Investigating the Effect of Different Thermal Stress on High Performance Polymers

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The fundamental relationships between polymer structure, composition and fire resistance were investigated in order to understand the enviable thermal and fire properties of high performance polymers. The thermal degradation and fire properties of intrinsically fire-resistant polymers (poly(etheretherketone) (PEEK), polybenzoxazole (PBO), and polyimide (PI) have been studied.

Two small-scale methods (pyrolysis combustion flow calorimetry (PCFC) and thermogravimetric analysis (TGA)) were carried out and combined in order to characterize the thermal decomposition behavior of the high performance polymers. These measurements provided access to data that are relevant to determining the ease of polymer combustion. Indeed, thermal stability, mass loss rate, the nature and properties of decomposition products, and char yield play a significant role in determining the flammability and decomposition behavior of polymers.

Thermogravimetric analyses performed under an inert atmosphere revealed that high performance polymers have a very high thermal stability as well as a high char yield (>50 wt% at 900 °C). These thermal analyses were also carried out at different heating rates in order to calculate the kinetic parameters of their degradation.

Different oxygen concentrations were used in other thermogravimetric analyses. Depending on the structure of the material evaluated, oxygen has different impacts. While some materials do not show any change on their onset of the degradation temperature (PEEK), others (PBO) show a significant difference even at low oxygen levels.

Mass Loss Cone Calorimetry (MLCC) was performed on PEEK and PI. The temperature profile at the back of the samples was taken and the heat release rates were measured. The fire resistance of PEEK and PI were thus evaluated.