coatings

MDPI

Supporting Information

Montmorillonite Synergized Water-Based Intumescent Flame Retardant Coating for Wood

Xiaochun Hu, Zhao Sun, Xiaojun Zhu and Zhiqiang Sun*

School of Energy Science and Engineering, Central South University, Changsha 410083, China; xchu@csu.edu.cn (X.C.H.); zsun@csu.edu.cn (Z.S.); xjzhu@csu.edu.cn (X.J.Z.)

* Correspondence: zqsun@csu.edu.cn

Abstract: In this study, montmorillonite (MMT) was used as an inorganic synergist to prepare the water-based intumescent flame retardant (IFR) ornamental coating for plywood. Results indicate that the 7 wt.% MMT modified IFR coating (No. 3) possesses the best fire resistance (longer than 20 min) of the tested samples according to the fire performance, which significantly declines the specific extinction area by 44.12 $m^2 \cdot kg^{-1}$ compared to the coating without MMT by cone calorimeter. Besides, characterizations such as XPS, XRD, TG, SEM and FTIR were characterized to investigate the surface and bulk properties as well as the morphology of MMT synergized water-based IFR coating. It is revealed that the residual nitrogenous polyaromatic structure and 25.5% residual mass in the No. 3 coating are a result of the effect of MMT on the antioxidation properties of char layer.

Keywords: montmorillonite; intumescent flame retardant; char layer; nitrogenous polyaromatic structure

Results and discussion

The residual mass of coatings at 200 °C, 400 °C, 500 °C, and 700 °C by the TG measurements is shown in Table S1.

Table 1. Residual mass of coatings at different temperature.

Specimen	Residual mass/%			
	200 °C	400 °C	500 °C	700 °C
No.0	93.0	50.4	36.8	0
No.2	93.6	54.7	42.9	20.7
No.3	92.6	55.0	44.4	25.5
No.4	93.9	59.1	48.3	32.2

Figure 1. The XRD and SEM information of MMT. The surface chemical composition of the No.0 and No.3 are analyzed delicately using XPS measurement. Fig. S2 display the survey-scan XPS spectrum of the two samples. The main peaks corresponding to P, C, N, and O are observed. Fig. S3-S5 shows the O_{1s}, P_{2p}, and C_{1s} spectra of No.0 and No.3, respectively.

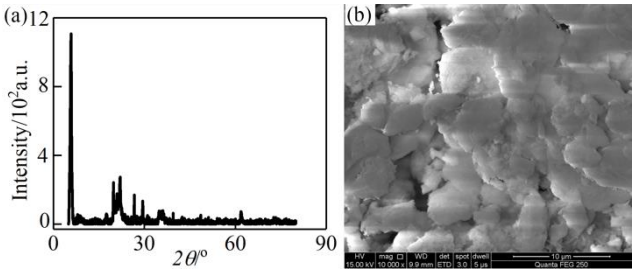

Figure 1. (**a**) The XRD pattern of MMT and (**b**) SEM image of MMT.

