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THREE-ELEMENT NANORODS

Nanometer-sized crystalline oxide rods exhibit useful properties

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Increasing the number and variety of items available on the menu of nanosized structures, researchers at Harvard University have developed procedures for preparing oxide nanorods made of three elements. The group has demonstrated that the materials are promising candidates as media for high-density data storage. The new synthesis strategy may be extended to other classes of materials and provides new opportunities for investigations in piezo- and ferroelectricity, magnetoresistivity, and other areas.

Most of the nanoscaled materials synthesis and characterization work reported thus far has focused on structures made of carbon, metals, semiconductors, and binary oxides. But assistant chemistry professor [Hongkun Park](#) has concentrated on preparing crystalline transition-metal oxide nanorods because of the unique physical properties associated with these materials.

Now, using a liquid-phase synthesis procedure in which bimetallic alkoxide precursors are decomposed, Park, graduate students Jeffrey J. Urban and Qian Gu, and postdoctoral associate Wan Soo Yun have prepared single-crystal BaTiO₃ and SrTiO₃ nanorods with a cubic perovskite structure [[J. Am. Chem. Soc.](#), **124**, 1186 (2002)].

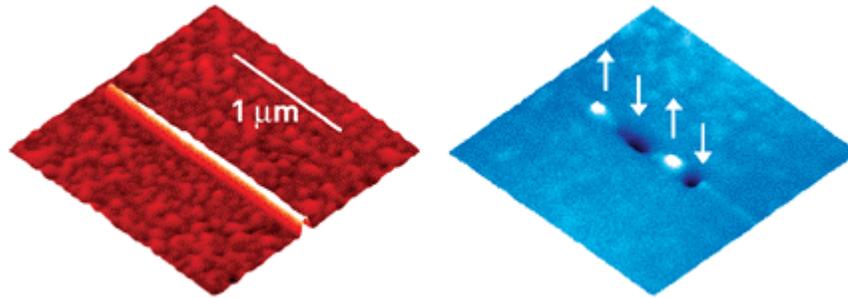
Harvard chemistry professor [Charles M. Lieber](#) remarks that the approach used by Park and coworkers "provides general access to a wide range of metallic and magnetic oxide nanoscale materials heretofore unexplored."

Park explains that ferroelectric oxides, such as barium titanate, exhibit spontaneous electric polarization--meaning that the materials' electronic dipoles can be oriented up or down by subjecting a specimen to an external electric field. Scientists find that property attractive because it makes the materials candidates for data-storage devices. The idea is to be able to write data in a medium by controllably polarizing small and closely spaced regions of the material at will. The zeros and ones of digital signals, for example, could be represented by dipoles oriented up or down.

Although a number of researchers have investigated ferroelectricity in thin-film materials, Park says it was unclear whether one-dimensional barium titanate wires with nanometer-sized diameters are ferroelectric. In a study aimed at answering that question and related ones, the

Harvard group used a scanning probe microscope with a conductive tip to selectively polarize--and then image--adjacent regions of a BaTiO₃ nanowire.

The group was able to polarize domains as small as 100 nm²--corresponding to a data density of nearly 1 terabit per cm² [*Nano Letters*, published Feb. 5 ASAP, <http://pubs.acs.org/journals/nalefd>]. The researchers point out that specimens stored under vacuum showed little polarization decay (spontaneous loss of "data") even after five days.



POLARIZED Scanning probe micrographs show that small domains in a 12-nm diameter BaTiO₃ nanowire (left) can be manipulated deftly. Using a tip that's biased positively and then negatively, adjacent regions of the wire can be polarized in either orientation (right).