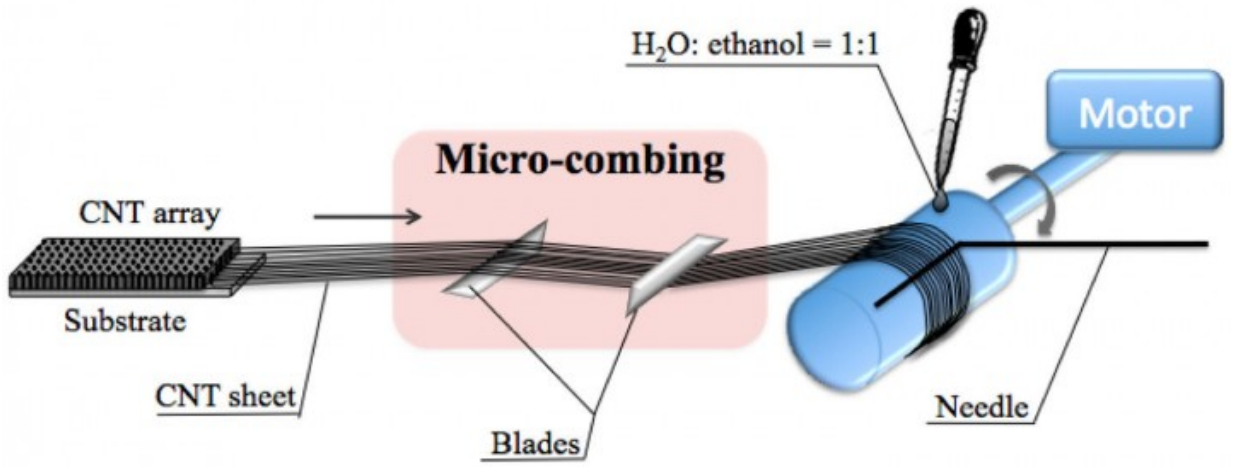
'Microcombing' creates stronger, more conductive carbon nanotube films

May 5 2015, by Matt Shipman



Credit: Liwen Zhang

Researchers from North Carolina State University and China's Suzhou Institute of Nano-Science and Nano-Biotics have developed an inexpensive technique called "microcombing" to align carbon nanotubes (CNTs), which can be used to create large, pure CNT films that are stronger than any previous such films. The technique also improves the electrical conductivity that makes these films attractive for use in

electronic and aerospace applications.