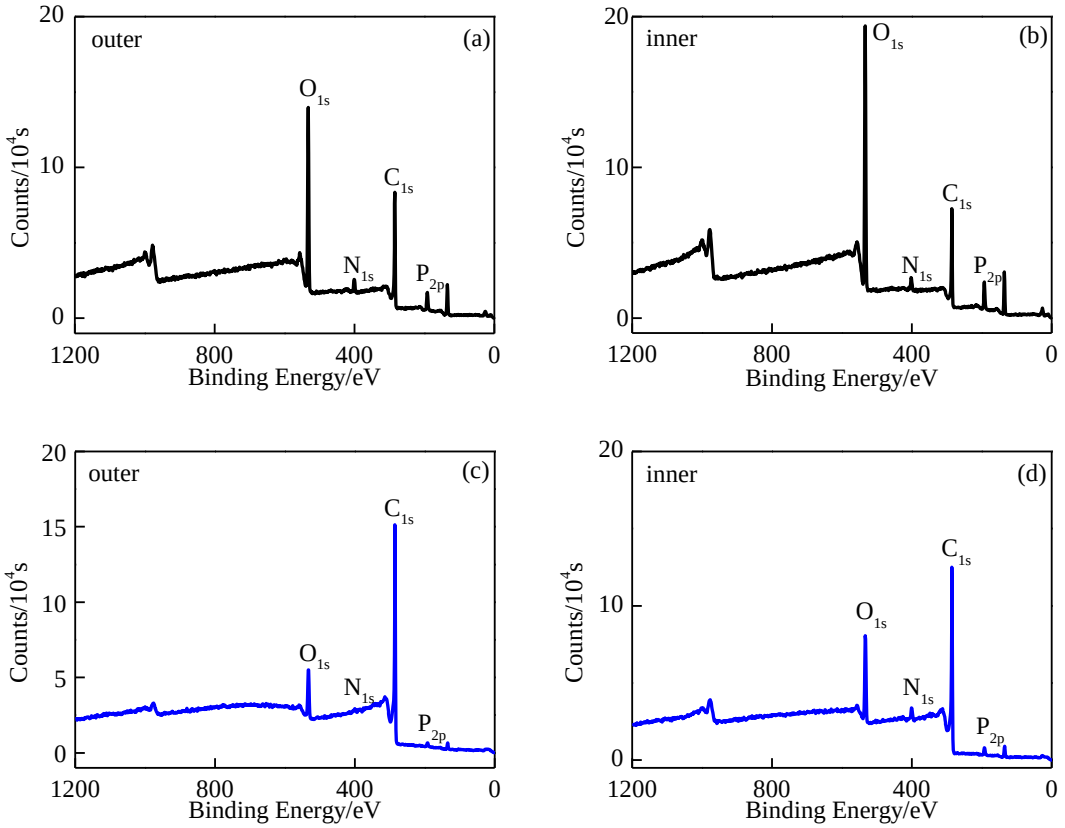

Figure 2. The composition of element for No.0 and No.3 outer and inner char layers.

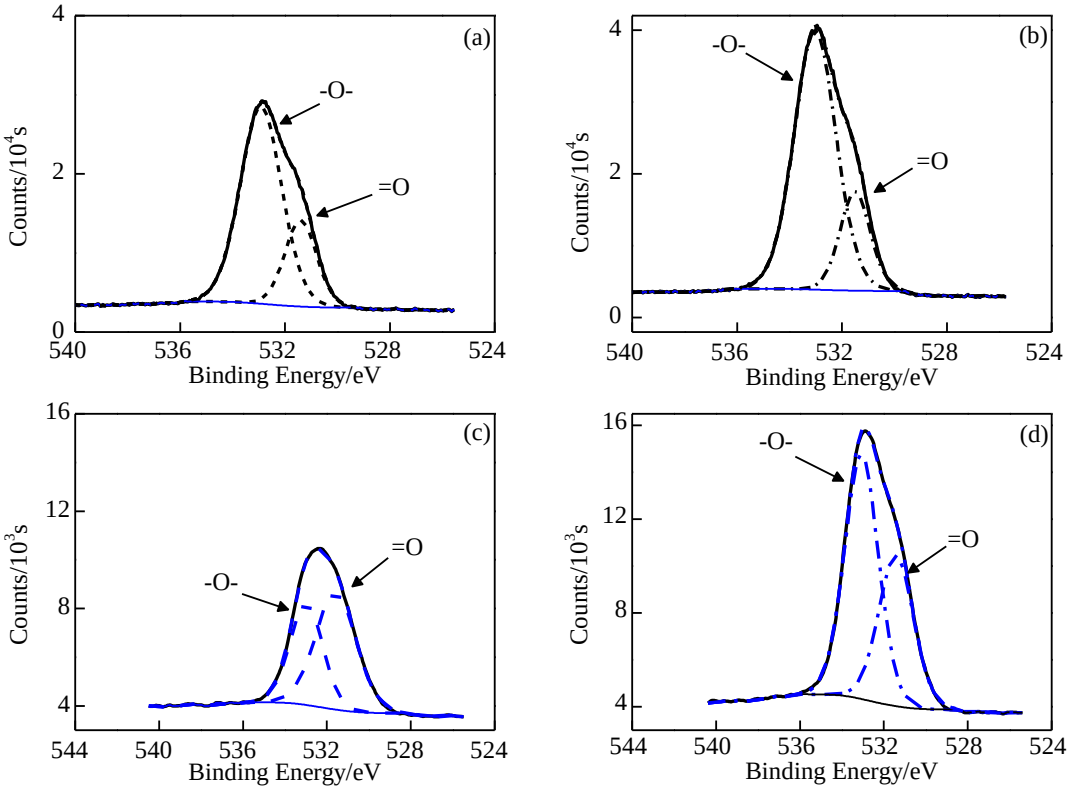

Figure 3. The O_{1s} XPS spectrum: (**a**) outer No.0; (**b**) inner No.0; (**c**) outer No.3; and (**d**) inner No.3.

