Buckyball aggregates are soluble, antibacterial

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Research offers clues about C60 behavior in natural environments

In some of the first research to probe how buckyballs will interact with natural ecosystems, Rice University's Center for Biological and Environmental Nanotechnology finds that the molecules spontaneously clump together upon contact with water, forming nanoparticles that are both soluble and toxic to bacteria.

The research challenges conventional wisdom: since buckyballs are notoriously insoluble by themselves, most scientists had assumed they would remain insoluble in nature. The findings also raise questions about how the buckyball aggregates â€“ dubbed nano-C60 â€“ will interact with other particles and living things in natural ecosystems.

The findings appear in the June 1 issue of the journal *Environmental Science & Technology*.

"The fact that nano-C60 dissolves in water raises questions about water as a vector for the movement of these types of materials," said Vicki Colvin, CBEN director, professor of chemistry and a co-author on the study.

Buckyballs are soccer ball-shaped molecules of 60 carbon atoms that were discovered at Rice in 1985. While a few companies are already using trace amounts of buckyballs in products, large-scale production of buckyballs is still a year or two away. Ultimately, companies hope to use

buckyballs in everything from pharmaceuticals to sporting goods.

The research team was led by Georgia Tech environmental engineer Joseph Hughes and included almost a dozen Rice collaborators. They found that nano-C60 readily dissolves in water. The clumps, which measured between 25 and 500 nanometers in diameter, were also found to persist for up to 15 weeks in freshwater.

The researchers also exposed nano-C60 to two common types of soil bacteria. They found the particles inhibited both the growth and respiration of the bacteria at very low concentrations -- as little as 0.5 parts per million.

"The antibacterial properties of the C60 aggregates also raise some interesting questions," said Colvin. "We think it may be possible to harness those properties for good applications, but we also advocate continued research on the potentially negative effects that these materials could have on the health of natural ecosystems."

Hughes, the study's lead author, said scientists don't yet know enough to accurately predict what impact buckyballs will have on the environment or in living systems, but he said the findings do illustrate the shortcomings of federal guidelines for the handling and disposal of buckyballs, which are subject to the same regulations as bulk carbon black.

"Not all carbon is the same," said Hughes. "Graphite and diamonds are both bulk carbon, for example, but current standards call for handling them in completely different ways. Our results suggest buckyballs also should be handled differently."

Other Rice collaborators include CBEN Executive Director Kevin Ausman; Jane Tao, assistant professor of biochemistry and cell biology;

Wenhua Guo, research scientist; Lawrence Alemany, senior research scientist; and graduate students J.D. Fortner, D. Y. Lyon, C.M. Sayes, A.M. Boyd, J.C. Falkner and E.M. Hotze.

Source: Rice University