Theory Indicates How to Boost Speed of Robotic Muscles

Currently, robotic muscles move 100 times slower than the human equivalent. Now, researchers at the Massachusetts Institute of Technology, led by Sidney Yip, have proposed a theory that indicates how to boost those speeds—making robotic muscles a thousand times faster than human muscles—with virtually no extra energy demands and the added bonus of a simpler design. This study appears in the November 4, 2005, issue of *Physical Review Letters* (198303; DOI: 10.1103/PhysRevLett.95.198303).

In this case, a robotic "muscle" is a device that can be activated to perform a task, like a sprinkler that is activated by pulling a fire alarm lever, said Yip, a professor of nuclear engineering and materials science and engineering. In the past few years, engineers have made artificial muscles from conjugated polymers.

"Conjugated polymers are also called conducting polymers because they can carry an electric current, just like a metal wire," said Xi Lin, a postdoctoral associate in Yip's laboratory. Conjugated polymers can actuate on command if charge can be sent to specific locations in the polymer chain in the form of solitons (charge density waves). Solitons are highly mobile charge carriers that exist because of the special one-dimensional chain character of the polymer.

Scientists already knew that solitons enabled conjugated polymers to conduct electricity. Lin's work attempts to explain how these materials can activate devices. This study is useful because scientists have until now been making conducting polymers in a roundabout way by doping the materials with ions that expand the volume of the polymer. That expansion was thought to give the polymers their strength, but it also makes them heavy and slow. Lin discovered that adding the ions is unnecessary, because theoretically, shining a light of a particular wavelength on the conducting polymer can activate the soliton (see Figure 1). Without the extra weight of the added ions, the polymers can bend and flex much more quickly. That rapid-fire motion enables the high-speed actuation of a device.

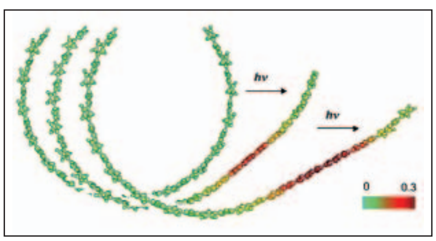

Figure 1. Theoretically, a conducting polymer can be actuated by shining a light of a specific wavelength (hν) on it. The polymer in this image is a chain (neutral charge, green) that is naturally curved before exposure. The effect of light (hν wavelength) is to create positive charges (red) in a localized area. The positive charges enhance the chemical bonding between the polymer units and straighten out the curved chain in that area. Following the charges, this localized straightening can move along the polymer chain rapidly.

Temperature Measured with a Nanoscale Sensor

Nanoparticle (NP) superstructures are important for the creation of smart materials, but most current examples of NP systems show limited response to environmental parameters and do not exhibit transitions of their three-dimensional structures in response to external stimuli.