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NANO HIGHLIGHT
Fabrication of Silver Nanowires on Patterned Polar Surfaces

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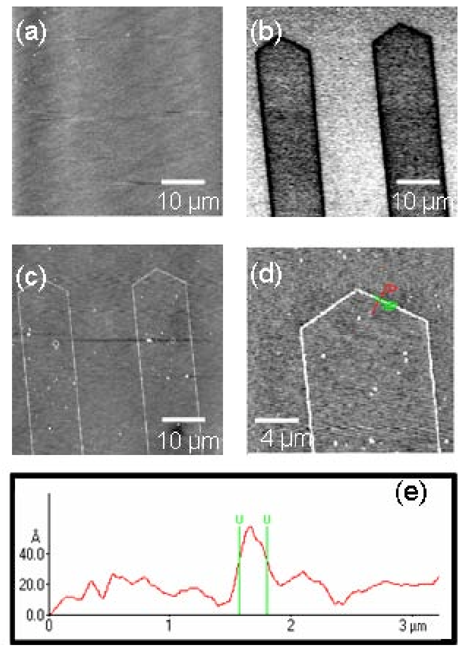
We have discovered a liquid phase processing method for the fabrication of silver nanowires. This method involves utilizing the unique property of spontaneous polarization in ferroelectric materials and the ability to pattern domains on the surface. When the surface is illuminated with super band gap light while immersed in solution, a photochemical reaction takes place on the surface. The product of the reaction is nanowires deposited on the domain walls. The width of the wire is determined by the exposure time, and the shape is determined by the ferroelectric domain pattern. The length is only limited by sample size.



An AFM topography image (a) shows the surface of polarity patterned lithium niobate before a deposition. Using piezo-force microscopy, (b), the domain walls are the black lines between the lighter and darker domains. After the liquid phase process, AFM topography images (c, d) establish that silver nanowires have formed on the domain walls. The line profile (e) shows the wire to be about 250 nm wide.

As the dimensions in electronic devices decrease from micron to nanometer scale, new approaches for fabrication of nanoscale structures and devices have been considered. Two general approaches to fabricating nanowires are the top-down approach, such as lithography processes, and the bottom-up approach in which molecules self-assemble to form nanowires. We present a simple liquid phase processing method to form the nanowires. It is possible to pattern domains in ferroelectric samples with the spontaneous polarization pointing into ('down' domain) or away from ('up' domain) the surface by applying a localized electric field with a scanning probe tip. The boundary between the up and down domains is called a domain wall. When a semiconductor is exposed to ultra violet light with an energy greater than the band gap of the material, photogenerated electron-hole-pairs are created. These photogenerated carriers will act to screen local fields. If the electron or hole reaches the surface before recombination it can respectively enable a reduction or oxidation reaction. This research has established that nanowires can be formed when a polarity patterned surface is exposed to light with a photon energy that is greater than the band gap of the ferroelectric material while the surface is immersed in a photoreducible solution (silver nitrate). Photoreduction occurs at the domain wall in a class of ferroelectric material which exhibit low electrical conductivity. Depending on the intensity of the light, the duration of the exposure, and the concentration of the solution, we have demonstrated the ability to control the width and height of these nanowires. The length and pattern of the nanowire is determined by the length of the domain wall which can be mm or greater.