

Alloying synergistic flame retardant effect improving fire resistance and mechanical properties of polyamide 6

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Introduction:

- Polyamide (PA) has strong flammability due to the large amount of methylene structure, which severely limits its application.
- Aluminum diethylhypophosphate(ADP) has excellent flame retardant properties for PA, but it has a negative impact on mechanical properties.
- The molecular structures of polyimide (PI) and PA6 are similar, adding PI with PA6 can form PI-PA6 alloy by the hydrogen bond effect and nice homogeneous phase, which will compensate for the adverse effect of ADP on the mechanical properties of PA6.
- This paper will focus on the influence of flame retardancy and mechanical properties of ADP/PI-PA6 alloying composites.

Results and discussion:

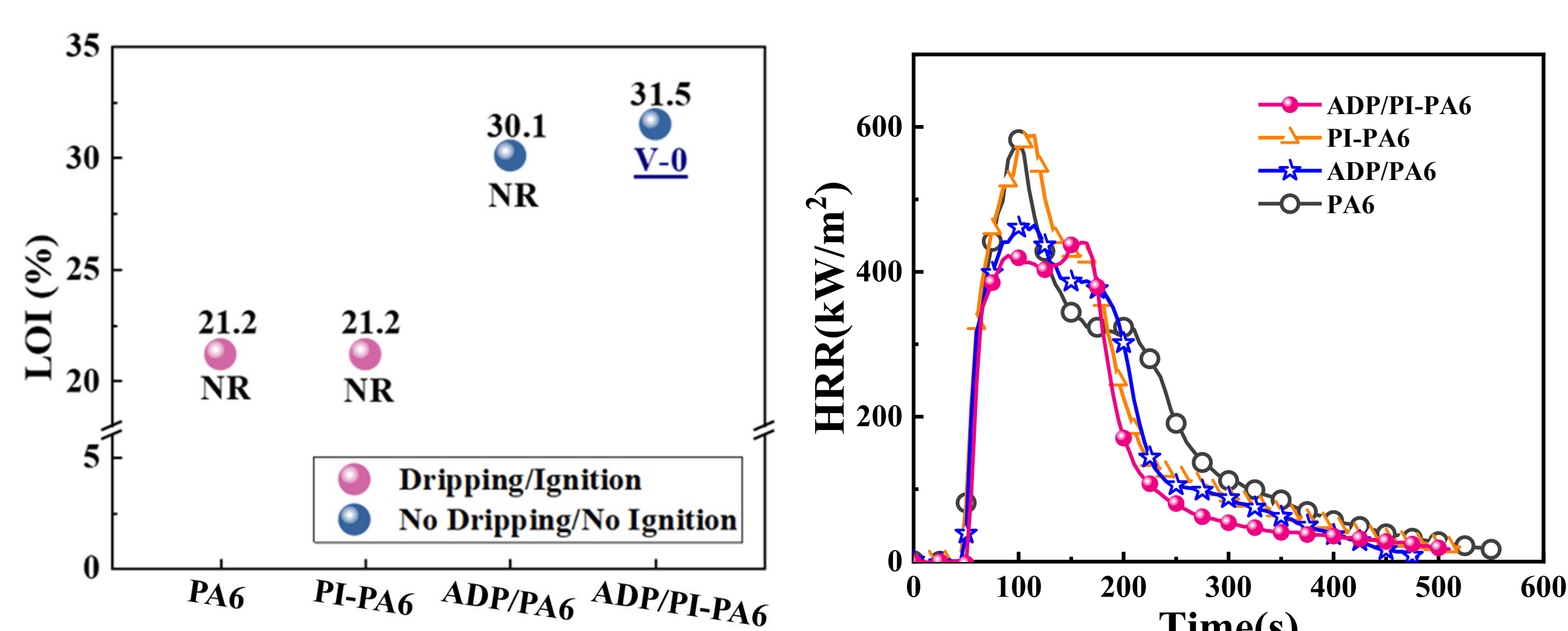


Fig.1 The LOI and UL94 values and HRR curves of PA6 composites

- It can not increase the flame retardancy of PA6 matrix by using PI alone.
- PI and ADP have a synergistic flame retardant effect and can provide PA6 with excellent flame retardant properties.

