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Seminar: Department of Chemistry
Drexel University
Philadelphia, Pennsylvania
February 4, 2001

SEEING CHEMISTRY BOND BY BOND WITH THE SCANNING TRANSMISSION ELECTRON MICROSCOPE.

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Prepared by the
SOLID STATE DIVISION
OAK RIDGE NATIONAL LABORATORY
Managed by
UT-BATTELLE, LLC, for the
U.S. DEPARTMENT OF ENERGY
Under contract no. DE-AC05-00OR22725
Oak Ridge, Tennessee

February 2001

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The scanning transmission electron microscope today produces an electron beam of atomic dimensions which allows the direct imaging of atomic arrangements in solid state materials and nanostructures. It also allows simultaneous electron energy loss spectroscopy, from specific sites seen in the image. In combination with first-principles theory, this represents a powerful set of tools to link the atomic scale chemistry to macroscopic properties. Four case studies will be presented: 1) The origin of electrical barriers at $SrTiO_3$ grain boundaries. 2) A quantitative explanation of the exponential decrease in grain boundary critical current with misorientation in the high temperature superconductor YBCO. 3) The structure of the decagonal quasicrystal $Al_{72}Ni_{20}Co_8$ and the origin of quasiperiodic tiling. 4) Correlation of atomic and electronic structure of the Si/SiO_2 interface and its influence on properties.