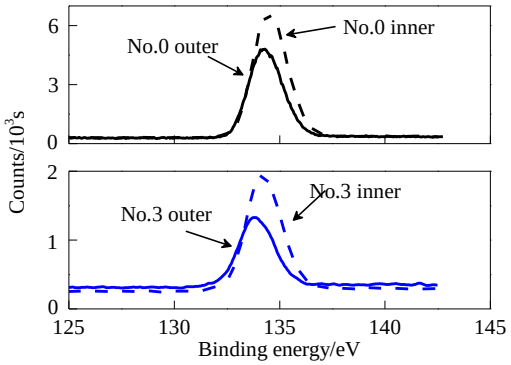

Figure 4. The P_{2p} XPS spectrum.

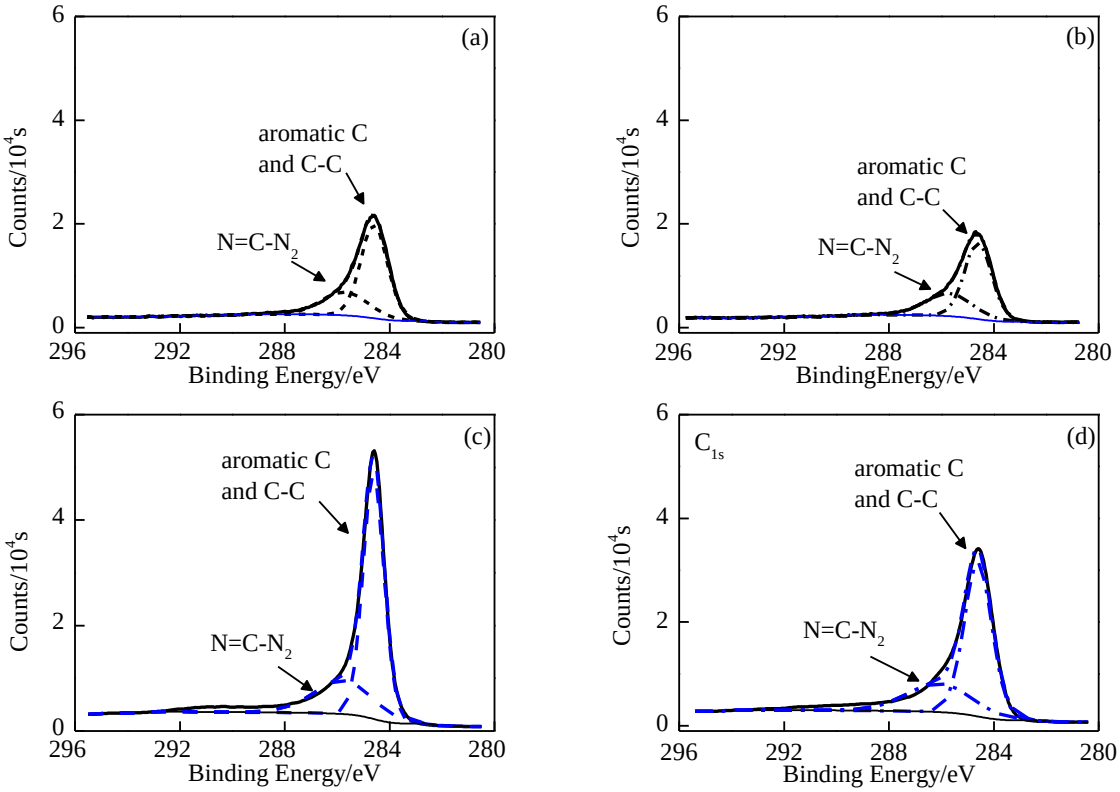

Figure 5. The C_{1s} XPS spectrum: (**a**) outer No.0; (**b**) inner No.0; (**c**) outer No.3; and (**d**) innerNo.3.

Abbreviations

APP	ammonium polyphosphate
DTA	differential thermal analysis
FTIR	Fourier transform infrared spectroscopy
IFR	intumescent flame retardant
MEL	melamine
MMT	montmorillonite
PER	pentaerythritol
SEA	specific extinction area

SEM	SEM
TG	thermogravimetry
TSP	total smoke production
TSR	total smoke release
TTI	time to ignition
XPS	X-ray photoelectron spectroscopy
XRD	X-ray diffraction