Supplementary Material

Core–Shell Nanostructured Latex for Multifunctional Anti-corrosion and Flame-Retardant Coatings

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3.Results and Discussion

3.1 Film-forming property of PVC-PU-PBA

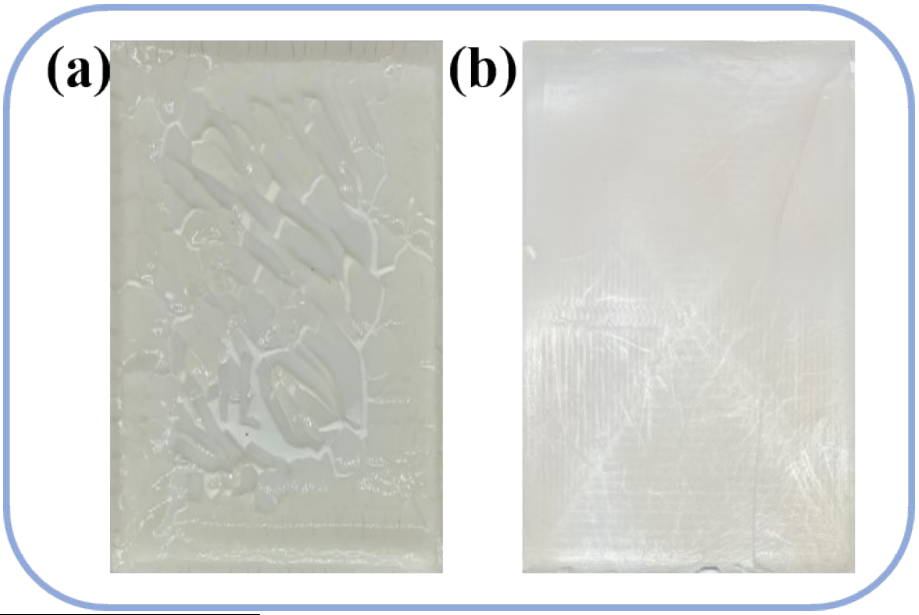

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Fig. S1. Film formation status diagram of (a) PVC and (b) PVC-PU-PBA

Compared with the PVC emulsion which could not film-forming, the PVC-PU-PBA film are smooth and flawless as can be seen from Fig.S1. This indicates that the addition of PU and BA significantly improves the film-forming properties of PVC.

3.2 The equivalent electrical circuits

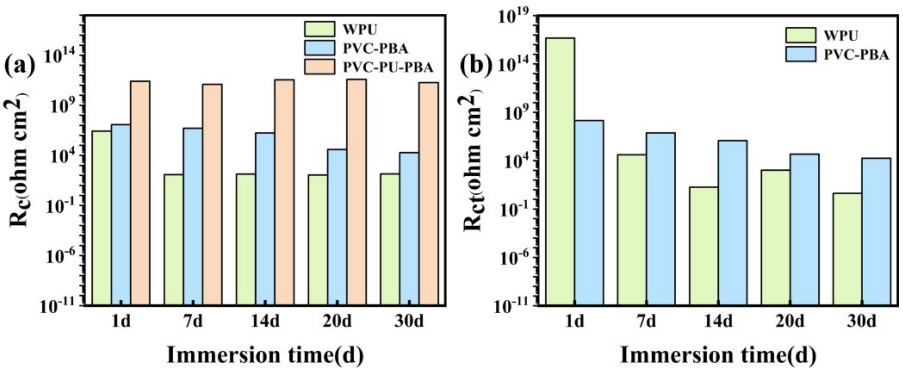

Fig. S2. Evolution of R_c and R_{ct} for the coatings during 30 days immersion.

Table. S1 Values of R_c (ohm.cm^2) at different immersion time

Immersion time	PU	PVC-PBA	PVC-PU-PBA
1d	2.69×10^{6}	1.18×10^{7}	2.54×10^{11}
7d	120.40	5.06×10^{6}	1.24×10^{11}
14d	135.80	1.70×10^{6}	3.52×10^{11}
20d	109.20	3.83×10^{4}	3.89×10^{11}
30d	141.00	1.85×10^{4}	1.85×10^{11}

Table. S2 Values of R_{ct} (ohm.cm^2) at different immersion time

Immersion time	PU	PVC-PBA
1d	4.78×10^{6}	1.43×10^{8}
7d	4.11×10^{4}	7.31×10^{6}
14d	17.88	1.16×10^{6}
20d	1.05×10^{3}	4.69×10^{4}
30d	4.08	1.81×10^{4}

In cases of composite coatings, there were all single time constant corresponding

to the capacitive response of the coating during the immersion process. R_c is the coating resistance that represents the ability of the coating to block current through its own defects and pores [1]. R_{ct} is the charge transfer resistance between steel and electrolyte, revealing the corrosion resistance of the steel [2]. Therefore, we discussed the coating resistance (R_c) and the charge transfer resistance (R_{ct}) of different coating and the related data were listed in Figs. S2a-b and Tables.S1-2, respectively. Generally, a higher R_c value indicates a greater protective performance of the coating. As shown in Fig.S2a and Table.S1, PVC-PU-PBA coated Q235 steel had the highest coating resistance compared to WPU and PVC-PBA coatings throughout the immersion process. Furthermore, PVC-PU-PBA coating has no R_{ct} value. The highest IE of 99.99%, was achieved by the PVC-PU-PBA coating after immersed in 3.5 wt% NaCl solution for 30 days as shown in Table.S3. Hence, the PVC-PU-PBA coating possess the best anticorrosive performance among all coatings.

