Combining scanning tunneling microscopy and synchrotron x-rays at the XTIP beamline

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The real-space observation of chemistry and magnetic structure using scanning tunneling microscopy (STM) or synchrotron-based x-ray microscopy (XM) continues to have a tremendous impact on our understanding of nanoscale materials. However, although STM provides high spatial resolution, it typically lacks direct chemical contrast and the ability to quantify magnetic moments. On the other hand, XM can provide chemical as well as magnetic sensitivity, but the spatial resolution is inferior. In order to overcome these limitations, we have developed a new technique that combines synchrotron radiation with the high spatial resolution of STM. The goal is to combine the spin sensitivity and chemical contrast of synchrotron x-rays with the locality of STM.

Recently, we demonstrated the power of SX-STM for elemental characterization and topography of individual Ni and Co nano-islands at 2 nm lateral resolution and at the limit of single atom height sensitivity [1,2]; tested new probe tip concepts based on carbon nanotubes [3] and multilayer tips [4]; and demonstrated x-ray imaging of nanoscale magnetic domains of an iron thin-film by x-ray magnetic circular dichroism (XMCD) contrast [5]. Further substantial advances are expected using the new low temperature (LT) SX-STM system, which has been developed over the last 3 years and is currently under commissioning [6].

To fully exploit the special capabilities of the new microscope, XTIP, a dedicated beamline for SX-STM is under construction at the Advanced Photon Source. To meet the scientific objective of the nanoscience and nanomagnetism communities most effectively, we are going to build a soft x-ray beamline with full polarization control operating over the 500-2000 eV energy range. The dedicated XTIP beamline will provide researchers access to a one-of-a-kind instrument. Among the potential breakthroughs are “designer” materials created from controlled assemblies of atoms and molecules, and the emergence of entirely new phenomena in chemistry and physics.

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