

Student Innovation Could Improve Data Storage, Magnetic Sensors

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Paul Morrow. Photo Credit: Rensselaer/Mark McCarty

Paul Morrow has come a long way from his days as an elementary school student, pulling apart his mother's cassette player. The talented young physicist has developed two innovations that could vastly improve magnetic data storage and sense extremely low level magnetic fields in everything from ink on counterfeit currency to tissue in the human brain and heart.

First, Morrow developed a nanomaterial that has never before been produced. The nanomaterial is an array of freestanding nanoscale

columns composed of alternating layers of magnetic cobalt and non-magnetic copper.

Morrow's three-dimensional arrangement of the magnetic and non-magnetic layers creates a material that exhibits promising magnetic properties for data storage and magnetic field sensing at room temperature. Similar technology is currently in use in hard drives around the world, but they both use a two-dimensional film design for the layers.

“Because the nanostructure is three-dimensional, it has the potential to vastly expand data storage capability,” Morrow said. “A disk with increased data storage density would reduce the size, cost, and power consumption of any electronic device that uses a magnetic hard drive, and a read head sensor based on a small number of these nanocolumns has promise for increasing spatial sensitivity, so that bits that are more closely spaced on the disk can be read. This same concept can be applied to other areas where magnetic sensors are used, such as industrial or medical applications.”

Morrow has also developed a microscopic technique to measure the minute magnetic properties of his nanocolumns. Prior to his innovation, no such method existed that was fine-tuned enough to sense the magnetic properties of one or even a small number of freestanding nanostructures.

The technique uses a specialized scanning tunneling microscope (STM) that Morrow built that contains no internal magnetic parts. Most STMs in use today have magnetic parts that make it impossible for them to operate reliably in an external magnetic field according to Morrow. With his modified non-magnetic STM, Morrow was able to use an electromagnet to control the magnetic behavior of his nanocolumns and measure the magnetic properties of fewer than 10 nanocolumns at one time.

“To date it has been extremely difficult to get an instrument to detect magnetic properties on such a small scale,” Morrow said. “With this type of sensitivity, engineers will be able to sense the very low level magnetic properties of a material with sub-micron spatial resolution.”

He is currently working to fine-tune the device to detect the properties of just one nanocolumn. His technique could have important implications for the study of other magnetic nanostructures for magnetic sensing applications including motion sensors for industrial applications, detection of magnetic ink in currency and other secure documents, and even help detect and further understand the minuscule magnetic fields generated by the human body.

His discoveries have been published in two articles in the journal *Nanotechnology*.

Morrow proudly originates from the city of Spartanburg, S.C., the only boy in a close family that includes three sisters. His father is a retired chemistry professor at Wofford College, the local liberal arts college that Morrow attended for his bachelor’s, and his mother is a master teacher who instructs elementary schoolteachers in improving their teaching methods. “Their love of learning and teaching has inspired me to one day become a teacher myself,” Morrow said.

Morrow will graduate from Rensselaer with a doctorate in physics, applied physics, and astronomy.

Source: Rensselaer Polytechnic Institute

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