New carbon composite holds promise for bionics

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(PhysOrg.com) -- Mimicking the human nervous system for bionic applications could become a reality with the help of a method developed at Oak Ridge National Laboratory to process carbon nanotubes.

While these nanostructures have electrical and other properties that make them attractive to use as artificial neural bundles in prosthetic devices, the challenge has been to make bundles with enough fibers to match that of a real neuron bundle. With current technology, the weight alone of wires required to match the density of receptors at even the fingertips would make it impossible to accommodate. Now, by adapting conventional glass fiber drawing technology to process carbon nanotubes into multichannel assemblies, researchers believe they are on a path that could lead to a breakthrough.

"Our goal is to use our discovery to mimic nature's design using artificial sensors to effectively restore a person's ability to sense objects and temperatures," said Ilia Ivanov, a researcher in the Center for Nanophase Materials Sciences Division. Ivanov and colleagues at ORNL recently published a paper in *Nanotechnology* that outlines the method of processing loose carbon nanotubes into a bundle with nearly 20,000 individual channels.

Ultimately, the goal is to duplicate the function of a living system by combining the existing technology of glass fiber drawing with the multi-functionality of sub-micron (0.4 micron) scale carbon nanotubes, according to Ivanov, who described the process.

"We make this material in a way similar to what you may have done in high school when making a glass capillary over a Bunsen burner," Ivanov said. "There, you would take the glass tube, heat it up and pull, or draw, as soon as the glass became soft."

Ivanov and John Simpson of the Measurement Science and Systems Engineering Division are doing something similar except they use thousands of glass tubes filled with carbon nanotube powder. After several draw cycles, they demonstrated that they could make fibers just four times thicker than a human hair containing 19,600 sub-micron channels with each channel filled with conducting carbon. Each carbon nanotube-containing channel is electrically insulated from its neighbors by glass so it can be used as an individual communication channel.

With this achievement, the researchers are moving closer to realizing one of their goals.

"The human hand has a density of receptors at the fingertips of about 2,500 per square centimeter and about 17,000 tactile receptors in the hand," Ivanov said. "So in terms of density of channels, we are already in the range needed for 17,000 receptors in the hand."

This multichannel composite has many other potential uses, including in aeronautics and space applications, where low weight of conducting wires is important,
The next steps are to make these channels highly conductive and then show sensor communication through individual channels.

Provided by Oak Ridge National Laboratory