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Cu^{2+}-doped intumescent flame retardant flexible polyurethane foam with excellent flame retardant and mechanical properties

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INTRODUCTION

Flexible polyurethane foam (FPUF) is widely used in aerospace, furniture, vehicles and other fields because of its low density and resilience properties[1]. However, FPUF with porous structure and combustible hydrocarbon segments is highly inflammability, which poses a great threat to the safety of human life and property[2]. Traditionally, halogen-based flame retardants with adaptability and high efficiency were widely applied for decades. Unfortunately, halogen-based flame retardants exhibit environmental and biological toxicity. Enhancing the carbonization ability of the FPUF is another important way for improving the flame retardance of FPUF[3].Specifically, among all the intumescent flame retardants (IFR), expanded graphite (EG) with excellent self-intumescent ability can enhance the flame retardance of FPUF. During combusting, EG can immediately form an intumescent char layer, which can slow down the transfer of the heat and mass, thus enhance flame retardance of FPUF. However, the poor compatibility between EG and FPUF would dramatically affect overall performance of FPUF[4]. Therefore, designing a novel intumescent flame retardant (IFR) for FPUF with high flame retardant efficiency becomes a real challenge.

EXPERIMENTAL

Cu^{2+}-doped intumescent flame retardant (Cu-IFR) was successfully separated from water by freeze-drying.

RESULTS & DISCUSSION

Flame retardance

LOI, butane torch burning test, and compressive stress-strain tests were used to evaluate the flame retardancy and mechanical of FPUF, FPUF/TCPP16.5% and FPUF/Cu-IFR16.5%.