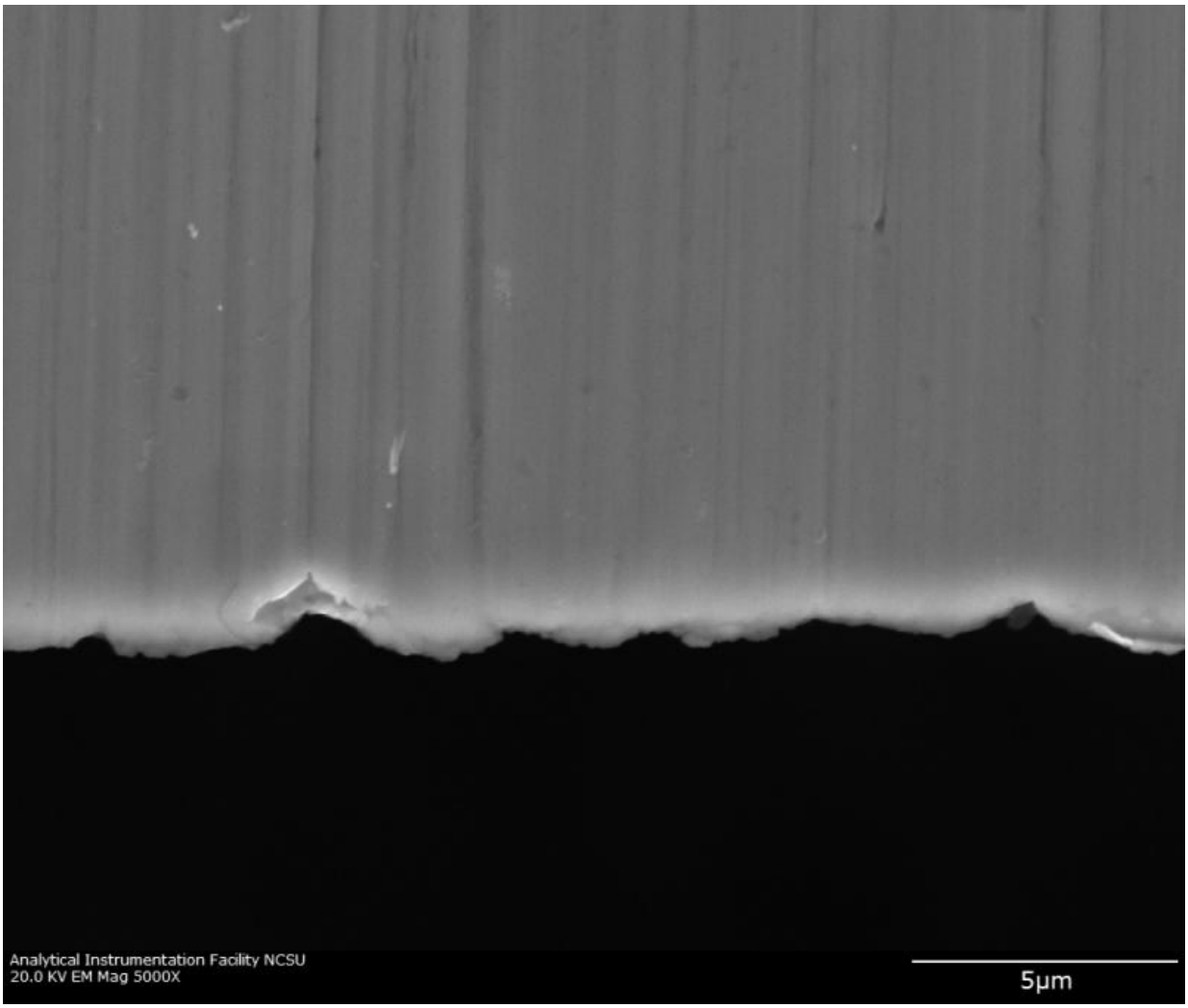
"It's a simple process and can create a lightweight CNT film, or 'bucky paper,' that is a meter wide and twice as strong as previous such films – it's even stronger than CNT fibers," says Yuntian Zhu, Distinguished Professor of Materials Science and Engineering at NC State and corresponding author of a paper describing the work.

The researchers begin by growing the CNTs on a conventional substrate in a closely packed array. The CNTs are tangled together, so when researchers pull on one end of the array the CNTs form a continuous ribbon that is only nanometers thick. This ribbon is attached to a spool, which begins winding the ribbon up.

As the spool pulls, the CNT ribbon is dragged between two surgical blades. While the blades appear straight to the naked eye, they actually have micrometer-scale fissures on their cutting edge. These fissures create a kind of "microcomb" that pulls the CNTs into alignment – just as a regular comb sorts through tangled hair.

When the ribbon of aligned CNTs is being wound onto the spool, the researchers apply an alcohol solution. This pulls the CNTs closer together, strengthening the bonds between CNTs.

The CNT ribbon wraps around itself as it winds around the spool, creating a layered film of pure CNTs. Researchers can control the thickness of the film by controlling the number of layers.



The micrometer-scale fissures on the edge of a surgical blade act as a "microcomb" to align carbon nanotubes. Credit: Yuntian Zhu

The CNT films made using the microcombing technique had more than twice the tensile strength of the uncombed CNT films – greater than 3 gigapascals for the microcombed material, versus less than 1.5 gigapascals for the uncombed material.

The microcombed CNT film also had 80 percent higher electrical

conductivity than the uncombed film.

"This is a significant advance, but we want to find ways to make CNT alignment even straighter," Zhu says. "It's still not perfect.

"In addition, the technique would theoretically be easy to scale up for large-scale production. We'd like to find an industry partner to help us scale this up and create a material for the marketplace."

More information: "Strong and Conductive Dry Carbon Nanotube Films by Microcombing." *Small.* doi: 10.1002/smll.201500111

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