Synchrotron X-ray Scanning Tunneling Microscopy

Volker Rose

Advanced Photon Source and Center for Nanoscale Materials, Argonne National Laboratory, 9700 S Cass Ave, Argonne, Illinois 60439, USA
vrose@anl.gov

Abstract

In this talk we will discuss the development of a novel high-resolution microscopy technique for imaging of nanoscale materials with chemical, electronic, and magnetic contrast [1,2]. It will combine the sub-nanometer spatial resolution of scanning tunneling microscopy (STM) with the chemical, electronic, and magnetic sensitivity of synchrotron radiation [3]. Drawing upon experience from a prototype that has been developed at the Advanced Photon Source to demonstrate general feasibility, current work has the goal to drastically increase the spatial resolution of existing state-of-the-art x-ray microscopy from only tens of nanometers down to atomic resolution. Key enabler for high resolution is the development of insulator-coated "smart tips" with small conducting apex (Figure 1) [4]. After entirely coating sharp tips with insulating films, the coating can be removed from the apex by means of high-resolution focused ion beam milling. Such tips drastically reduce the background of photoejected electrons that would otherwise cause an undesired signal at the sidewall of the tip. The novel microcopy technique will enable fundamentally new methods of characterization, which will be applied to the study of energy materials and nanoscale magnetic systems. A better understanding of these phenomena at the nanoscale has great potential to improve the conversion efficiency of quantum energy devices and lead to advances in future data storage applications.

References

[1] V. Rose, J.W. Freeland, S.K. Streiffer, "*New Capabilities at the Interface of X-rays and Scanning Tunneling Microscopy*", in *Scanning Probe Microscopy of Functional Materials: Nanoscale Imaging and Spectroscopy*, S.V. Kalinin, A. Gruverman, (Eds.), Springer, New York (2011), pg 405-432.
[2] M.L. Cummings, T.Y. Chien, C. Preissner, V. Madhavan, D. Diesing, M. Bode, J.W. Freeland, V. Rose, Ultramicroscopy 112, 22 (2012).
[3] V. Rose, T.Y. Chien, J.W. Freeland, D. Rosenmann, J. Hiller, V. Metlushko, J. Appl. Phys. 111, 07E304 (2012).
[4] V. Rose, T.Y. Chien, J. Hiller, D. Rosenmann, R.P. Winarski, Appl. Phys. Lett. 99, 173102 (2011).

Acknowledgements

The author acknowledges generous funding by the Office of Science Early Career Research Program through the Division of Scientific User Facilities, Office of Basic Energy Sciences of the U.S. Department of Energy through Grant SC70705. Work at the Advanced Photon Source, the Center for Nanoscale Materials, and the Electron Microscopy Center was supported by the U. S. Department of Energy, Office of Science, Office of Basic Energy Sciences, under contract DE-AC02-06CH11357.

Webpage

http://www.aps.anl.gov/Xray_Science_Division/Sxspm/

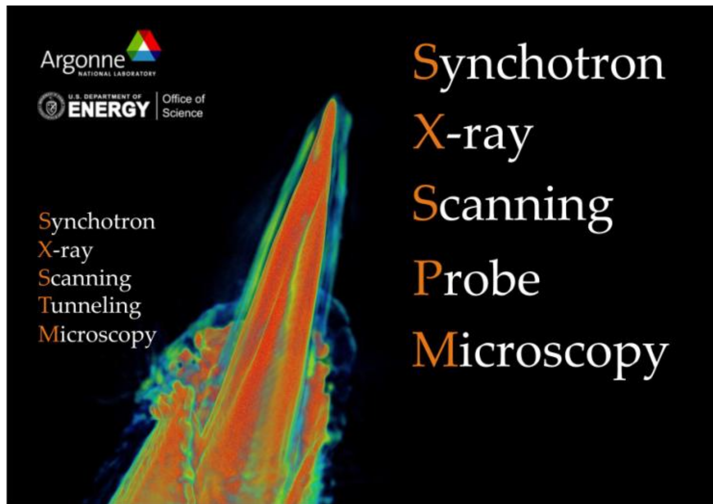

Figure 1: X-ray nanotomography surface rendering of a smart scanning tunneling microscope tip. The platinum-iridium tip (red) has been coated with a SiO_2 insulating layer (green). Image obtained using the Center for Nanoscale Materials Hard X-Ray Nanoprobe beamline at Sector 26 of the Advanced Photon Source, USA.