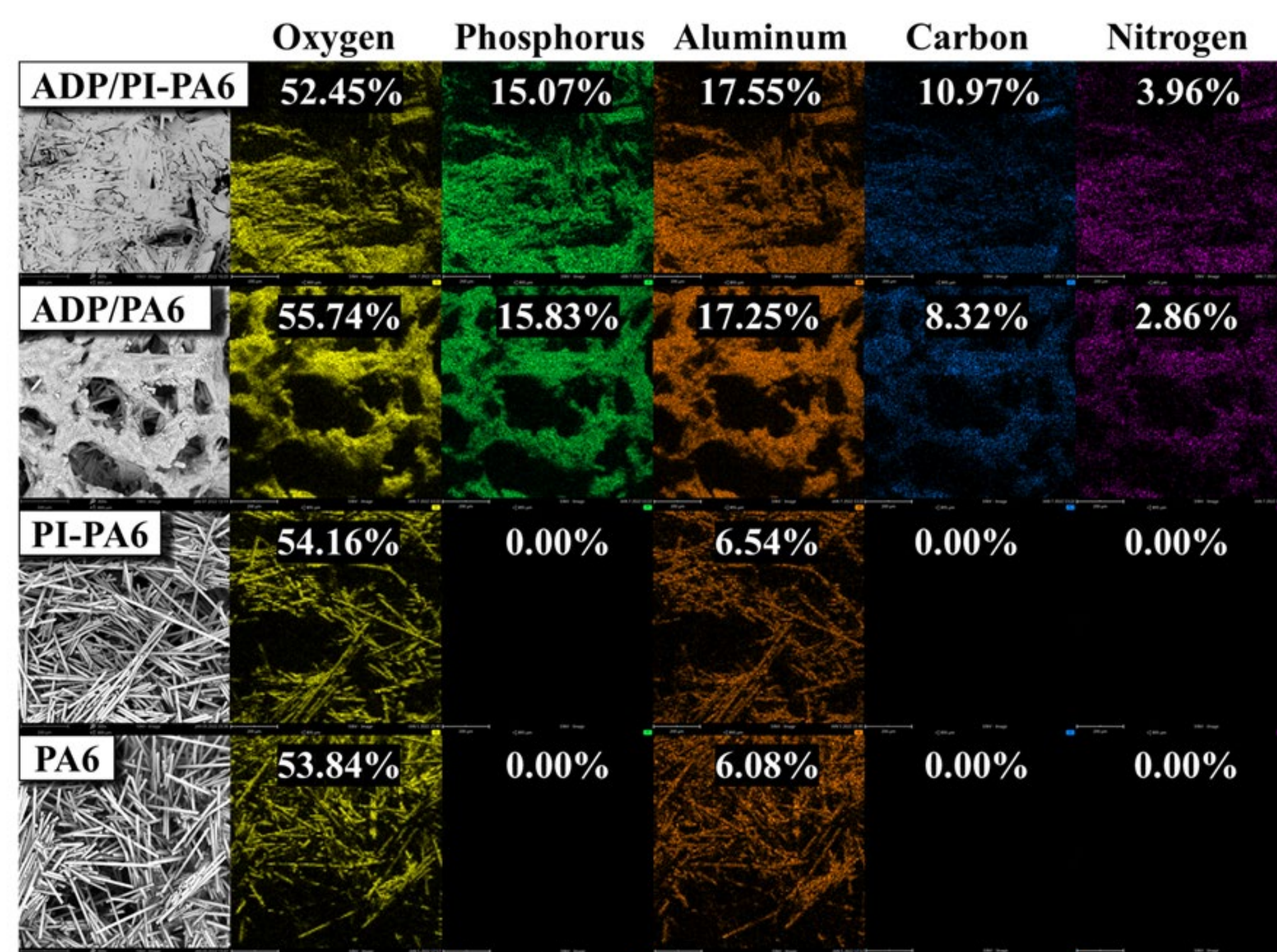


Fig.2 EDX scanned photos of surface residue from cone calorimeter test

- During the combustion process, PI and ADP can synergistically improve the charring effect of PA6.

