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INFORMATION TECHNOLOGY AND THE ADVANCED PHOTON SOURCE

Information is power, and the Argonne Advanced Photon Source (APS) is a powerful tool for scientists carrying out synchrotron x-ray investigations of the materials that are crucial for our information technology.

New insights about the way digital video disc (DVD) technology works have been gained by North Carolina State University and Colorado School of Mines researchers using extreme-brightness x-ray beams from the APS. They examined—at the microscopic level—the alloy used in DVDs and were able to calculate the optimum ratio of elements within the material. This information will help to "fine tune" the alloy, which could lead to the development of more efficient data storage devices as well as computers that could be sent into orbit and reprogrammed as needed without sending up another spacecraft or a satellite.

As cell phones, laptops, MP3 players, and other electronic devices become smaller, and "smart cards" become more prevalent, the importance of ferroelectric materials (crystalline materials that have switchable electric polarization) keeps growing. These materials must be formed as very thin films, down to a few nanometers thick. Understanding how ferroelectric films change as they become thinner is crucial to utilizing them. Researchers from Argonne, Hebrew University, the University of Michigan, Northern Illinois University, the University of Washington, and Brookhaven National Laboratory used APS x-ray beams to take a close look (think molecules) at the nature of ultrathin ferroelectric materials, revealing key details about how these materials behave when they are only a few atoms thick.

Information storage technologies are becoming smaller, even as the demand for storage capacity increases. New devices require atomic-scale-precision methods of manufacturing high-quality layers of different semiconducting materials that can be stacked to form superlattices. The magnetic characteristics of superlattices have been studied, but the microscopic mechanisms that make them work have been hidden. Researchers from Argonne, the Max Planck Institute for Solid State Research, the University of Arkansas, the European Synchrotron Radiation Facility, and the Rutherford Appleton Laboratory used APS x-ray beams to obtain the first detailed microscopic picture of the landscape along a superlattice plane, revealing new insights about magnetic interplay at the interface and how to control it.

The Advanced Photon Source at the U.S. Department of Energy's Argonne National Laboratory provides this hemisphere's brightest x-ray beams for research. Scientists and engineers using the APS help assure a bright future for our nation by carrying out research that promises to have far-reaching impact on our technological and economic competitiveness, our health, and our fundamental knowledge of the materials that make up our world.

Argonne is a U.S. Department of Energy laboratory managed by UChicago Argonne, LLC
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Digital video disc (DVD) technology is by no means new, but that doesn't mean we know everything about the way these devices store our movies and data. New insights into the functioning of this mature technology have come from North Carolina State University and Colorado School of Mines researchers using the Materials Research Collaborative Access Team beamline 10-ID at the Argonne Advanced Photon Source. Their findings may lead to advances in data storage as well as within the computer industry as a whole.

See: D.A. Baker[1], M.A. Paesler[1], G. Lucovsky[1], S.C. Agarwal[1], and P.C. Taylor[2], "Application of Bond Constraint Theory to the Switchable Optical Memory Material $Ge_2Sb_2Te_5$," Phys. Rev. Lett. **96**, 255501 (2006).
DOI: 10.1103/PhysRevLett.96.255501
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See also: http://www.aps.anl.gov/Science/Highlights/2006/20060731.htm

A research team comprising members from Argonne, Hebrew University, the University of Michigan, Northern Illinois University, the University of Washington, and Brookhaven National Laboratory used the X-ray Operations and Research (XOR)/BESSRC 12-ID, XOR 7-ID, and XOR/PNC 20-ID beamlines at the APS to take a closer look at the nature of ultrathin ferroelectric perovskites. Their work provides some key details about how these materials behave when they are only a few atoms thick.

See: D.D. Fong[1], C. Cionca[2], Y. Yacoby[3], G.B. Stephenson[1], J.A. Eastman[1], P.H. Fuoss[1], S.K. Streiffer[1], Carol Thompson[4], R. Clarke[2], R. Pindak[5], and E.A. Stern[6], "Direct Structural Determination in Ultrathin Ferroelectric Films by Analysis of Synchrotron X-ray Scattering Measurements," Phys. Rev. B **71**, 144112 (2005).
DOI: 10.1103/PhysRevB.71.144112
Author affiliations: [1]Argonne National Laboratory, [2]University of Michigan, [3]Hebrew University, [4]Northern Illinois University, [5]Brookhaven National Laboratory, [6]University of Washington
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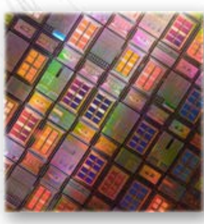
See also: "The Thinnest of the Thin: Ultrathin Ferroelectric Films," *APS Science 2005*, the annual report of the Advanced Photon Source at Argonne National Laboratory, ANL-05/29, p. 35 (May 2006) and on the Web at http://www.aps.anl.gov/News/Annual_Report/APS_Science_2005.pdf



Studies of the interface between two materials have a rich history of revealing new physics that are not present when either constituent material is studied by itself. Researchers used both x-ray magnetic circular dichroism (at XOR 4-ID-C beamline at the APS and beamline ID08 of the European Synchrotron Radiation Facility) and neutron reflectometry to obtain the first detailed microscopic picture of the magnetic landscape along the superlattice plane, revealing intriguing new insights into the subtle interplay between ferromagnetism and superconductivity at the interface.

See: J. Chakhalian[1,2], J.W. Freeland[3], G. Srajer[3], J. Strempfer[1], G. Khaliullin[1], J.C. Cezar[4], T. Charlton[5], R. Dalgliesh[5], C. Bernhard[1], G. Cristiani[1], H.-U. Habermeier[1], and B. Keimer[1], "Magnetism at the interface between ferromagnetic and superconducting oxides," Nat. Phys. **2**, 244 (April 2006). DOI: 10.1038/nphys272
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See also: *APS Science 2006, the annual report of the Advanced Photon Source*, "Interface Effects in Magnetic Oxide Superlattices," ANL-06/23, p. 28, and on the Web at http://www.aps.anl.gov/News/Annual_Report/APS_Science_2006.pdf.