Better protection against decomposition and fire

# Nanoparticles prove doubly effective

Invisible: Tiny nanoparticles will improve the properties of the plastic manufactured from these granules.

**Flame retardants in plastics can prevent fires occurring in electrical devices and thus help to save lives. In warm, humid environments, however, fire retardants tend to make plastic brittle. Researchers at Bayer MaterialScience have now come up with a neat solution to this problem in the form of nanoparticles which, when added to a plastic, not only protect it against chemical decomposition, but also improve its fire performance.**

When the first computer and monitor housings containing environmentally friendly flame retardants came on to the market at the end of the 1980s, material research experts rejoiced at the news that phosphates would at last replace the products based on chlorine and bromine compounds that had traditionally been used. These compounds were by then discredited because of their tendency to form toxic, gaseous compounds when they burn. Indeed, ecologically safe phosphates proved to be the ideal flame-retardant additives in polycarbonate blends because they do not impair the material's strength or its resistance to mechanical stresses.

At the end of the 1990s, however, the experts were stunned to discover that more and more housings containing phosphate additives were becoming brittle and displaying cracks within a relatively short time. This mainly affected equipment that had been subjected simultaneously to strong heat and high atmospheric humidity – like printers and copiers. The air heated up during the copying process expels water vapor from the paper, resulting in a lethal combination of heat and moisture.

Initial tests by the manufacturers of the electrical devices showed that, under these 'tropical' conditions, phosphates degrade to form phosphoric acids which, in turn, attack the plastic molecules and ultimately split the long molecule chains. The consequence of this is that the material becomes brittle and fractures very easily under minimal loads. Experts call this phenomenon 'hydrolytic decomposition'. "That's why one of our customers – one of the biggest manufacturers of office machines in the world – asked us to come up with a new plastic formulation that was resistant to hydrolysis," recalls chemist Dr. Thomas Eckel, laboratory manager at Bayer MaterialScience in Dormagen.

Eckel specializes in the raw materials for the polymer blends used to manufacture components like interior trim and air vents for cars as well as housings for printers and copiers. The trade name of these plastics is Bayblend®. To produce a ready-to-use Bayblend® with the desired properties, research chemists like Eckel must combine the right ingredients in the right quantities. Apart from polycarbonates, these ingredients include ABS plastics, which

Slow burner: Helmut Wolff tests the new plastic in an open flame.

give the blend its toughness and are contained, for example, in toy bricks, plus, as necessary, flame retardants, Teflon and other additives.

## Performance testing in the tropical air-conditioning chamber

To begin with, Eckel and his colleague Dr. Eckhard Wenz developed a rapid testing process. Most office machine manufacturers had been testing the plastic specimens for 2,000 hours (83 days) at 65 °C and 80 percent humidity. "We selected a temperature of 95 °C," says Eckel. "Under these conditions, hydrolytic degradation occurs many times faster and the testing time can be reduced to one week." This enabled the Bayer research team to test a number of different blends in the space of a few weeks. Of particular interest here were the alkaline substances that neutralize phosphoric acids without changing the characteristics of the plastic.

The Bayer chemists in Dr. Dieter Wittmann's group soon tracked down the right candidate: a nano-size aluminum compound that had already proved to be ideal for use as a flame retardant. The particles encourage the charring of the plastic surface and thus prevent flames from spreading. In addition, the tiny particles have both weakly acidic and weakly alkaline properties – they are amphoteric, in other words. In relation to their size, they have an enormous surface area and thus offer the phosphoric acid molecules enough space to accumulate there.

The first patented flame-retardant polycarbonate/ABS blends with nanoparticles are now on the market under the name Bayblend® FR 3000. Because of their improved fire properties and their resistance to hydrolysis, they are used to protect, among other things, computer housings in humid containers on their journey from South-East Asia to their port of destination. Eckel: "Very soon, we will follow this up with a new variant, Bayblend® FR 3010, which could be used for the front panels of washing machines and dryers, because this is another area frequently exposed to steam." Yet even though the nanoparticles are only really needed for extremely hot and moist environments, there are still too many broken plastic components around without nanoparticles – and therefore too many dissatisfied customers.

A successful test: Dr. Thomas Eckel (l.) and Dr. Dieter Wittmann inspect plastic parts.

**Applications for polycarbonates**

Some 2.5 million tons of polycarbonate were manufactured around the world in 2004 for a wide variety of applications. As the basis for plastic blends, they are used for computer housings, among other things.

- 32 % Optical storage media
- 22 % Electrical/Electronics
- 16 % Polycarbonates for blends
- 14 % Construction
- 9 % Automotive
- 7 % Other applications

www.free.definition.com/Polycarbonate.html
The Internet lexicon provides a brief overview of polycarbonates.