# Molding better plastics with clay

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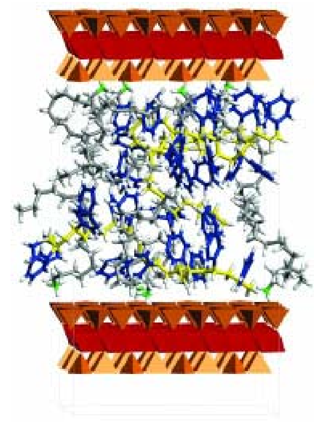
The future may once have been mere plastics, but today the future is *super*plastics. Plastics are being treated with nanoparticles to create stronger, cleaner, more flame-resistant plastics. The concept dates back to experiments in the 1950s mixing clay with liquid rubber in tire manufacture, but today researchers are putting a new twist on the process, focusing on improving many of the plastics' material properties.

One method of reducing plastic flammability involves treating the plastic with polybrominated diphenyl ethers (PBDEs). But PBDEs resist physical, chemical, and biological degradation, and they can leach out into the environment. Some PBDEs can trigger neurologic reactions similar to those caused by polychlorinated biphenyls. So Evangelos Manias, director of the Nanostructured Materials Lab at Pennsylvania State University, is working on the dispersion of nanometer-thin particles of natural clays to plastics to improve flame resistance.



**Superplastics.** Plastic polymers are combined with clay nanoparticles to create a stronger, cleaner, more flame-resistant material.

Photo credit: Evangelos Manias

The clays (mainly montmorillonite) and plastic blend invisibly. Mixing montmorillonite with a polymer such as polypropylene forms a polymer similar to the untreated form, but more highly fire resistant; when it does burn, it does so cleanly. If the composite is exposed to heat, the clay creates a barrier of "char" on the outside, preventing heat and oxygen from penetrating and fueling combustion (as well as preventing toxic decomposition materials from exiting). The new blend is also stronger and less permeable to both liquids and gases.

Jeffrey Gilman, an expert on nanocomposites and flame resistance in polymers at the National Institute of Standards and Technology, believes clay alone won't reduce flammability enough to allow for complete substitution for PBDEs; adding more clay does not yield a corresponding decrease in flammability, he says, and can yield a very rigid, concrete-like polymer. But Manias says the addition of clay allows for much less PBDE to be used.

Manias believes the clay-polymer compounds should be recyclable, although there have not yet been any major studies in that area. It might be different, he admits, in a use such as auto body recycling, where a much greater volume of clay might be involved, but he adds that not enough research has been done to substantiate that concern. Bert Powell, a senior scientist for Southern Clay Products, says, "There are some processors now who prepare clay nanocomposites by creating a concentrate, which is then diluted to the desired concentration through the addition of untreated polymer. That tends to imply that mixing treated and untreated [polymers] in recycling won't be an issue."

Manias says the clay can be added at the final stages of polymer processing without changing current industrial practices. "The small amounts of clay do not cause any wear in the equipment, and when appropriate organoclays are used, manufacturers can use the same equipment, timing, and settings as in their normal processes," he says.

The Federal Aviation Administration has shown interest in the technology for uses such as airplane seat covers and overhead bins. (The administration partially funded joint research by Gilman and Manias that was featured in the July 2000 issue of *Chemistry of Materials*.) General Motors, Basell, Southern Clay Products, and Blackhawk Automotive Plastics have produced a nanocomposite step-assist for 2002 GMC Safari and Chevrolet Astro vans. Gilman says the technology is already used in sports equipment, and is being considered for use in a heart pump codeveloped by Penn State and Arrow International.

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