

## REALLY TINY TWEEZERS

Stephen W. Carmichael,<sup>1</sup> Mayo Clinic

Laser tweezers take advantage of the forces around converging beams of light to exert slight pressures on small structures. Whereas these optical devices have allowed for some elegant studies of cell biology, wouldn't it be great if we had mechanical tweezers that offered even better manipulation? In a recent paper, Philip Kim and Charles Lieber demonstrated a fabulous device they called "nanotweezers."<sup>2</sup>

Logically, they used nanotubes as the key structural component for their nanotweezers. Carbon nanotubes are particularly strong for their size, they conduct electricity, and they can be fabricated as small as 1 nanometer (nm) in diameter. With nanotubes serving as the tines of the tweezers, Kim and Lieber devised a very clever arrangement for the hub. They took a standard glass tube, 1 mm in diameter, and pulled it to a tapered end of about 100 nm. They then evaporated a very thin coat of chromium and then gold on one side, then rotated the rod 180° and deposited metal on the other side. Each coated side operated as an independent electrode. Using the same techniques used for attaching tips to scanning probe microscopes, they attached a carbon nanotube to each electrode, arranged so that the nanotubes projected past the end of the coated glass tube. It looks like a pair of tiny tweezers!

These and other manipulations were performed under direct visualization. The fact that the nanotubes scattered light allowed them to be visualized by dark-field microscopy. The authors pointed out that optical resolution was the limiting factor in the assembly process. If they could assemble nanotweezers inside a scanning electron microscope, for example, they could make them even smaller. It will not surprise me when they do this. With their present equipment, they could assemble a pair of nanotweezers in about 2 hours, with better than a 50% success rate. Very impressive!

Up to this point, we have described a pair of nanotubes with their distal ends suspended in space, and their proximal ends attached to independent electrodes. But tweezers don't

work until you bring the ends of the tines together. Here's where Kim and Lieber took advantage of the electromechanical properties of carbon nanotubes. When they imposed a biased voltage across the two electrodes, the tines deflected toward each other. This was an elastic deflection, since this could be repeated and the tines would return to their original position when the voltage was removed. The deflections were not linear with respect to voltage. Up to 5 volts, the tips of the tweezers barely moved, at 8.3 volts the distance between the tips had decreased to about 50% of the 0 volt value, and when the voltage was increased to 8.5, the tips suddenly snapped together. The van der Waals interaction between the tips kept them together, even when the voltage was returned to 0. When a voltage was applied between the tweezer's electrodes and a nearby ground electrode, the nanotweezers opened readily.

To demonstrate that the nanotweezers can perform mechanical work, Kim and Lieber used their device to manipulate polystyrene spheres 310 nm in diameter and gallium-arsenide nanowires. They pointed out that the electromechanical actuation of the nanotweezers is not ideal for work in an aqueous solution, however they suggested ways around this problem so that nanotweezers could be used to physically move organelles within living cells.

In addition to using the nanotweezers for mechanical work, Kim and Lieber demonstrated the capability for electrical measurements since the nanotubes serve as conducting wires to the nanoworld. Ohmic behavior of the nanowires and doped particles could be measured, and these measurements were consistent with independent measurements.

As nanotechnology advances, we will need smaller and smaller tools. Now we can add nanotweezers to our armamentarium! ■

1. The author gratefully acknowledges Dr. Charles Lieber for reviewing this article.
2. Kim, P., and C.M. Lieber, Nanotube Nanotweezers, *Science* 286:2148-2150, 1999

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★ The new officer election of the Microscopy Society of America is now official and is as follows:

President-Elect: Ron Anderson

Secretary: Janet H. Woodward (2000-2002)

Director, Physical Sciences: Thomas F. Kelly (2000-2002)

Director, Biological Sciences: Sara E. Miller (2000-2002)

The complete list of officers is available from the web site:  
<http://www.msa.microscopy.com/MSADocs/MSAOfficers.html>

#### 2001 MICROSCOPY SOCIETY OF AMERICA AWARDS

All MSA Members are reminded that applications are currently being solicited for the 2001 MSA Awards. The Awards include:

**Distinguished Scientist Awards:** These Awards recognize preeminent senior scientists from both the Biological and Physical disciplines who have a long-standing record of achievement during their career in the field of microscopy or microanalysis.

