ADVANCED FUNCTIONAL MATERIALS

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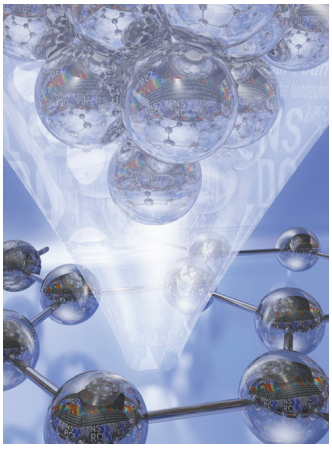
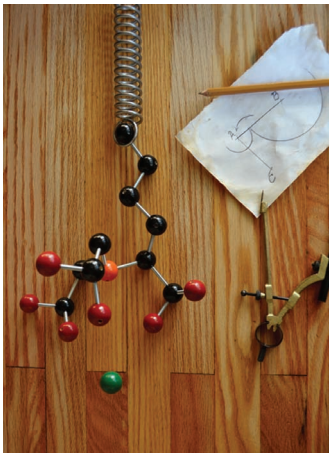


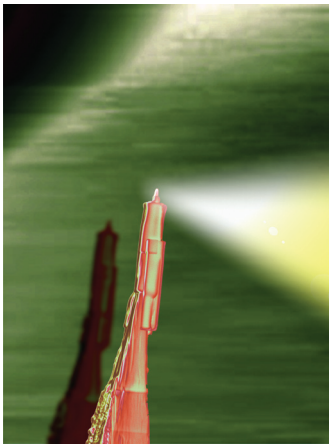
Scanning Probe Microscopy

An artistic vision of the interaction between the Nanoscale Science Research Centers (NSRCs) and the user community is rendered as a scanning tunneling microscope tip above a surface. NSRCs combine two elements, namely the support of an external user program and an in-house research program, including development of new, commercially unavailable instrumental platforms, operation of unique commercial equipment, and dissemination of this expertise and capabilities to a broad scientific community. This Special Issue, guest-edited by Sergei Kalinin, showcases recent progress in scanning probe microscopy across the NSRCs. Figure courtesy of Stephen Jesse, ORNL.

Dynamic Force Spectroscopy

The photograph on the inside cover illustrates the mechanical measurement of bond energies. This is the essence of dynamic force spectroscopy, which uses the bending of an atomic force microscope cantilever to measure the work required to break a bond. On page 2525, James J. De Yoreo and co-workers show how this technique can be used to probe the binding free energy between biominerals and the proteins that control their growth.





Synchrotron X-Ray Scanning Tunneling Microscopy

On page 2646 Volker Rose and co-workers present a smart tip for synchrotron X-ray scanning tunneling microscopy that is entirely coated by an insulating oxide, except at the tip apex. The tip is only sensitive to X-ray-excited tunnel currents and not to photoejected electrons caused by classical photoemission, which would degrade the spatial resolution. The bright light in the image, coming in from the right, that hits the tip apex schematically represents the synchrotron beam during an experiment.

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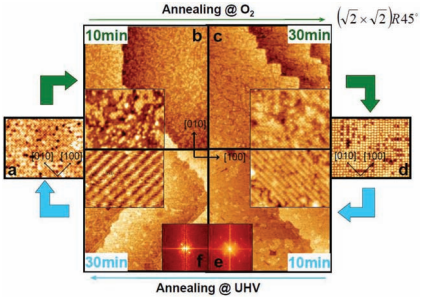
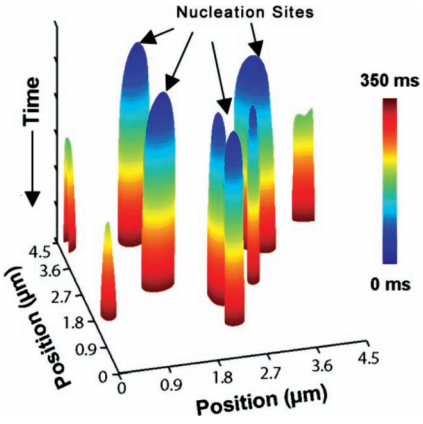
Strongly Correlated Materials



