Unofficial 'Spider-Man' follows nature's lead

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Eden Steven tested whether his spider silk wires would conduct electricity when bent — they did.

Eden Steven, a physicist at Florida State University's MagLab facility, discovered that simple methods can result in surprising and environmentally friendly high-tech outcomes during his experiments with spider silk and carbon nanotubes, the results of which are now published in the online research journal *Nature Communications*.

"If we understand basic science and how nature works, all we need to do is find a way to harness it," Steven said. "If we can find a smart way to harness it, then we can use it to create a new, cleaner technology."

Steven is the lead investigator on the paper "Carbon nanotubes on a spider silk scaffold." The experiment may result in practical applications in electrical conductivity and more.

Think of a nanotube as a one-atom thick sheet of carbon that's been rolled into an infinitesimally tiny tube. A nanotube's diameter is at least 10,000 times smaller than a strand of human hair. Physicists know that when things get that microscopically minute, they act very strange. Researchers worldwide are intrigued by the properties of carbon nanotubes, including their amazing strength and ability to conduct electricity and heat.

Steven wanted to see what would happen when strands of spider silk were coated with carbon nanotubes. Keeping with his theme of simplicity, he gathered the spider silk himself, hiking around the MagLab and using a stick to gather webs. To adhere the powdery carbon nanotubes to the spider silk, he ultimately discovered that just a drop of water worked best.

The dazzling results have drawn the attention of national media. Steven, now unofficially known as the MagLab's Spider-Man, has already been interviewed by Discovery News, New Scientist, Materials 360 and The Hindu.

"It turns out that this high-grade, remarkable material has many functions," Steven said of the silk coated in carbon nanotubes. "It can be used as a humidity sensor, a strain sensor, an actuator (a device that acts as an artificial muscle, for lifting weights and more) and as an electrical wire."

Rather than add to the already immense amount of toxic elements and complex, non-biodegradable plastics found in today's electronic devices and as pollution in our environment, Steven wanted to investigate eco-friendly materials. He was especially interested in materials that could deal with humidity without complicated treatments and chemical additives. Spider silk fit the bill.

"Understanding the compatibility between spider silk and conducting materials is essential to advance the use of spider silk in electronic applications," Steven wrote in the Nature Communications paper. "Spider silk is tough, but becomes soft when exposed to water. … The nanotubes adhere uniformly and bond to the silk fiber surface to produce tough, custom-shaped, flexible and electrically conducting fibers after drying and contraction."

Steven collaborated with six other scientists on the research project, including Florida State University Physics Department Chair James Brooks and Fulbright scholar and Iraqi physicist Wasan Saleh. Saleh worked with Steven and Brooks at the MagLab in 2011 as one of 10 Iraqi Fulbright scholars, and the only woman in the Iraqi group, to visit Florida State that summer.

In addition to Saleh, with the University of Baghdad, the other researchers who collaborated on the paper were: Steve F.A. Acquah, with the FSU Department of Chemistry and Biochemistry; Rufina G. Alamo, with the FAMU-FSU Department of Chemical and Biomedical Engineering; Victor Lebedev, with the Institute of Materials Science of Barcelona; and Vladimir Laukhin, with the Catalan Institution for Research and Advanced Studies in Barcelona.

Fostering such diverse scientific alliances is part of what makes the MagLab a dynamic workplace.

"The Magnet Lab and its sister materials centers at FSU provide an interdisciplinary environment that attracts the expertise of scientists from across the entire university and around the world to come here to do collaborative science," said MagLab physicist Brooks. "In such an environment the scientific imagination can run wild in unexpected directions."