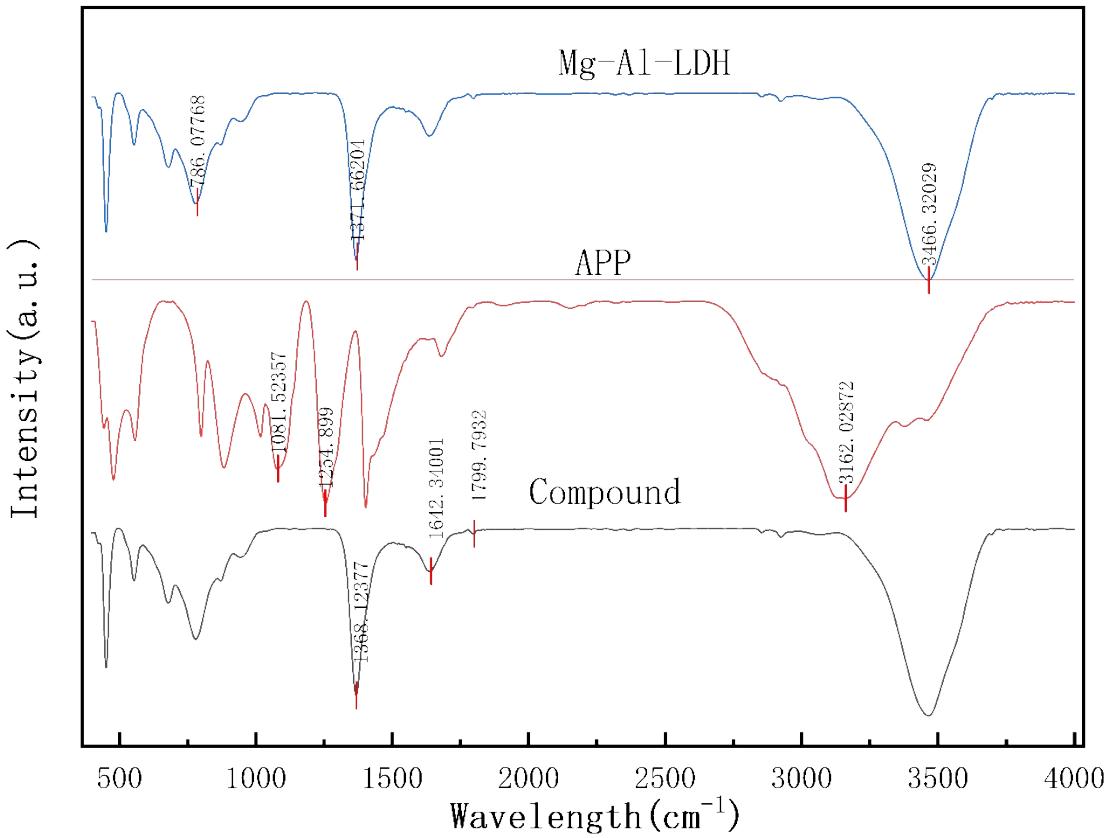


Figure S1 The FTIR of LDH, APP and Compound (EVA4)

All core characteristic peaks of Mg-Al-LDH and APP (such as Mg-O-Al stretching vibration peak of LDH and P=O peak of APP) are retained in the spectral lines of the composite, indicating that both components exist in the composite without decomposition. Characteristic peaks of MgAl-LDH:Mg-O-Al stretching vibration peak (786 cm^{-1}), interlayer/surface hydroxyl (-OH) stretching vibration wide peak

(3400-3600 cm^{-1});Characteristic peaks of APP: chain P-O-P stretching vibration peak (1081 cm^{-1}), end base P=O stretching vibration peak (1254 cm^{-1}, slightly offset but still clear due to interface interaction), ammonium (NH_4^+) N-H stretching vibration peak (3162 cm^{-1}). The retention of these core peaks proved that the composite process did not destroy the laminate structure of MgAl-LDH and the phosphorus oxygen bond and ammonium radical structure of APP, and the compound effectively retained the essential characteristics of both.

