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Na Li

University of Texas at Dallas, USA

Spinning nanotubes into artificial muscles, super capacitors and energy harvesters

Humans long ago discovered the basic secrets of yarn spinning and used them to create strong yarns from short natural fibers such as wool and cotton. In recent decades, the discovery of carbon nanotubes has enabled us to downsize this process by spinning fibers 10,000 times smaller in diameter than a human hair. Such simple twisting processes can increase the strength of carbon nanotube aerogel sheets over 1,000 times by densely pack the nanotubes into yarns. The small diameter of the nanotubes (~10 nm) within these thermally- and electrically-conducting sheets enables nanotube yarns to be highly-flexible. Twisting functional guest materials together with nanotube sheets can form knottable, weavable, and knittable supercapacitor yarns that facilitate ultrafast charge and discharge cycles, binder free lithium ion battery yarns, biofuel cell yarn electrodes, and high critical-current-density superconducting yarns. Spinning also causes strong mechanical coupling between yarn twist and the guest material within a yarn, due to helical alignment of the high-stiffness nanotubes. This unusual property has allowed us to make stimuli-responsive yarns that act as artificial muscles. Such muscles can actuate in response to electricity, chemical pickup, light absorption or heat, and provide greater force than natural skeletal muscle. These multifunctional yarns seek to enable a new era of smart textiles that can store energy, sense and actuate to adjust the comfort of a wearer, and harvest energy from human motion.

Biography

Na Li has received her BS and PhD degree in Chemistry from Nankai University in China. She currently works as a Research Scientist in the Alan G MacDiarmid NanoTech Institute, at the University of Texas at Dallas. She has her expertise in fabrication and processing of nanomaterials, especially into multifunctional yarns. Her study mainly focuses on high performance artificial muscle fibers, novel energy conversion and harvesting solutions, bio-mimetic soft robotics, and stimuli-responsive textiles.

na.li@utdallas.edu

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