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.

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.

Cost-Effective Portable Spin Coater

Two-Stage Spinning
Dispense liquid during Stage 1
Spin-up and flatten during Stage 2
Adjustable Speed
Stage 1
500 to 2500 rpm
2 to 18 seconds
Stage 2
1,000 to 8,000 rpm
3 to 60 seconds
Vacuum Chucks
Wide Range of Vacuum Chucks
Available To Hold Different Substrates in KW-4A Spin Coater

KW-4A SERIES PRODUCT LINE

For more information, see http://advertisers.mrs.org
Metal–Oxide–Metal Heterojunction Nanowires Formed

Oxide nanowires are currently being developed and investigated for a variety of nanoelectronics applications because of their unique properties and potential opportunities for “bottom-up” assembly. Going a step further, if metal–oxide–metal (MOM) heterojunctions could be formed, sandwiching a functional oxide between two noble-metal nanowires, they could have distinct advantages over all-oxide nanowires. The synthesis of MOM nanowires using a template-based method has now been reported by J.S. Tresbeck and A.L. Vasilyev of the University of Connecticut and N.P. Padture of the Ohio State University.

As reported in the October 2005 issue of the Journal of Materials Research (p. 2613; DOI: 10.1557/jmr.2005.0347), the researchers examined Au-SnO2-Au systems and Au-NiO-Au systems (see Figure 1 for Au-SnO2-Au nanowires). Au-Sn-Au and Au-Ni-Au nanowires were formed inside anodic aluminum oxide (AAO) templates with 60- and 220-nm diameter nanoholes, respectively. First, one side of the template was sealed using 0.5-μm-thick Ag thin film. A small 0.5-μm Ag segment was electroplated within the nanoholes. Au was then electroplated inside the nanoholes. This was followed by Sn or Ni electroplating. Au was then again electroplated on top of the Sn or Ni. The Ag and the AAO template were then dissolved using nitric acid and NaOH, respectively, yielding Au-Sn-Au or Au-Ni-Au nanowires, which were centrifuged and rinsed. These nanowires were subjected to heat treatment to yield Au-SnO2-Au (through oxidation of Sn to SnO and then SnO to SnO2) or Au-NiO-Au nanowires, through oxidation of Ni to NiO. The nanowires were then dispersed in deionized water or ethanol. These MOM nanowires were examined in both a scanning electron microscope and a transmission electron microscope.

The overall length of Au-SnO2-Au nanowires in one case was more than 2 μm. The Au diameter was ~60 nm, and the SnO2 segment was ~60 nm in diameter and ~70 nm in length. Grain size in the SnO2 ranged from 5–10 nm. Similarly, the overall length of a Au-NiO-Au nanowire was more than 7 μm, with a Au diameter of ~270 nm, a NiO diameter of ~300 nm, and ~200 nm length. These dimensions varied for different templates used.

The study has demonstrated the feasibility of synthesizing MOM nanowires in the Au-SnO2-Au and the Au-NiO-Au systems. This synthesis method appears to be applicable to a wide variety of metal-oxide combinations. Also, there are several potential unique advantages of this architecture. The dimensions of the functional oxide segment in the nanowires can be controlled by varying the electroplating conditions. The synthesis method described here also offers the possibility of better control over the structure and characteristics of the oxide segments. Site-specific assembly of the MOM nanowires into nanoscale circuits is a possibility. The structure of the nanowires may also enable the direct measurement of the functional properties of the oxides at the nanoscale.