**Burton Medal:** The Burton Medal was initiated to honor the distinguished contributions to the field of microscopy and microanalysis of a scientist who is less than 40 years of age on January 1st of the award year. (Please note the change in the selection criterion regarding age.)

**Optical Imaging Association-MSA Outstanding Young Investigator Award:** This Award, initiated in 1999, recognizes the distinguished contributions in the field of optical microscopy made by a scientist who is less than 40 years of age on January 1st of the award year.

**Outstanding Technologist Awards:** These Awards honor technologists from both the Biological and Physical Sciences who have made significant contributions such as the development of new techniques which have contributed to the advancement of microscopy and microanalysis.

**Morton D. Maser Distinguished Service Award:** This Award was initiated to recognize outstanding volunteer service to the Society as exemplified by Mort Maser, who served the Society for many years with great dedication. This award is made to honor an MSA member who has provided significant volunteer service to the Society over a period of years.

The Distinguished Scientist, Burton Medal, OIA-MSA Outstanding Young Investigator and Outstanding Technologist Awards Nominations should include:

- 1) a letters from the primary MSA nominator describing the research accomplishments of the candidate with particular emphasis on the unique technical achievements in the Physical or Biological Sciences; and
- 2) supplemental letters of support from other members of the scientific community.

The Morton D. Maser Distinguished Service Award Nomination should include:

- 1) a letters from the primary MSA nominator describing the basis for the nomination; and
- 2) supplemental letters of support from other members of MSA.

**The Deadline for receipt of Awards Nomination Packages is December 15, 2000.** Please contact the MSA Business Office for additional information. Tel.: (800)538-3672  
 eMail: [BusinessOffice@MSA.Microscopy.com](mailto:BusinessOffice@MSA.Microscopy.com)

## JUST FOR FUN MICROGRAPH CONTEST

Due to the response (and the fun) of having our contest last year, in the upcoming M&M 2000 Conference in Philadelphia (August 14/17), we will repeat the contest.

The concept of the contest is based upon composite images, made up of two or more images, at least one of which must be microscopical in nature. Contestants may enter up to two images and do not have to be present to win.

Entries will be displayed in our booth and conference attendees will be invited to vote on which they consider the most "creative and interesting". First prize will be \$300, the second prize will be \$200 and the third prize will be \$100. Winning entries, and perhaps others, will be featured as covers on this publication. All contestants will receive their choice of two microscopy prints by David Scharf.

Entries must, of course, be in hard copy. They may be either in black and white or full color. While any reasonable size is acceptable, a size of around 8 1/2 x 11 inches is recommended. Entries should be mounted on a rather stiff backing material. A 3" x 5" card should accompany each entry—with image description and contributors name and affiliation.

Entries are welcome from all microscopists, certain to include those overseas as well as manufacturers and suppliers.

Those with a potential interest in participating in the contest should advise by fax (608-836-1969) or by eMail ([microtoday@mindspring.com](mailto:microtoday@mindspring.com)). We, in turn, will insure that they receive any further information on the contest.

Entries may be sent to Microscopy Today in advance of the conference or may be delivered to our booth at the conference.

I hope that you will consider participating.

...Don Grimes, Editor



## FRONT COVER IMAGE

### Pentacene Crystal

The cover is a high-resolution image, in 1 nm steps, of a growth crystal of pentacene (an organic substance).

To visualize the growth function of crystals enables the control of crystal shape and size. The required high resolution can be obtained only with the highest quality probes.

This high resolution image was made on ThermoMicroscopes Explorer™ SPM using a dLever™ silicon conical tip. For additional information on this image visit the ThermoMicroscopes website at: [www.thermomicro.com](http://www.thermomicro.com)

Sample courtesy of Professor Tom Jackson, Pennsylvania State University.