STUDY ON THE THERMAL DEGRADATION OF A MIXTURE OF A NOVEL CAGED BICYCLIC PHOSPHATE AND AMMONIUM POLYPHOSPHATE

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In order to understand the intumescent flame retardant effect of a novel caged bicyclic phosphate (Trimer, tri (1-oxo-2,6,7-trioxa-1-phosphabicyclo [2,2,2] octane-methyl) phosphate) and ammonium polyphosphate (APP) used in intumescent coatings [1] and some polymers such as polypropylene [2], the thermal degradation of Trimer, APP and their mixture were studied.

Different degradation behavior of Trimer/APP (mass ratio of 2:1) from Trimer and APP was observed by thermogravimetric analysis (TG) shown in Fig.1. Trimer shows higher thermal stability, its first weight loss peak reached 43.2 %/min (30 % weight loss at 375 ℃), and relative main gaseous products are hydrocarbon containing compounds. The experimental TG curve of Trimer/APP, compared with the theoretically calculated one, showed lower initial degradation temperature and higher char residue at 800 ℃, demonstrating interactions of Trimer and APP during thermal degradation. Such interactions were evidenced by gaseous degradation products analyzed by TG-FTIR.

It is interesting that Trimer couldn't expand alone, but after mixed with APP expanded rapidly during about 365~420 ℃ (see Fig. 2) and with more P, O and N compounds being kept in condensed phase proved by X-ray photoelectron and spectroscopy (XPS) shown in Fig. 3. These results demonstrated the synergistic effect involving cross-linking reactions between Trimer and APP during the thermal degradation process. The synergistic main products of the char residue should be polyphosphate and its derivatives.

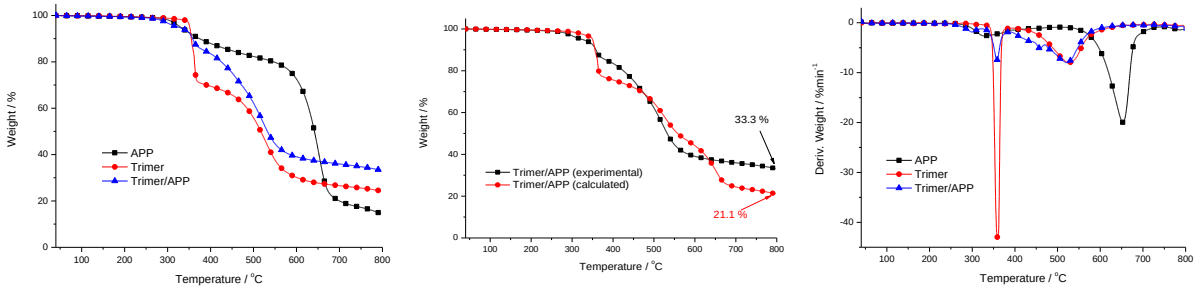

Fig. 1 TG (left and middle) and DTG (right) curves of APP, Trimer and Trimer/APP under N_2 atmosphere (20 °C/min)

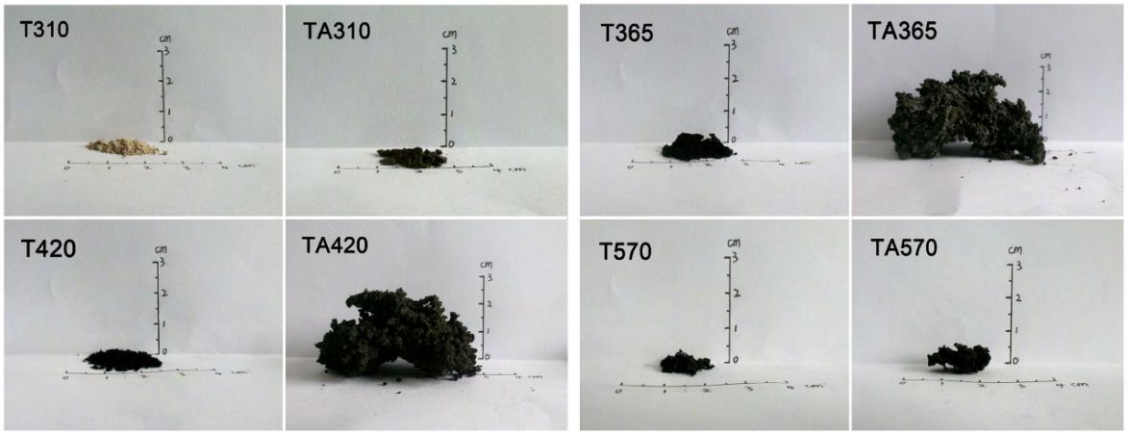

Fig. 2 Digital pictures of Trimer (T) and Trimer/APP (TA) after thermal-oxidative degradation at different temperatures

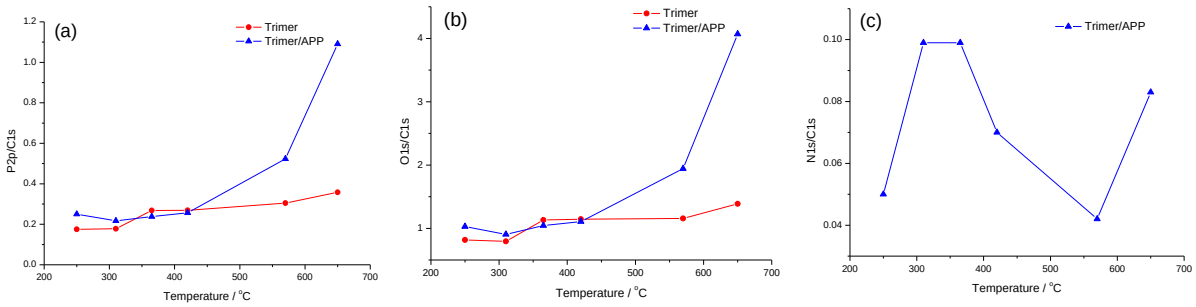

Fig. 3 Comparison of P2p/C1s (a), O1s/C1s (b) ratios of Trimer and Trimer/APP, and N1s/C1s ratio of Trimer/APP (c) with temperature increased

Reference

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