Promising fire retardant results when clay nanofiller has space

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(PhysOrg.com) -- If materials scientists accompanied their research with theme songs, a team from the National Institute of Standards and Technology and the University of Maryland might be tempted to choose the garage punk song "Don't Crowd Me"* as the anthem for the promising, but still experimental nanocomposite fire retardants they are studying.

That's because the collaborators have demonstrated that the more widely and uniformly dispersed nanoscale plates of clay are in a polymer, the more fire protection the nanocomposite material provides.

Writing in the journal *Polymer*,** the team reports that in tests of five specimens—each with the same amount of the nanoscale filler (5 percent by weight)—the sample with the most widely dispersed clay plates was far more resistant to igniting and burning than the specimen in which the plates mostly clustered in crowds. In fact, when the two were exposed to the same amount of heat for the same length of time, the sample with the best clay dispersion degraded far more slowly. Additionally, its reduction in mass was about a third less.

In the NIST/UMD experiments, the material of interest was a polymer—a type of polystyrene, used in packaging, insulation, plastic cutlery and many other products—imbued with nanometer scale plates of montmorillonite, a type of clay with a sandwich-like molecular structure. The combination can create a material with unique properties or properties superior to those achievable by each component—clay or

polymer—on its own.

Polymer-montmorillonite nanocomposites have attracted much research and commercial interest over the last decade or so. Studies have suggested that how the clay plates disperse, stack or clump in polymers dictates the properties of the resultant material. However, the evidence—especially when it comes to the flammability properties of the nanocomposites—has been somewhat muddy.

Led by NIST guest researcher Takashi Kashiwagi, the NIST-UMD team subjected their clay-dispersion-varying samples to an exhaustive battery of characterization methods and flammability tests. Affording views from the nanoscopic to the microscopic, the array of measurements and flammability tests yielded a complete picture of how the nanoscale clay plates dispersed in the polymer and how the resultant material responded when exposed to an influx of heat.

The researchers found that with better dispersion, clay plates entangle more easily when exposed to heat, thereby forming a network structure that is less likely to crack and leading to fewer gaps in the material. The result, they say, is a heat shield that slows the rate of degradation and reduces flammability. The NIST team, led by Rick Davis, is now exploring other approaches to reduce flammability, including the use of advanced materials and novel coating techniques.

More information:

* Keith Kessler, "Don't Crowd Me."
** M. Liu, X. Zhang, M. Zammarano, J.W. Gilman, R.D. Davis and T. Kashiwagi. Effect of Montmorillonite dispersion on flammability properties of poly(styrene-co-acrylonitrile) nanocomposites. *Polymer*. Vol. 52, Issue 14, June 22, 2011.