Table. S3 Polarization parameters of coatings in 3.5% NaCl solution

Sample	E_{corr}(V)	I_{corr}(A/cm^2)	CR (mm/year)	IE (%)
Bare Q_{235}	-0.6120	1.78×10^{-4}	2.06	--
PU	-0.4551	4.12×10^{-6}	4.78×10^{-2}	97.68
PVC-PBA	-0.6076	3.92×10^{-7}	4.54×10^{-3}	99.78
PVC-PU-PBA	0.3460	5.32×10^{-13}	6.16×10^{-9}	99.99

The inhibition efficiency (IE, %) of the coatings was calculated according to equation (1) and the corrosion rate (CR mm/years) was obtained by the equation (2).

$$IE=\frac{i^0_{corr}-i_{corr}}{i^0_{corr}}\times100\% \quad (1)$$

where i^0_{corr} and i_{corr} are corrosion current density of the Q235 steel without and with the coatings, respectively.

$$CR=\frac{M\times I_{corr}}{n\rho F}\times87600 \quad (2)$$

In which M is the molecular weight of Fe (56 mol/g) and n is the chemical price of Fe. In addition, ρ is the electrode density of Q235 steel(7.9 g/cm^3), and f is Faraday constant (26.8 Ah/mol) [3].

3.3 Flame retardancy of composites

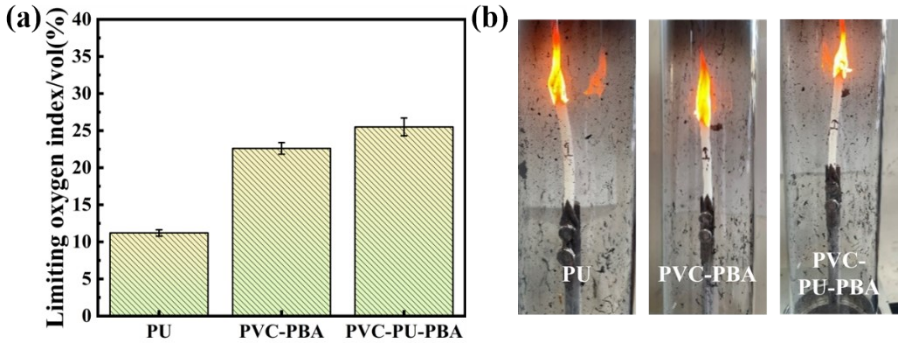

Fig. S3. PU, PVC-PBA, PVC-PU-PBA composites in LOI post-test.

As can be seen from Fig.S3, the limiting oxygen index of the PVC-PU-PBA latex has certain flame-retardant properties compared to pristine PU, and the intrinsic flame-retardant property of PVC was reflected well [4]. The flame-retardant properties of PVC-PU-PBA latex was improved with the combination of the PVC, PU, and PBA, because the fluidity of the melt decreases with the increase of the degree of crosslinking and the formation of a certain carbon layer, making the limiting oxygen index values of the latexes also increased [5].

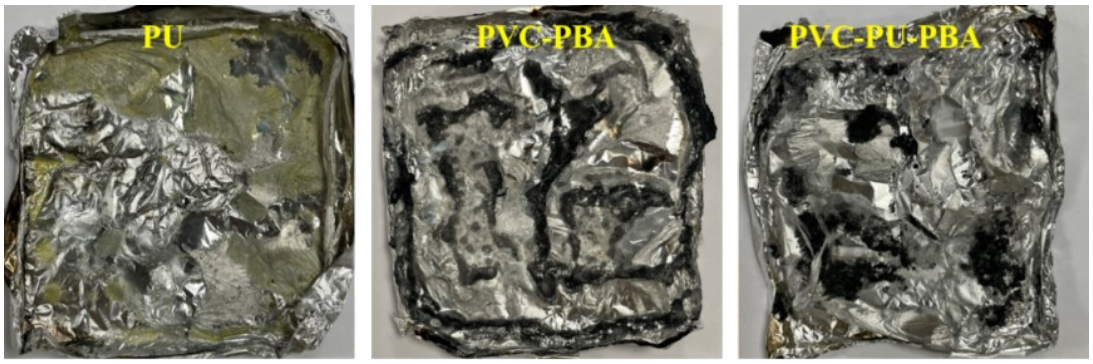

Fig. S4. Digital photographs of char residues of PU, PVC-PBA, and PVC-PU-PBA after the cone calorimeter test.

References

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