Controllable surface tuning provides the opportunity to study how structural, electronic, and magnetic properties respond to the broken symmetry and opens avenues for exploration of completely new physical properties. Recent progress in in situ observations and tuning of physical and chemical phenomena on the surfaces of strongly correlated oxide thin films and crystals, including atomic-level structural studies, control, and tuning of the physical properties is reviewed.

Ferroelectric Materials



Functional properties of ferroelectric materials depend both on the residual domain states and on the mobility of domain walls in response to the applied electric and stress fields. Through advanced spectroscopic techniques on model ferroelectric capacitors, it is possible to determine the domain nucleation sites and domain wall velocity as a function of pulse amplitude and widths, in a single experiment.

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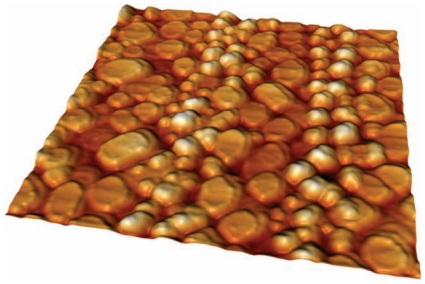
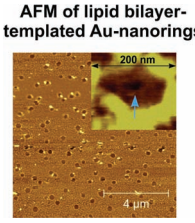
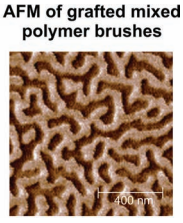
Scanning Tunneling Microscopy



Cross-sectional scanning tunneling microscopy and spectroscopy (XSTM/S) for complex oxides has recently been developed. XSTM/S is an ideal tool to directly probe the electronic properties at interfaces of dissimilar complex oxides. The understanding of the emerging phenomena at complex oxide interfaces could be pushed further with the nanometer-scale electronic information obtained by XSTM/S.

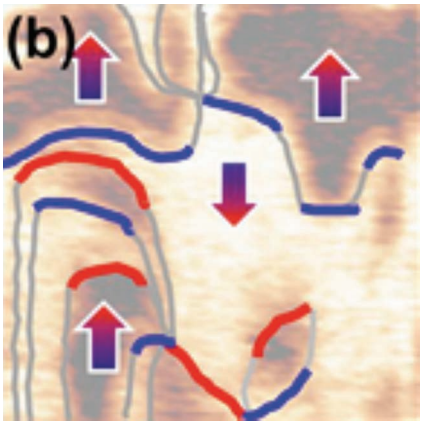
Nanocomposites



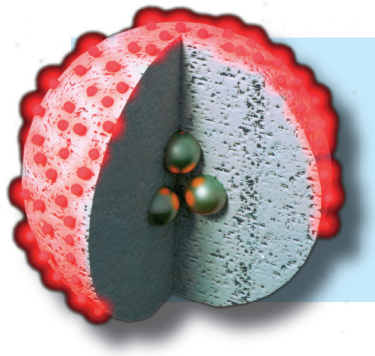


Scanning probe microscopy allows for high-resolution characterization and manipulation of nanocomposite membranes. Several examples are shown and their characterization/manipulation are discussed including lipid/nanoparticle composites and grafted mixed polymer systems.

Ferroelectrics



Nanometer-scale electronic transport in engineered interfaces in ferroelectrics, such as domains and topological defects, has emerged as a topic of broad interest. The use of scanning probe microscopies to access topological defects and directly measure their unique properties is reviewed. It is found that observation of enhanced conduction at domain walls can be attributed to segregation of carriers at charged walls. Furthermore, the potential distribution around a curved or tilted wall can be highly assymetric, even for nominally uncharged walls due to strain and flexo-electric couplings.



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