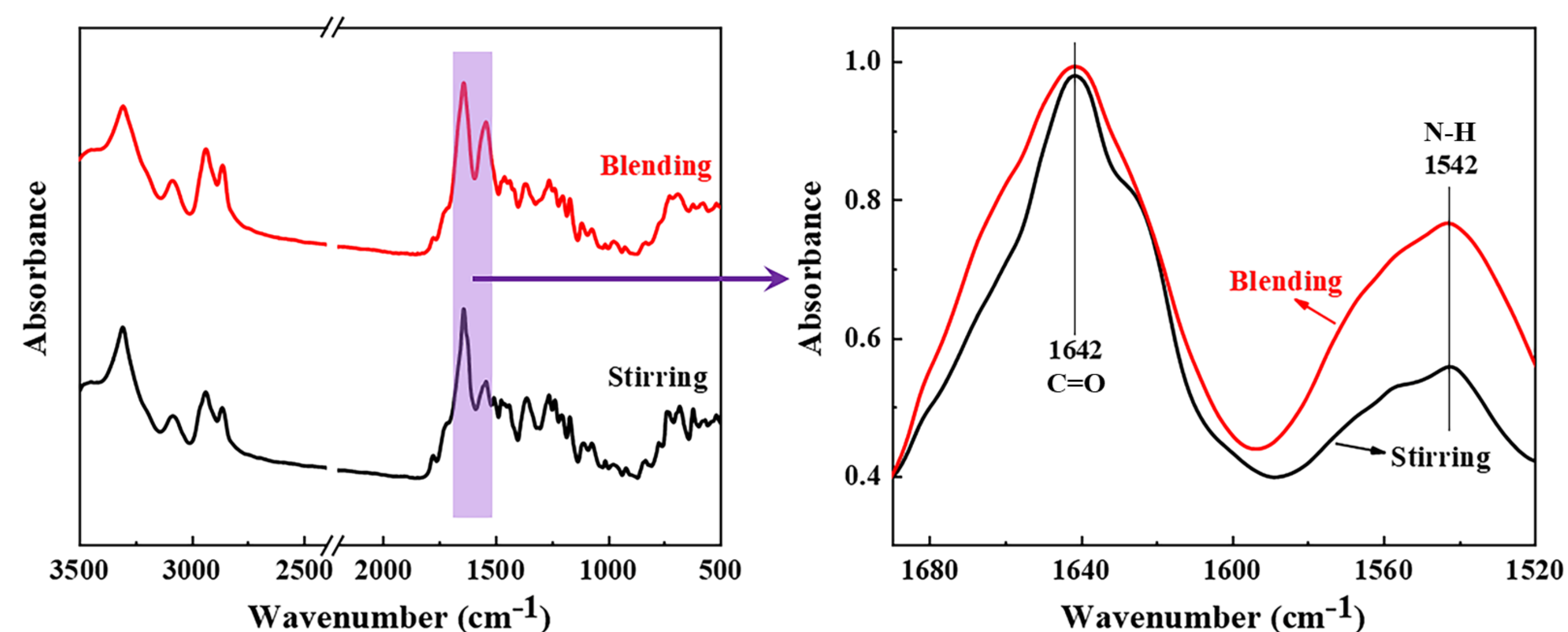


Fig.3 FTIR spectra of PI and PA6 blending with different methods (Blending: melt blending at 245°C; Stirring: physical mixing at room temperature.)

- The existence of hydrogen bonding between PI and PA6 during the melting mixing process at high temperature.

