Nanocar with Buckyball Wheels Paves Way for Other Molecular Machines

In the November 2005 issue of *Nano Letters* (p. 2330; DOI: 10.1021/nl051915k), researchers from Rice University have described the synthesis and movement of nanocars (see figure 1). These single-molecule vehicles measure 4 nm × 3 nm and have four buckyball wheels connected to four independently rotating axles and an organic chemical chassis. The research team was able to show that, rather than sliding around on a smooth gold surface, the nanocar rolled on its wheels.

The research was conducted as a proof-of-concept for directional control of nanoscale transporters. Rice researchers Jim Tour and Kevin Kelly hope to build upon the work by designing nanotrucks, light-driven nanocars, and other transports that can ferry atoms and molecules in non-living fabrication environments. The transporters will be akin to hemoglobin and other biological transport systems that move oxygen and other key materials in the machinery of living cells.

The nanocar consists of a chassis and axles made of well-defined organic groups with pivoting suspension and freely rotating axles. The wheels are buckyballs, spheres of pure carbon containing 60 atoms apiece. The entire car measures just 3–4 nm across, making it slightly wider than a strand of DNA.

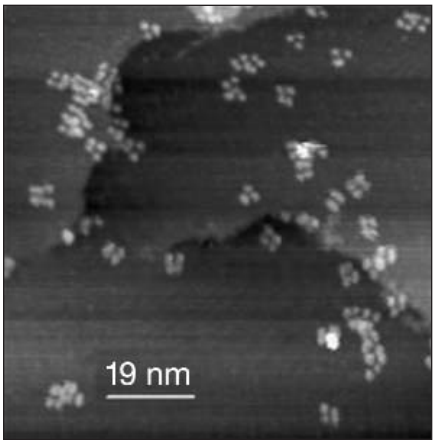

Figure 1. Scanning tunneling microscopy of nanocars. Credit: K. Kelly and A. Osgood/Rice University.

Other research groups have created nanoscale objects that are shaped like automobiles, but Kelly said that their vehicle actually functions like a car, rolling on four wheels in a direction perpendicular to its axles. Kelly and graduate student Andrew Osgood measured the movement of the nanocars across a gold surface. At room temperature, strong electrical bonds hold the buckyball wheels tightly against the gold, but heating to about 200°C frees them to roll. To prove that the cars were rolling rather than sliding, Kelly and Osgood took scanning tunneling microscopy (STM) images every minute and watched the cars progress. Because nanocars' axles are slightly longer than the wheelbase—the distance between axles—the researchers could determine the way the cars were oriented and whether they moved perpendicular to the axles.

In addition, Kelly's team found a way to grab the cars with an STM probe tip and pull them. Tests showed it was easier to drag the cars in the direction of wheel rotation than it was to pull them sideways.

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