TECHNICAL BRIEF

CHAR FORMATION IN POLYMERS

Additives that increase the amount of charcoal-like residue or carbonaceous char that forms during polymer combustion are very effective fire retardants (FR). Research efforts have focused on mechanisms to reduce polymer flammability by promoting char formation since the early 1980's

Char formation reduces the amount of small, volatile polymer pyrolysis fragments, or fuel, available for burning in the gas phase; this in turn reduces the amount of heat released and fed back to the polymer surface. The char also insulates the underlying polymer, due to its low thermal conductivity, and reradiates incident energy away from the polymer surface. The char must also function as a mass transport barrier, by physically delaying the volatilization of decomposition products and/or chemically reacting with decomposition products.

The physical structure of the char is important in this role. Thick, foamy char appears to be more fire resistant than brittle, thin char. This char-enhancing approach is most successful when the polymer chars rapidly and early in the burning process. To be useful, the charring process must occur at a temperature above the polymer processing temperature, but below the temperature where rapid gasification of the polymer to combustible fuel occurs.

The charring of a thermally-thick sample leads to the formation of three zones: a surface charred zone, comprising char and no polymer; an interfacial (pyrolysis) zone, containing a mixture of char and polymer; and a polymer zone, comprising virgin polymer and no char

Proper addition of non-halogenated flame retardants will impart this increased flame retardancy to a variety of polymers. Specifically, the flame retardants imparts improved char yield, char density, self-extinguishing characteristics, thermal insulation (upon activation), and/or lower smoke emissions to the composition. In addition, these flame retardant compositions are halogen-free and metal-free, which impart known benefits to systems beyond the flame retardancy benefits.

Mechanical properties of polymeric materials often suffer from large particle sizes of filler type materials. Additional features such as lower particle size and surface coatings improve key properties of nonhalogenated fire retardants and broaden their existing applications. In fact, during processing a more homogenous distribution of these flame retardants can be achieved, thus creating increased fire retardant performance of the polymer.