Coating improves electrical stimulation therapy used for Parkinson's, depression, chronic pain

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Dr. Edward Keefer. Image: UT Southwestern Medical Center

Researchers at UT Southwestern Medical Center have designed a way to improve electrical stimulation of nerves by outfitting electrodes with the latest in chemically engineered fashion: a coating of basic black, formed from carbon nanotubes.

The nanotube sheathing improves the signals received and transmitted by electrodes, which researchers say is a potentially critical step for advancing electrical nerve stimulation therapy. This type of therapy increasingly shows promise for diseases ranging from epilepsy to depression to chronic leg and back pain.

By implanting electronic nerve stimulators, doctors elsewhere have provided a quadriplegic patient with the ability to move a computer cursor at will, and monkeys have been able to move objects in a virtual world with mere mind power. For individuals who lose an arm or leg and rely on prosthetics, implanted stimulators offer promise in restoring feelings of sensation.

"The key to success for these types of brain-machine interfaces is where the electrode meets the nerve tissue," said Dr. Edward Keefer, instructor of plastic surgery at UT Southwestern and lead author of the study appearing in a recent issue of *Nature Nanotechnology*. "When we coat the electrodes with carbon nanotubes, it improves the stimulation of the nerve and the feedback from the sensors."

Depending on the way the nanotubes are fashioned, researchers were able to bolster either the stimulation or receptive capabilities to improve performance. In some tests, the nanotube coating improved performance by fortyfold, while in others it improved by a factor of as much as 1,600.

Nanotubes look like lattices rolled into a tube on a microscopic scale. Although they are 1/50,000 the width of a human hair, nanotubes are nonetheless among the stiffest and strongest fibers known, as well as excellent conductors of electricity.

Those properties proved to be just the attributes needed to help electrophysiologists conquer some of the hurdles facing them – issues such as battery power and chemical stability.

The carbon nanotube coating improves conductivity, which means less energy is needed to power the nerve stimulator. That can help reduce routine maintenance, such as the need to change batteries in implanted stimulation devices, as well as reduce tissue damage caused by the electrical charge.

"Our process is like taking a Ford Pinto, pouring on this chemical coating, and turning it into a Ferrari," Dr. Keefer said.

Researchers have tried several types of electrochemical coatings to see if they could improve conductivity, but the coatings often break down quickly or fail to stay affixed to the electrodes. The carbon nanotube coating shows far more promise, although further research is still needed, Dr. Keefer said.

"The development of new technologies by Dr. Keefer to potentially restore function in wounded tissues and future transplantations is exciting," said Dr. Spencer Brown, assistant professor of plastic surgery who heads research in the Nancy Lee and Perry R. Bass Advanced Plastic Surgery and Wound Healing Laboratory at UT Southwestern.

Source: UT Southwestern Medical Center

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