

Fig. 1: Synthesis process of TDBTZP

Research background: As a natural material, cotton fabric has excellent breathability, comfortable wearing, easy dyeing and processing. Because of these advantages, cotton fabrics have been widely used in transportation, packaging, clothing, industry and many other fields. However, cotton fabrics are flammable, with a LOI of only 18.4%, which may seriously threaten people's property and life safety. Therefore, it is of great significance to develop an environmentally friendly and efficient flame retardant for cotton fabrics.

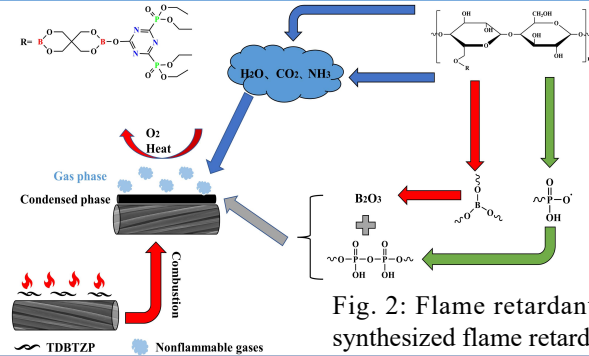


Fig. 2: Flame retardant mechanism of the synthesized flame retardant

Vertical flammability test

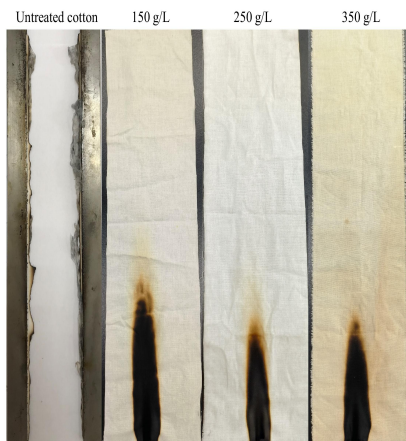


Fig. 3: Vertical flammability test of cotton fabrics treated with different concentrations of flame retardants.

TG test

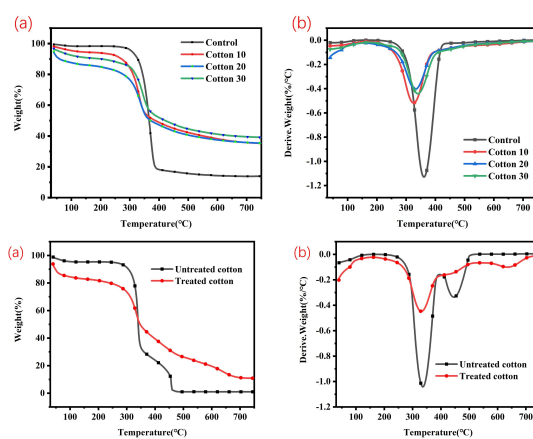


Fig. 4: TG (a) and DTG (b) curves of untreated and treated cotton fabrics in nitrogen atmosphere; TG (a) and DTG (b) in the air.

TG-IR test

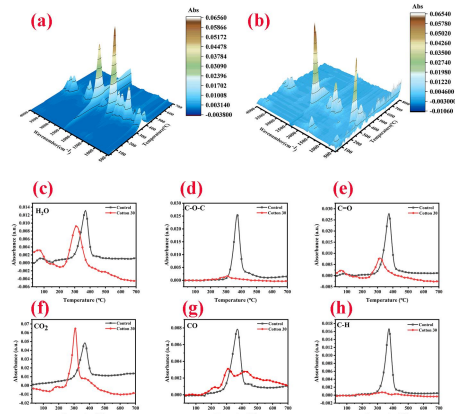


Fig. 5: 3D TG-IR spectra of cotton and cotton 30 (a, b); FT-IR spectra of different groups (c-h).

Cone calorimeter test

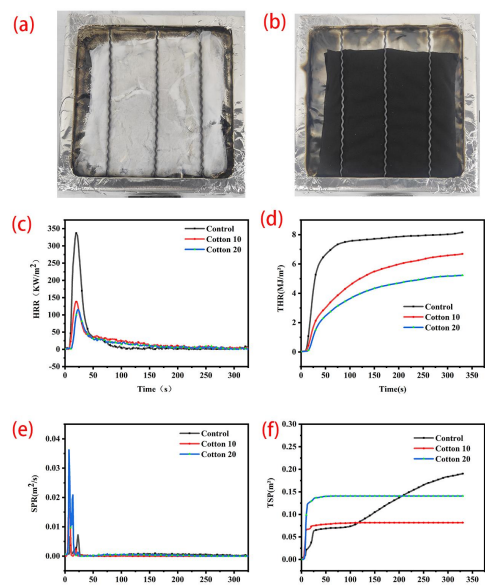


Fig. 6: Digital photos of untreated (a) and treated (b) cotton after cone calorimetry test; HRR (a), THR (b), SPR (c) and TSP (d) curves of samples.

XPS test

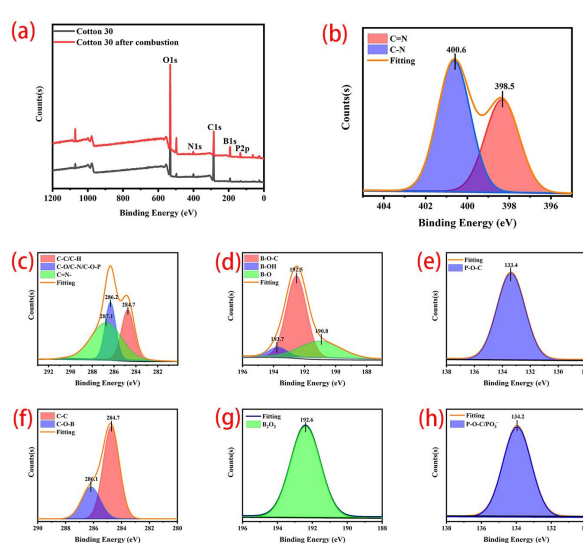


Fig. 7: XPS spectrum of flame retardant cotton fabric before and after combustion (a); XPS spectra of N1s (b), C1s (c), B1s (d) and P2p (e) elements before combustion; XPS spectra of C1s (f), B1s (g) and P2p (h) elements of cotton 30 after combustion.

Conclusion

A new type of B/P/N flame retardant TDBTZP was synthesized. The structure of TDBTZP was characterized by FT-IR, ¹H NMR. The results of thermogravimetric analysis show that TDBTZP can endow cotton fabric with positive thermal stability and charring ability, and still retain 10.9% carbon residue in the air at 750 °C. The results of cone calorimetry showed that the HRR, THR and TSP of the treated cotton fabric were lower than those of the pure cotton fabric, and the maximum carbon residue was 19.1%. In a word, the flame retardant synthesized in this paper provides a new way for the preparation of flame retardant cotton fabric and has a good application prospect.