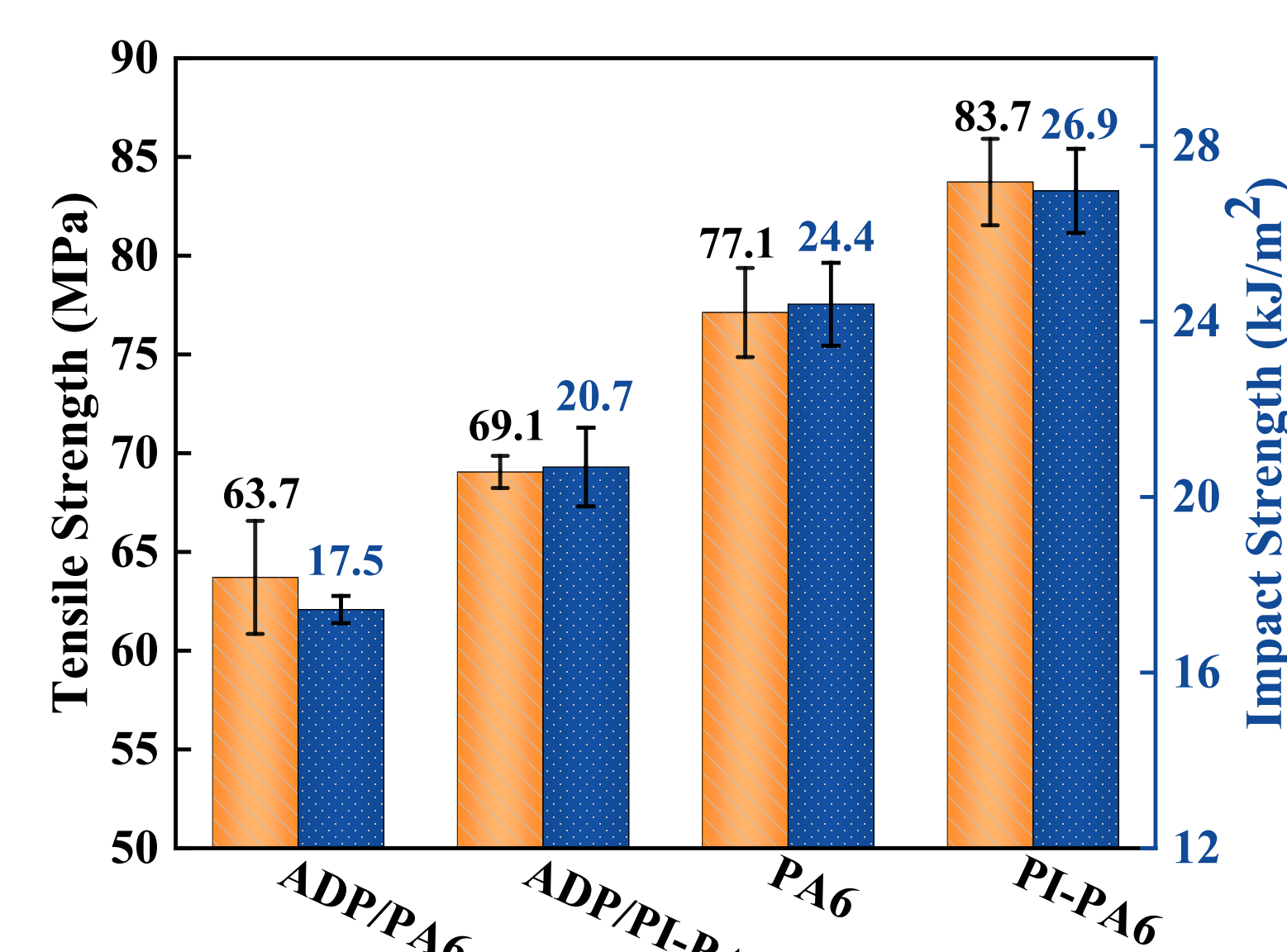


Fig.4 Tensile strength and impact strength test results of PA6 composites

- PI can compensate the damaged effect of ADP on the mechanical properties in PA6.
- The nature of PI enhancing PA6 mechanical properties is the alloying effect and the intermolecular interaction of PI-PA6.

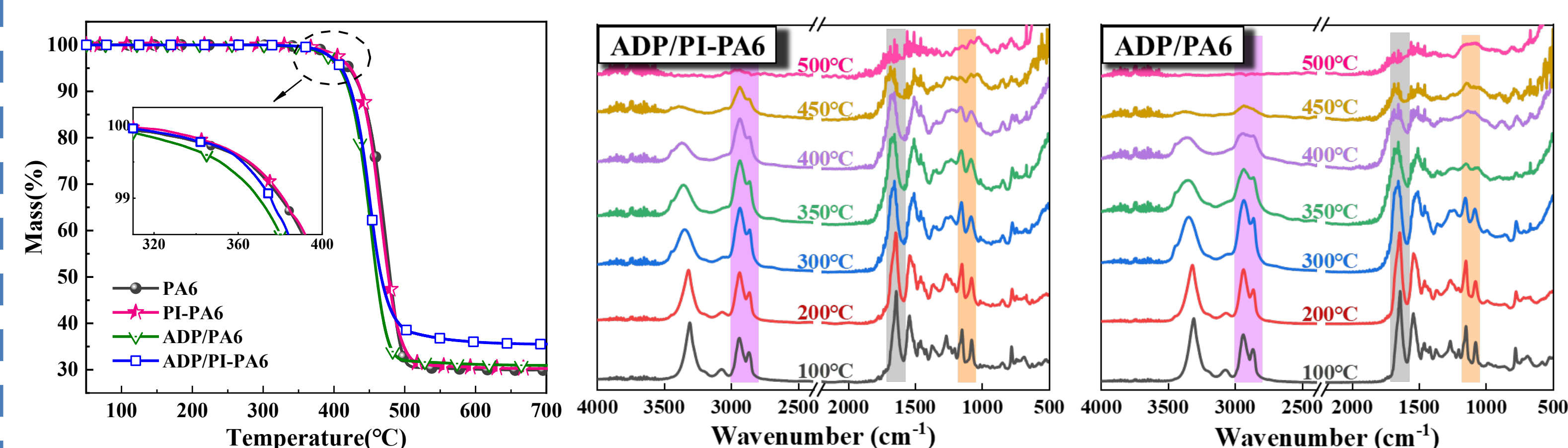


Fig.5 TGA curves of composites Fig.6 FTIR spectra of condensed phase at different temperatures during situ heating stage infrared spectrometer test.

