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The Evolution of Strong, Fast, Powerful, Durable and Cheap Polymer Artificial Muscles From Carbon Nanotube Muscles

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ABSTRACT:

Three successive generations of twist-spun artificial muscles are described that provide both torsional and tensile actuation. Our first generation of twist-spun muscles, which are electrochemically powered by volume changes induced by double-layer charge injection, provide torsional rotation speeds of 590 rpm, and torsional strokes of 250° per millimeter of actuator length, which is 1000 times that for earlier artificial muscles. Our second generation muscles, which require no electrolyte and are based on guest-infiltrated carbon nanotube yarns, can torsionally actuate at 11,500 rpm and deliver 85 times higher power density during contraction than natural muscles. Our third generation muscles, which are thermally, electrothermally, or chemically powered polymer fibers, can rotate at 100,000 rpm, contract by up to 49%, generate 5 times the gravimetric power of a car engine, lift 100 times heavier loads than the same length and weight human muscle, or actuate at 7.5 cycles/s for millions of cycles. These polymer muscles can be cheaply made from fishing line or sewing thread. The strokes of these polymer muscles has be increased to a remarkable $\pm 9000\%$ and their applications in areas as diverse as thermal energy harvesting and comfort-adjusting textiles will be described. *This work resulted from collaboration between The University of Texas at Dallas, The University of Wollongong (Australia), Hanyang University (South Korea), The University of British Columbia (Canada), and Namik Kemal University (Turkey).*

BIOGRAPHY:

Ray Baughman became the Robert A. Welch Professor of Chemistry and Director of the NanoTech Institute at the University of Texas in Dallas in August 2001, after 31 years in industry. He is a Member of The National Academy of Engineering and The Academy of Medicine, Engineering and Science of Texas; a foreign member of the European Academy of Sciences; a Fellow of the Royal Society of Chemistry, the National Academy of Inventors, and the American Physical Society; an Academician of The Russian Academy of Natural Sciences; an honorary professor of 7 universities in China; and is on editorial or advisory boards of *Science* and other journals. Ray has 80 issued US patents and 415 refereed publications, with over 31,200 citations and an H-index of 79.

Doherty Hall 2315, 11:30AM
Friday, February 17, 2017