nanotoday
Volume 6, Issue 5, October 2011, Pages 443

doi:10.1016/j.nantod.2011.08.006 | How to Cite or Link Using DOI
Permissions & Reprints

Researchers switch onto ZnO nanowire piezotronic memories

Available online 19 September 2011.

nanotoday
Volume 6, Issue 5, October 2011, Pages 443

''We need to see how the properties change when you move from the bulk to the micron scale and then to the nanometer scale,'' says Bassiri-Gharb. ''We need to understand what really happens to the extrinsic and intrinsic responses of the materials at these small scales.''

Gopalan sees future prospects for the approach in fabricating very high storage density memory devices, strain- and electric field-tunable photonic crystals and new applications in high frequency, high resolution ultrasound imaging.

E-mail address: cordelia.sealy@googlemail.com

1748-0132/$ — see front matter
doi: 10.1016/j.nantod.2011.08.009

Researchers switch onto ZnO nanowire piezotronic memories

Cordelia Sealy

Nanoscale mechanical devices linking the biological and electronic worlds could prove essential for interfacing between humans and computers, sensing and actuating in nanorobotics and smart nanoelectromechanical systems (NEMS). Such devices require the integration of mechanical devices, sensors, actuators, and electronics — including memories — on a single chip. But non-volatile resistive memories are all based on electrical switching of resistance and are not suitable for such direct interfacing.

Now researchers Zhong Lin Wang and Wenzhuo Wu of Georgia Institute of Technology have devised what they claim is the first piezoelectrically modulated resistive switching device based on ZnO nanowires [W. Wu, Z.L. Wang, Nano Lett. (2011), doi:10.1021/nl201074a]. The memory devices take advantage of the unique piezoelectric properties of ZnO nanowires, namely that the semiconducing material changes resistance when strained.

In these piezoelectrically modulated resistive memory (PRM) devices, the piezoelectric charge or resistance change induced by deformation is used to control the flow of current through the ZnO nanowires (Fig. 1). So the write/read access is achieved via electromechanical modulation directly.

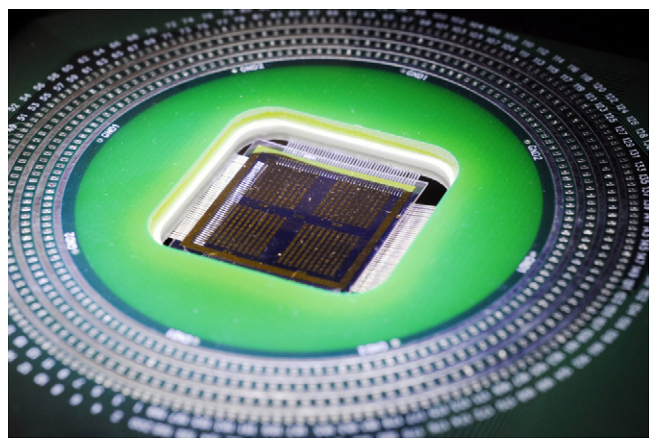

Figure 1 An array of piezoelectrically modulated resistive memory (PRM) cells shown through an optical microscope. (Credit: Gary Meek, Georgia Tech.)

''Because ZnO is both piezoelectric and semiconducting, when you strain the material with a mechanical action, you create a piezopotential. This piezopotential tunes the charge transport across the interface — instead of controlling channel width as in conventional field effect transistors,'' explains Wang.

The strain or deformation could result from a human action, a biological activity like the heart beating or the motion of an actuator or nanorobot.

The researchers create arrays of ZnO nanowires that act as non-volatile resistive switching memories. The devices can be written, and information can be read out, while they can also be erased and re-used. Wang says that the devices have the potential for implementing novel nanoelectromechanical memories and integrating with NEMS technology to achieve micro/nano-systems.

''Nonvolatile resistive switching memories using ZnO nanowire arrays as the storage medium may be readily implemented for applications such in flexible electronics and force/pressure imaging,'' he says. ''Non-Boolean neuromorphic computing might also be realized by integrating arrays of high-density resistive memory cells on flexible substrates.''

Cheol Seong Hwang of Seoul National University in Korea says that the idea of adding a new input in the form of a piezoelectric voltage induced by mechanical deformation into a resistance memory cell is novel and has not been considered previously.

''This [is a] new conceptual breakthrough,'' he says, ''providing the device with the ability to 'memorize the strain' and read it out by an electrical signal in a 'digital' manner.''

E-mail address: cordelia.sealy@googlemail.com

1748-0132/$ — see front matter
doi: 10.1016/j.nantod.2011.08.006