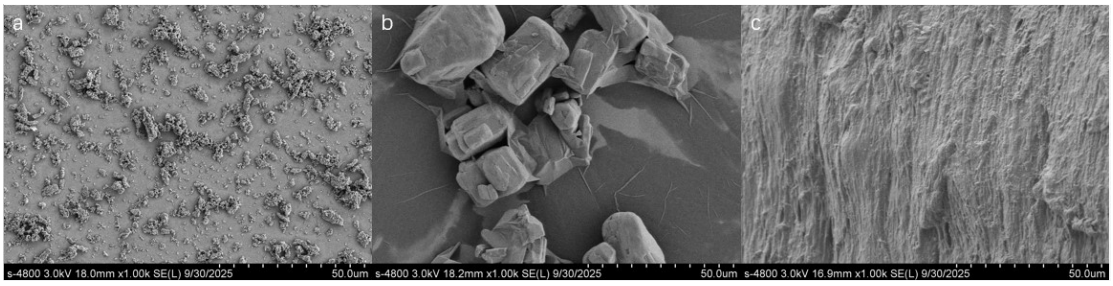
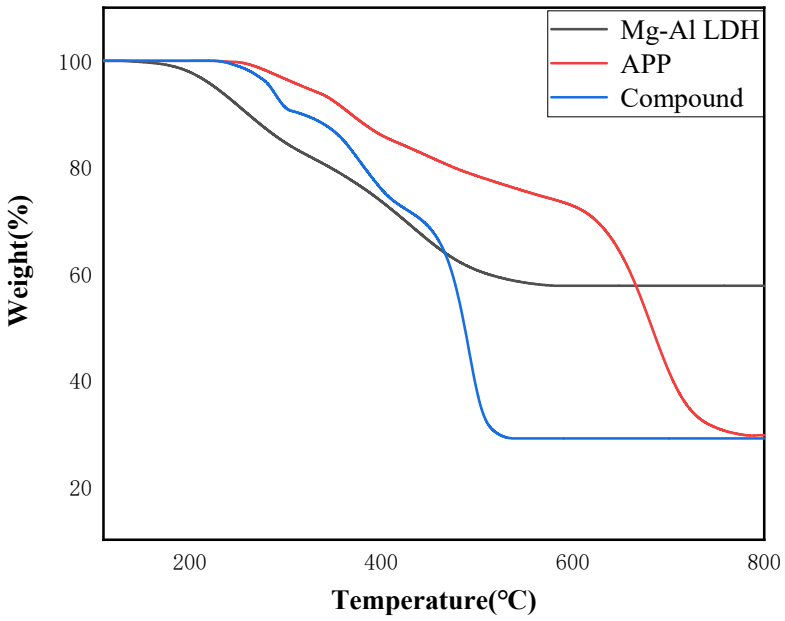
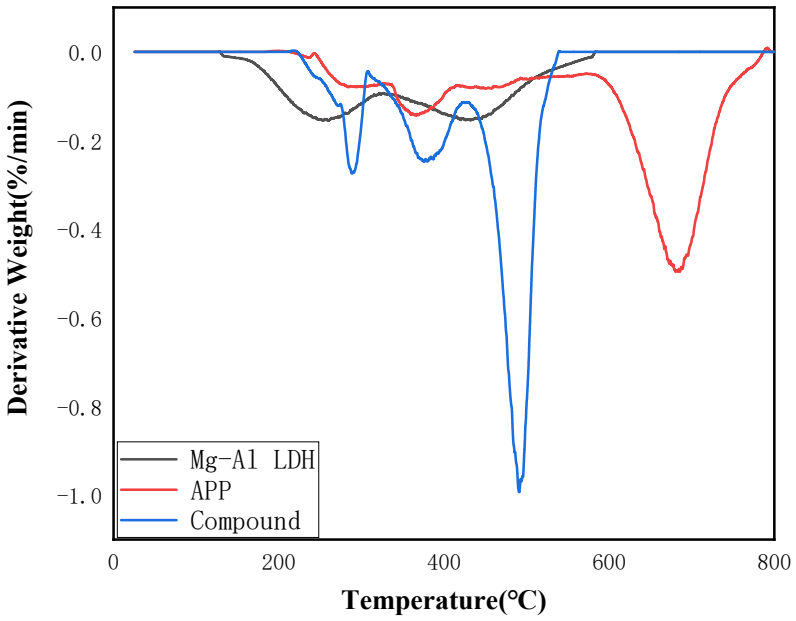


Figure S2 The SEM of (a)LDH (b)APP (c)Compound (EVA4)

If the agglomerated LDH is used directly, it cannot form a continuous barrier layer, and the flame retardant effect is poor. When used alone, the dispersion of block app is poor, and the flame retardant components cannot be uniformly released. The flame retardant efficiency is low. The flake structure of LDH in the composite is uniformly attached to the block surface of app, and the agglomeration is reduced. The interface is tightly bonded, and the composite has good dispersion.



(a)



(b)

Figure S3 (a)TGA and (b)DTG curves of LDH,APP and Compound (EVA4)

The formulation of EVA4 is as follows:40wt%EVA, 47wt%MgAl-LDH, 8wt%APP, 5wt%MC226.

MgAl-LDH has good thermal stability and forms a continuous metal oxide layer during combustion, which blocks heat and oxygen, but has no chemical flame retardant effect; The thermal stability of app is poor, but it releases NH_3 (dilution) and H_3PO_4 (catalytic carbonization) during decomposition, which has good chemical flame retardant effect; The composite not only retains the physical barrier of LDH, but also enhances the chemical flame retardancy of APP through catalytic decomposition, and its thermal stability is better than that of app.

