Los Alamos scientists detect and track single molecules with nanoscale carbon cylinders

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LOS ALAMOS, New Mexico, January 10, 2012—Many physical and chemical processes necessary for biology and chemistry occur at the interface of water and solid surfaces. Researchers at Los Alamos National Laboratory publishing in *Nature Nanotechnology* have now shown that semiconducting carbon nanotubes—light emitting cylinders of pure carbon—have the potential to detect and track single molecules in water.

Using high-speed microscopic imaging, they found that nanotubes could both detect and track the motion of individual molecules as they bombard the surface at the water interface. Traditional techniques to investigate molecules on surfaces cannot be used in water because the study requires low-pressure atmospheres such as one finds in space. The team is hopeful that their work will lead to practical, nanotube-based, single-molecule detectors in aqueous biological and chemical environments.

Molecular motion and attachment to surfaces is important for driving chemistry that ranges from the production of ammonia on metal to the enzymatic oxidation of glucose. The attachment takes place through sporadic motion followed by a collision with the surface to which the molecule sticks. Molecules can then move along the surface where they can collide with other molecules and undergo chemical reactions.

In traditional “surface science” experiments these processes are imaged in a vacuum where other molecular species from the air cannot blur the image. In solutions such as water, there has been no way to do this directly. Consequently, researchers have been searching for a material that can be used in water to detect individual molecules for surface-science applications.

Inspired by this challenge, a team of Los Alamos scientists (Jared Crochet, Juan Duque, Jim Werner, and Steve Doorn) at LANL's Center for Integrated Nanotechnologies explored using light-emitting carbon nanotubes as detectors. With techniques developed by others, the team used soap and water to stabilize the nanotubes where they could be imaged directly with a high-speed video camera. When illuminated with laser light, these tubes shine brightly, like long glow sticks.

When the glowing nanotubes are exposed in water to different chemicals, the researchers saw that certain spots of the tube would briefly go dim as the molecules bombarded the surface. This allowed them to determine how effectively certain molecules would stick to the surface. The researchers were also able to track the motion of molecules as they moved along the surface. The team is now examining how chemical reactions proceed on nanotube surfaces to better understand chemistry at the water interface for biological and chemical applications.

The paper is titled “Photoluminescence imaging of electronic impurity-induced exciton quenching in single-walled carbon nanotubes,” and can be found online at http://www.nature.com/nnano/journal/vaop/ncurrent/full/nnano.2011.227.html.

It also can be accessed via digital object number http://dx.doi.org/10.1038/NNANO.2011.227. The DOI can be used to retrieve the abstract and full text (*Nature* abstracts are available to everyone, full text only to subscribers).

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