Emerging material for space applications

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The Air Force Research Laboratory (AFRL, Hattiesburg, Miss.) and Hybrid Plastics (Hattiesburg, Miss.), an AFRL spinoff, report that they have fabricated a survivable, drop-in POSS (polyhedral oligomeric silsesquioxanes) polymer replacement for the ubiquitous but short-lived Kapton material that many space components currently use. Funding for the effort is provided by the United States Air Force and the Defense Advanced Research Projects Agency (DARPA).

Kapton, a polyimide, degrades because spacecraft surfaces in low Earth orbit must endure high atomic oxygen (AO) flux, bombardment by charged particles and thermal cycling along the full spectrum of solar radiation.

The Air Force says "POSS polymers may soon replace Kapton for all military and commercial space applications." Hybrid Plastics is partnering with the Air Force in developing POSS technology for this and other space applications. The AFRL flew several POSS-based polymer samples, including POSS/Kapton polymides on the International Space Station for nearly four years as part of the Materials International Space Station Experiment (MISSE). Tests of polymers containing POSS showed that they are radiation insensitive and provide at least a ten-fold improvement in the AO erosion rate over existing Kapton polymers. This order of magnitude change is expected to help in the development of a new generation of space-survivable materials.

POSS is a nanomaterial based on silicon-derived building blocks that provide nanometer-scale control to dramatically improve the thermal and mechanical properties of traditional polymers while offering easy incorporation using existing manufacturing protocols. These compounds have an average diameter of just 1.5 nanometers. POSS nanomaterials can be used both as direct replacements for hydrocarbon-based materials or as low-density performance additives in traditional plastics. They release no VOCs, and, thereby, produce no odor or air pollution. They are biocompatible, recyclable, non-flammable, and competitively priced with traditional polymer feedstocks. POSS materials reportedly can be incorporated into any existing polymer system through blending, grafting or copolymerization.