Piezoforce Imaging of Confined Oxide Nanowires

Levy, Akash

A technique called piezoresponse force microscopy (PFM) was used to non-destructively image and dimension conductive nanostructures created at the interface between LaAlO3 and SrTiO3. Comparisons of PFM imaging with a previously established destructive method for quantifying ~10 nanometer nanowires indicate very good agreement. Nanoscale regions at the interface of LaAlO3/SrTiO3 can be reversibly switched between electrically conducting and electrically insulating with an Atomic Force Microscope (AFM) tip. A software program was developed to scan a voltage-biased AFM tip in a programmed pattern over the LaAlO3 surface, allowing nanoscale lines and other complex patterns to be “written” and “erased” at the LaAlO3/SrTiO3 interface. A three-dimensional visualization tool was developed with VPython, an open-source programming tool, to monitor the progress of the nanoscale writing. Simultaneous measurements of the conductivity of these nanostructures were performed using a lock-in amplifier. The PFM response of the LaAlO3/SrTiO3 interface was measured by applying an alternating voltage to the conductive nanostructures, and measuring the resulting deflection of an electrically-isolated AFM tip that scanned the surface of the sample. The raster-scanned PFM images were analyzed to determine the wire widths. The PFM-derived widths were compared to those obtained from erasure experiments. PFM had a spatial resolution of approximately 25 nm, with the advantage of being non-destructive. PFM imaging may become a useful technique for researchers interested in developing new families of nanoelectronics circuitry using the LaAlO3/SrTiO3 interface. The technique provides a relatively simple, high-resolution method for the non-destructive imaging of conductive nanostructures.

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