Artificial muscles based on conducting polymer and carbon nanotubes

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Work Could Lead to Advanced Limbs for Amputees, Robots

Researchers at the NanoTech Institute at The University of Texas at Dallas (UTD) have been awarded a $750,000, 20-month grant to develop artificial muscles that convert chemical energy to mechanical energy. The award was made by the United States Defense Advanced Research Projects Agency (DARPA), whose charter is to develop new technologies for military applications.

UTD NanoTech Institute researchers have long pioneered in inventing artificial muscles that are electrically powered, and their discoveries in this area have led to industrial commercialization efforts in the United States, Japan and Sweden. This new program is more ambitious – to make artificial muscles that are chemically powered, like natural muscle, and exceed the force generation, contraction and speed of their natural counterpart.

Electrically powered artificial muscles based on conducting polymer and carbon nanotubes were first described by the principal investigator of this new program, Dr. Ray H. Baughman, Robert A. Welch Professor of Chemistry and director of the UTD NanoTech Institute. Carbon nanotubes are nanosize cylinders of graphite sheets and conducting polymers are plastics made “metallic” by doping. Dr. Alan MacDiarmid, James Von Ehr Distinguished Chair in Science and Technology at UTD and a winner of the Nobel Prize for the co-discovery of conducting polymers, has made pioneering advances in developing conducting

polymer artificial muscles.

While the carbon nanotube muscles can exceed the performance of natural muscle by generating a hundred times the force and elongating twice as fast, the contraction is less than one-tenth that of natural muscle. The conducting polymer muscles provide similar contractions to natural muscles, but have neither high cycle life nor high energy conversion efficiencies. The goal of the DARPA-funded program is to eliminate these problems and convert from electrically powered to chemically powered artificial muscles.

The proposed fuel-powered artificial muscles are at the same time fuel cells, supercapacitors and mechanical actuators, so the same elements convert a high energy density fuel to electrical energy, store this energy and use it to do mechanical work. These artificial muscles will use strong, tough carbon nanotube yarns that were recently described in the prestigious journal Science by UTD researchers and a colleague from an Australian national laboratory.

“An important possible eventual application of this research is artificial limbs that function like natural arms and legs – including the ability to move and manipulate objects -- both for amputees and robots,” Baughman said. “While we are very far from achieving this vision at present, we have already experimentally demonstrated primitive devices that directly convert the chemical energy of fuels to mechanical motion.”

The first “fuel cell artificial muscle” was demonstrated at UTD by Research Scientist Von Howard Ebron, Research Associate Zhiwei Yang and Dr. John Ferraris, interim dean of the university’s School of Natural Sciences and Mathematics.

Source: University of Texas at Dallas