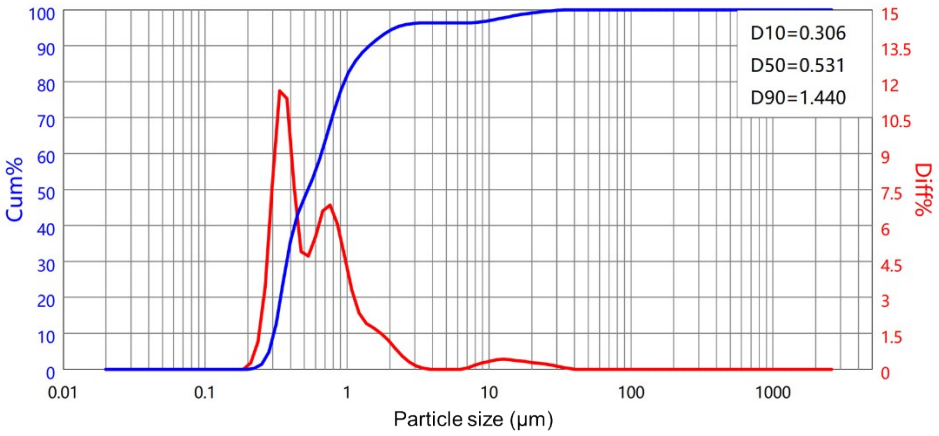


Figure S4:The particle size of Mg-Al LDH

MgAl-LDH particles are mainly distributed in the range of 0.2-2.0 μ m (accounting for 94.22%), belonging to sub micron to low micron materials.

D50=0.531 μ m is close to the peak particle size of 0.352 μ m, indicating that the main distribution body is concentrated.

Sample	Pure EVA	EVA0	EVA1	EVA2	EVA3	EVA4	EVA5	Pure APP
Variance	4.08	4.89	4.10	4.56	4.20	5.19	4.29	4.33

Table S1: Variance report of tensile test results

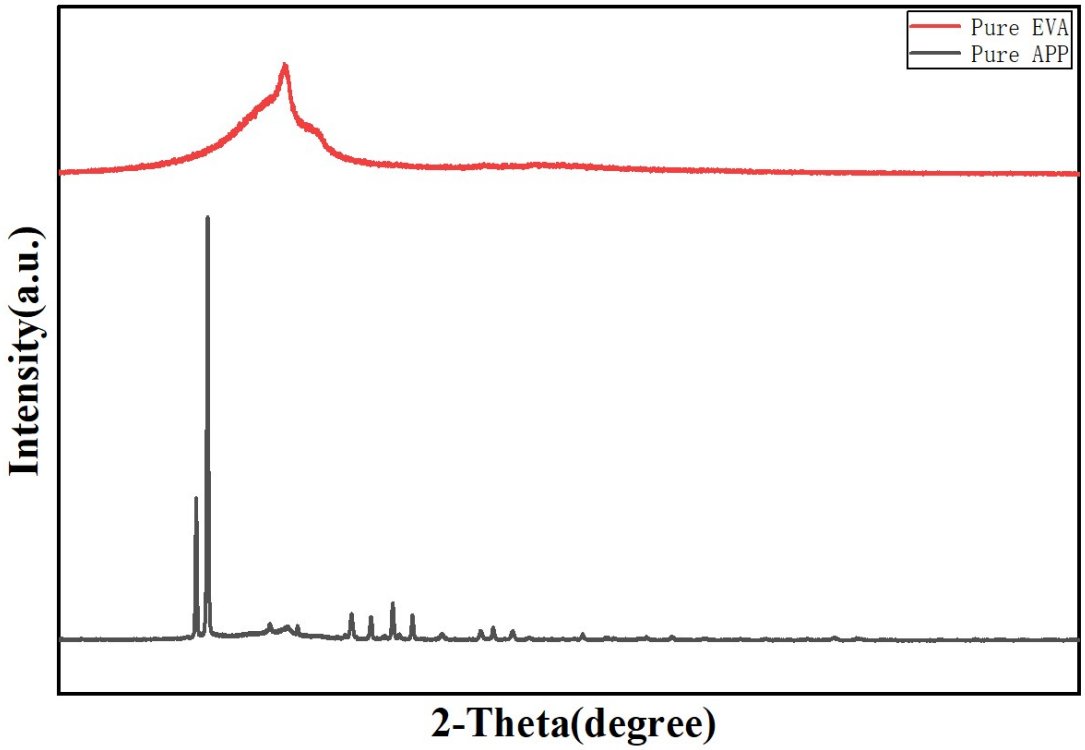


Figure S5: XRD patterns of pure EVA and pure APP

Pure EVA exhibits a wide and weak diffraction peak near 21.5 °, which is a typical characteristic of the semi crystalline structure formed by its ethylene segment. In contrast, app shows sharp and strong diffraction peaks with the main peaks at about 15 ° and 27° (2 θ), which clearly corresponds to its crystalline morphology. The highly ordered crystal structure of app is the basis for its flame retardant function as an acid source and gas source. In the subsequent composites, the crystal structure of app was destroyed during thermal decomposition, and the released phosphorus containing species interacted with the metal oxides produced by LDH decomposition, which jointly promoted the formation of dense carbon layer. Therefore, it is very important to clarify the initial crystal state of raw materials for understanding the thermal degradation process and synergistic flame retardant mechanism of app/ldh/eva system.