Focused Ion Beam Methodologies Pave the way for "Ferroelectronics"

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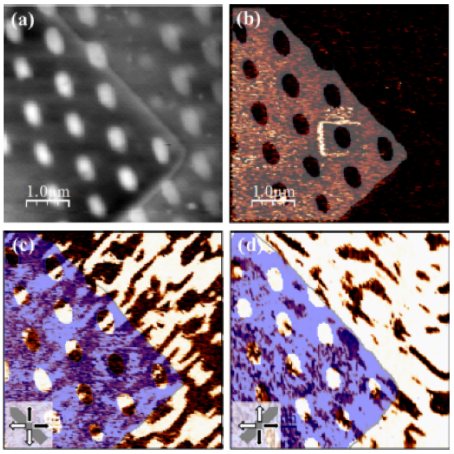
As we reach the physical limit of Moore's law and silicon based electronics, alternative schemes for memory and sensor devices are being proposed on a regular basis. The properties of ferroelectric materials on the nanoscale are key to developing device applications of this intriguing material class, and nanostructuring has been readily pursued in recent times. Focused ion beam (FIB) microscopy is one of the most significant techniques for achieving this. When applied in tandem with the imaging and nanoscale manipulation afforded by proximal scanning force microscopy tools, FIB-driven nanoscale characterization has demonstrated the power and ability which simply may not be possible by other fabrication techniques in the search for innovative and novel ferroic phenomena. At the same time the process is not without pitfalls; it is time-consuming and success is not always guaranteed thus often being the bane in progress.[1]
A level of sophistication using nanostructuring to control domain dynamics has been established in nanomagnetism that is far beyond the equivalent state-of-the-art in ferroelectrics. For ferroelectrics, completely new forms of domain wall nanoelectronics could be created in which "now-you-see-it, now-you-don't" conducting channels would entirely dictate device function. Merging FIB patterning with piezoresponse force microscopy to create interesting domain wall functionality and new methods of domain control paves the way for next generation "ferroelectronics".



Nanoislands milled out of a BFO lamellar structure via a process of repeated ion milling. a) Topography, b) vertical PFM phase, c), d), lateral PFM phases, orthogonal to each other. [2]

[1] S.R. Burns, J.M. Gregg, V. Nagarajan, *Adv. Funct. Mater.* **2016**, *26*, 46.
[2] A. Morelli, F. Johann, S.R. Burns, A. Douglas, J.M. Gregg, *Nano Lett.* **2016**, *16*, 8.