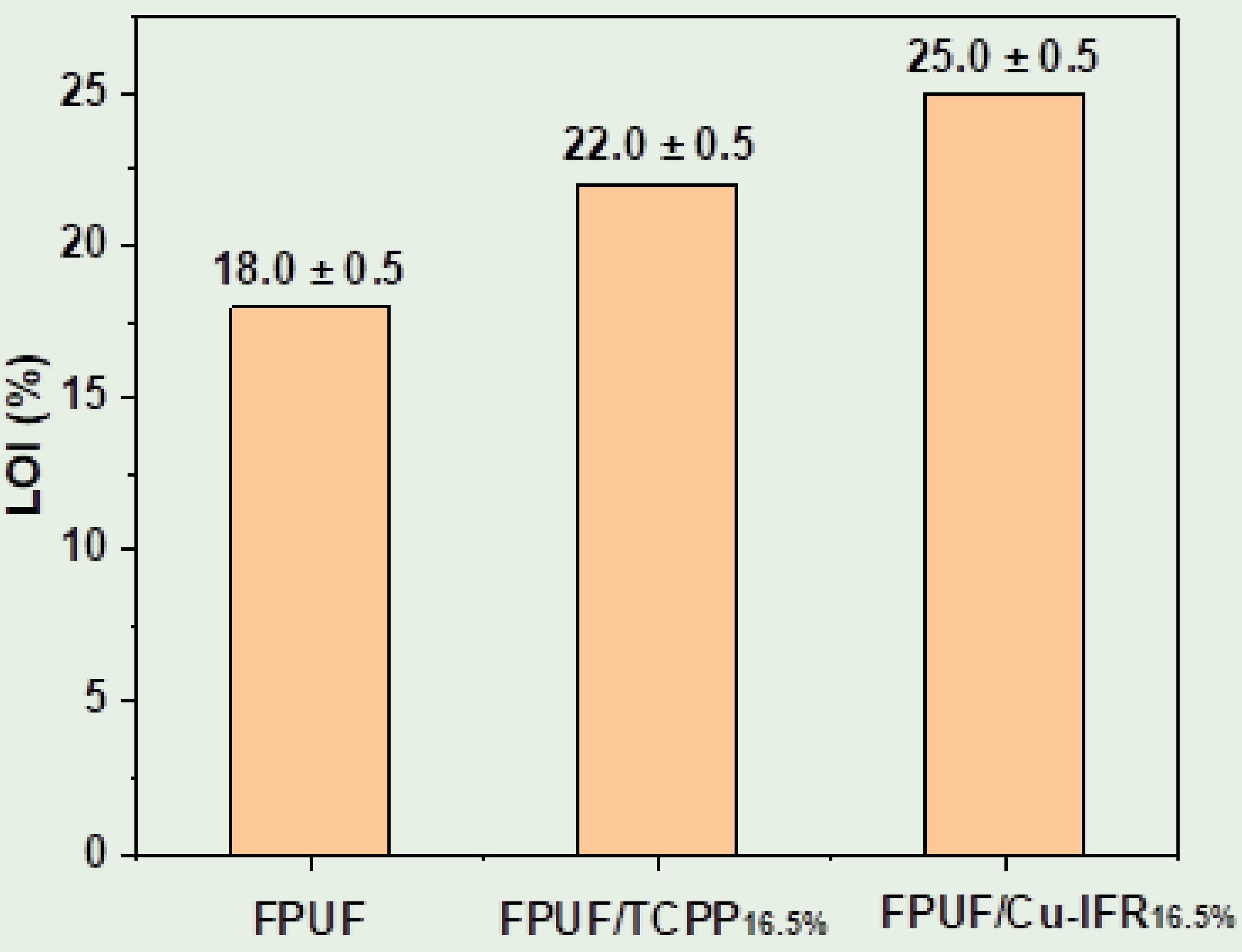

Figure 1. Limit oxygen index of FPUF, FPUF/TCPP16.5% and FPUF/Cu-IFR16.5%

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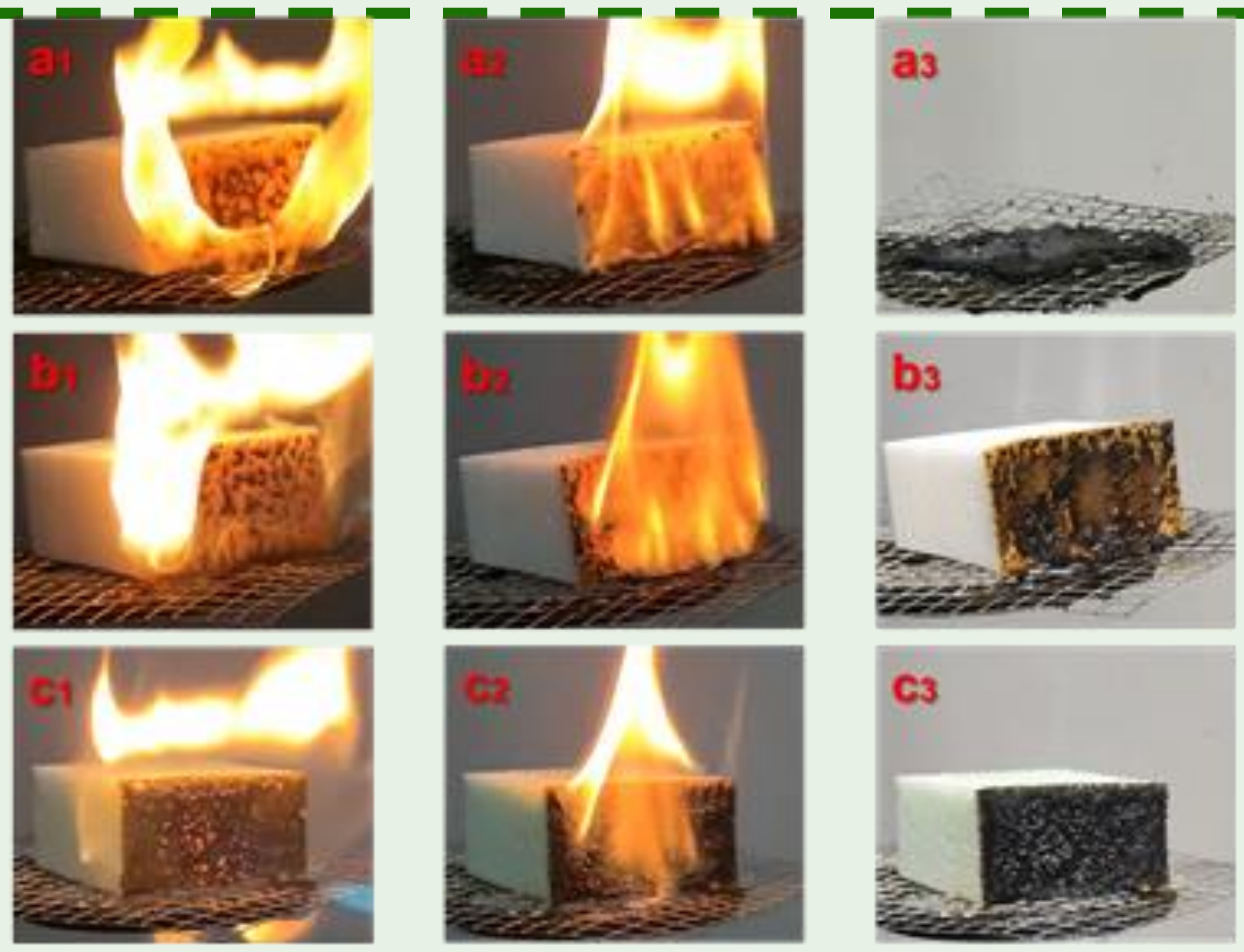

Figure 2. Digital photos of butane torch burning test for FPUF (a1-a3), FPUF/TCPP16.5% (b1-b3), FPUF/Cu-IFR16.5% (c1-c3).

compressive stress-strain

Table 3. Compressive strength and deformation rate data for FPUF, FPUF/TCPP16.5% and FPUF/Cu-IFR16.5% compressive stress-strain tests.

Sample	FPUF		FPUF/TCPP16.5%		FPUF/Cu-IFR16.5%	
	Cycle 1	Cycle 100	Cycle 1	Cycle 100	Cycle 1	Cycle 100
Compressive strength (kPa)	18.8	18.5	15.2	15.0	36.7	33.4
Deformation rate (%)	0.28	0.42	0.28	0.41	0.27	0.62

CONCLUSION

Compared with FPUF and FPUF/TCPP16.5% and FPUF/Cu-IFR16.5%The limiting oxygen index (LOI) increased from 18.0% FPUF to 25.0% FPUF/ Cu-IFR16.5%, while the LOI of FPUF/TCPP16.5% could only reach 22.0% with the same addition amount of tri (1-chloro-2-propyl) phosphate (TCPP). After 10 s of butane flare combustion, FPUF/TCPP16.5% will self-extinguish within 30 s, while FPUF/Cu-IFR16.5% will self-extinguish within 5 s. The compressive strength of FPUF/ Cu-IFR16.5% increased significantly from 18.8 kPa to 36.7kPa, and the deformation rate was only 0.62% after 100 times of cyclic compressive stress-strain tests.

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