- When PI and ADP are used together, they can increase the amount of char residue of PA6 composites and also improve the thermal stability in the material.

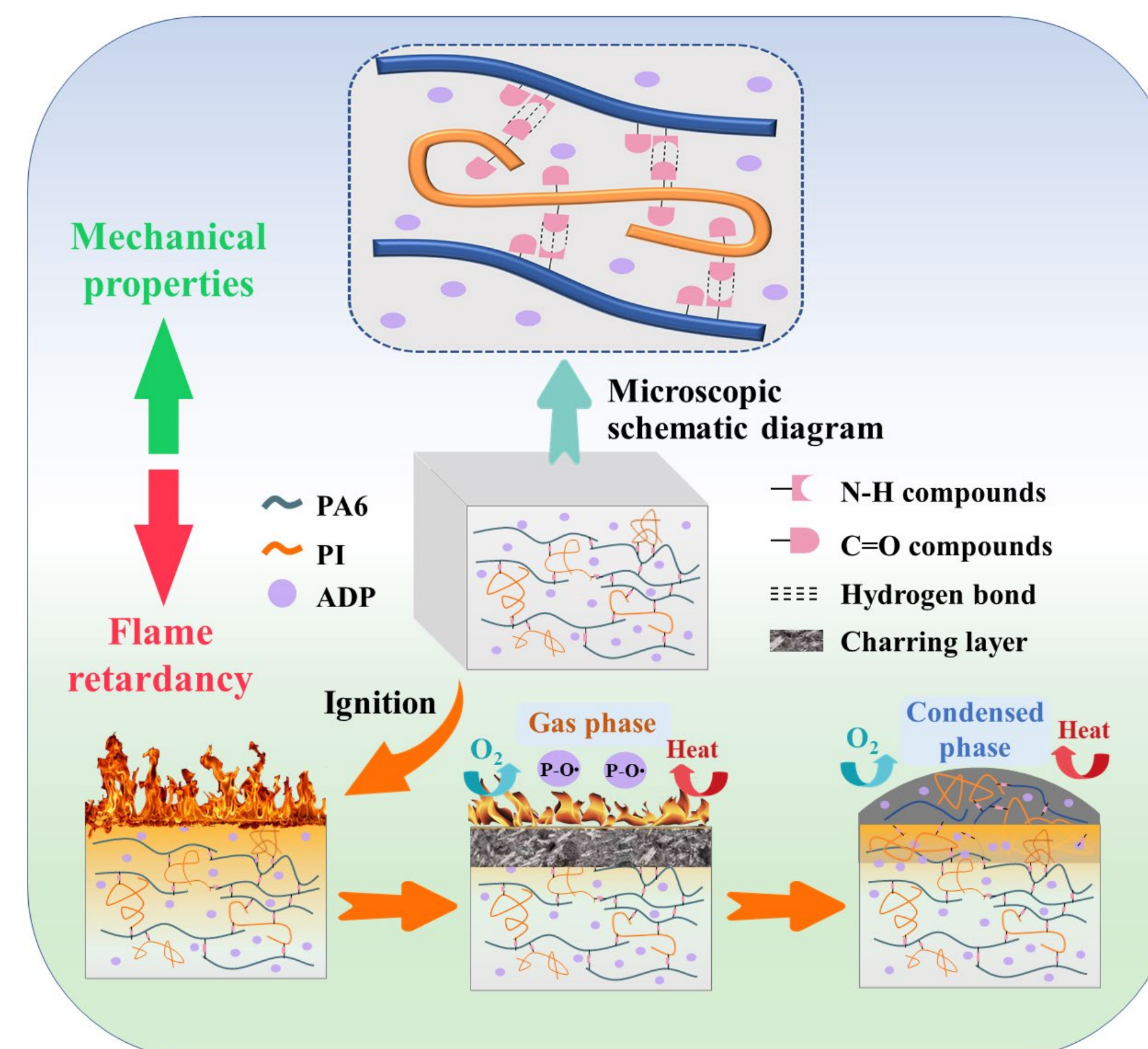


Fig.7 Schematic diagram of the alloying synergistic flame retardant mechanism

- The PI-PA6 alloy could weaken the adverse impact of ADP on mechanical properties for PA6 matrix.
- The alloying synergistic flame retardant system constructed between PI-PA6 alloy with ADP exerts excellent flame retardant properties in the gas phase and condensed phase.