Video shows buckyballs form by 'shrink wrapping'

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The birth secret of buckyballs -- hollow spheres of carbon no wider than a strand of DNA -- has been caught on tape by researchers at Sandia National Laboratory and Rice University. An electron microscope video and computer simulations show that "shrink-wrapping" is the key; buckyballs start life as distorted, unstable sheets of graphite, shedding loosely connected threads and chains until only the perfectly spherical buckyballs remain.

The research is available online and slated to appear in an upcoming issue of *Physical Review Letters*.

Buckyballs were discovered at Rice in 1985, but understanding the intimate details their formation has vexed scientists. Buckyballs form at high temperatures, and one long-standing theory of their genesis is the "hot giant" hypothesis, which suggests that the carbon atoms first assemble by the thousands in flat graphite sheets. Heat distorts the sheets, "shrink wrapping" them into ever-smaller shapes, and buckyballs survive thanks to their perfect symmetry.

"This 'hot evolution' is so rapid that it was nearly impossible to prove or disprove it by experimental observation," said study co-author Boris Yakobson, professor of mechanical engineering and materials science at Rice. "Sandia's Jianyu Huang solved this problem by creating an ingenious, controllable heat bath inside a 10-nanometer-wide nanotube. That allowed him to capture video of giant fullerenes gradually shrinking."

Huang, who performed the experiments while at Boston College and analyzed the data at Sandia, said the results constitute the first experimental evidence for the 'shrink-wrapping' and 'hot-giant' fullerene birth mechanisms.

Huang captured the high-resolution images using a transmission electron microscope (TEM). The video shows a large fullerene, with an estimated 2,000 atoms of carbon gradually shrinking. It confirmed predictions about the atomic mechanisms that Yakobson's team at Rice had made based on detailed computer simulations.

"If heat is sustained, as it was when we took these images, the fullerenes undergo a further shrinking and vanish," Huang said. "This confirms an aspect of 'shrink wrapping' theory that was predicted by Rice's Rick Smalley and Bob Curl made shortly after they discovered fullerenes."

Huang and Yakobson said it may be possible to exploit the findings to control the fullerene formation process and tailor fullerenes for a variety of applications.

Video available at: www.youtube.com/watch?v=NSNlE8AreeM

Source: Rice University