Carbon Nanotubes Could Aid Human Bones on the Mend

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Osteoporosis sufferers and victims of broken bones may have the tiniest of friends in carbon nanotubes, according to researchers at the University of California, Riverside.
The strength, flexibility and light weight of carbon nanotubes – structures 100,000 smaller than a human hair – allow them to act as scaffolds to hold up regenerating bone, according to Distinguished Professor of Chemistry Robert C. Haddon, the director of the Center for Nanoscale Science and Engineering at UC Riverside.

"They're the perfect replacement: Small, strong, and they're carbon based," said Haddon, lead author of a paper titled A Bone Mimic Based on the Self-Assembly of Hydroxyapatite on Chemically Functionalized Single-Walled Carbon Nanotubes, which was published in June in the American Chemical Society's journal Chemistry of Materials. Haddon's UCR co-authors included graduate students Bin Zhao and Hui Hu, and postdoctoral researcher Swandhin K. Mandal.

The findings by Haddon and his colleagues may lead to improved flexibility and strength of artificial bone, new types of bone grafts and to inroads in the treatment of osteoporosis. Haddon expects it will attract interest from other researchers and companies interested in developing new bone-graft materials and techniques.

"This research is particularly notable in the sense that it points the way to a possible new direction for carbon nanotube application, in the medical treatment of broken bones," said Leonard Interrante, editor of Chemistry of Materials, in an American Chemical Society statement. Interrante is also a professor of chemistry and chemical biology at Rensselaer Polytechnic Institute in Troy, N.Y. “This type of research is an example of how chemistry is being used everyday, worldwide, to develop materials that will improve people’s lives.”

Artificial bone scaffolds have been made from a wide variety of materials, such as polymers or peptide fibers. Their drawbacks include low strength and the potential for rejection in the body.

“The single walled carbon nanotubes are extremely strong materials,” Haddon said. “And since bone is a composite mixture of organic and inorganic material, the nanotubes make an excellent replacement for the organic part.”

Single-walled carbon nanotubes are a form of carbon, like graphite or diamond, where the atoms are arranged like a rolled-up tube of chicken wire. They are among the strongest known materials in the world.

Bone tissue is a natural composite of collagen fibers and crystalline hydroxyapatite, which is a mineral based on calcium phosphate. Haddon and his team have demonstrated that carbon nanotubes can mimic the role of collagen as a scaffold for inducing the growth of hydroxyapatite crystals.

The trick, Haddon said, was finding a way to cluster the growth of hydroxyapatite crystals on the carbon nanotube scaffold. By chemically treating the nanotubes, it was possible to attract calcium ions and this promoted the crystallization process while improving the biocompatibility of the nanotubes by increasing their water solubility.

Haddon’s findings also show that nanotechnology can be used in a variety of ways to help the body heal itself.

He and Assistant Professor of Neuroscience, Vladimir Parpura, together with other UCR researchers are investigating the role of carbon nanotubes in the formation of similar scaffolds to stimulate the growth of neurons.

Link: Abstract of the Article

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