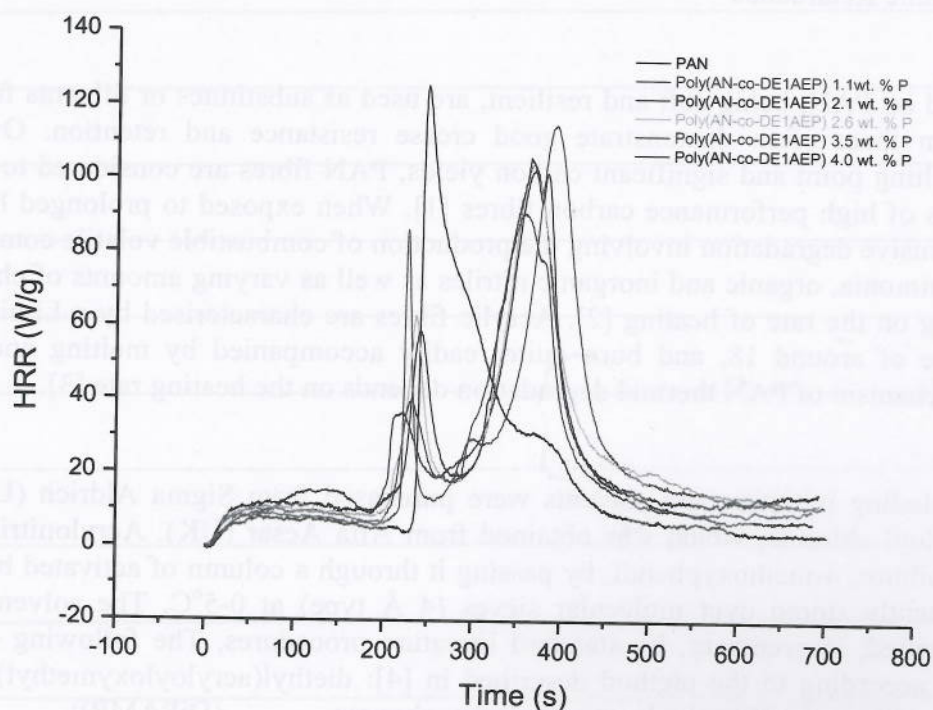


also gave the values for the maximum amount of heat released per unit mass per degree of temperature, i.e. heat release capacity measured in  $\text{kJg}^{-1}\text{K}^{-1}$ , and this can be considered as a reliable indicator regarding flammability of a material [5].

## Results

The results of TGA indicated noticeable differences between thermograms (obtained in nitrogen and in air) of PAN and the copolymers, even of those containing only minimal amount of modifying groups. The amounts of char residue produced at  $700^{\circ}\text{C}$ , in both atmospheres, were significantly higher for the copolymers, as opposed to PAN, suggesting an occurrence of a condensed phase activity of phosphonate groups.

The PCFC data confirmed the flame-retardant effect of modifying groups attached to the PAN chains. For example, the introduction of phosphonate units into the polymer backbone reduces the HRR values (Figure 1). The other parameters such as the peak Rate of Heat Release (RHR), Total Heat Released (THR) and Heat Release (HR) capacity values were also found to be reduced for the copolymers. Indeed, the incorporation of DE1AEP groups led to a decrease in HR capacity from  $200.7 \text{ kJg}^{-1}\text{K}^{-1}$  for PAN to  $102.1 \text{ kJg}^{-1}\text{K}^{-1}$  for poly(AN-co-DE1AEP) containing 4 wt. % of P. Therefore, it can be concluded that the incorporation of covalently-bound P-containing groups in PAN modified its thermal degradation behaviour and also resulted in an enhancement of the fire retardance.



**FIGURE 1.** Heat Release Rate (HRR) versus time for samples of PAN and poly(AN-co-DE1AEP) containing various amount of phosphorus.

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