New X-ray microscopy technology to 'see' both the chemical and physical aspects of materials

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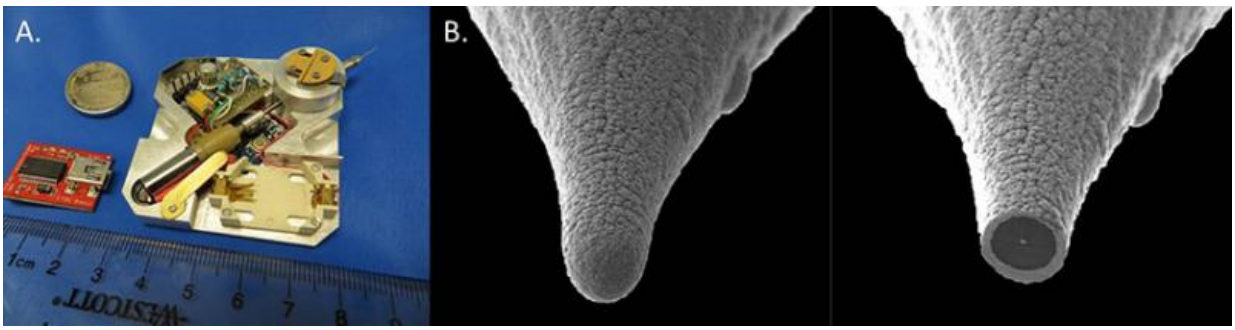

A. The new patent includes a compact programmable NANOrotator that allows the fabrication of “smart” tips. B. Coaxial “smart” tips serve as novel x-ray detectors, shown before (left) and after (right) nanofabrication. Credit: Argonne National Laboratory

A new patent blazes a path forward for a way to simultaneously determine the physical structure and chemical makeup of materials close to the atomic level using a combination of microscopy techniques.

Synchrotron light sources are used for material characterization in condensed matter physics, materials science, chemistry, biology, and energy science. However, even with the best synchrotron X-ray microscope available to date, direct chemical imaging cannot be reached

below a spatial limit of about 10 nanometers. Now, scientists can chemically fingerprint surfaces to potentially overcome this spatial limitation and open new routes to develop the next generation of materials.

Comprehensive understanding of nanoscale systems requires tools with both the ability to resolve nanometer structures as well as the direct observation of chemical composition and magnetic properties. X-ray microscopy methods provide the desired chemical and magnetic sensitivity, but the spatial resolution, or the ability to "see" tiny structures, is limited.

On the other hand, scanning tunneling microscopy (STM) achieves the requisite high spatial resolution; however, it has a fundamental drawback – it is chemically blind. Now, scientists at the U.S. Department of Energy's Argonne National Laboratory have advanced a new technology that pairs the powerful capabilities of x-ray analysis and STM. This long-standing goal has become reality through the development of "smart" nanofabricated coaxial multilayer probes that serve as detectors in the microscope as well as a programmable nanomanipulator to fabricate these.

Further, a specialized electronic filter was invented that allows scientists to obtain simultaneous topographic and chemical information on surfaces, giving the chemical fingerprint of the material while also providing a detailed, clear image of the physical structure. The researchers expect that the new patent will ultimately enable the study of the electronic, chemical, and magnetic properties in individual atoms.

More information: "Simultaneous topographic and elemental chemical and magnetic contrast in scanning tunneling microscopy." U.S. Patent 8,850,611, September 30, 2014.

"An easy-to-implement filter for separating photo-excited signals from topography in scanning tunneling microscopy." *Review of Scientific Instruments* 84, 063704 (2013). [DOI: 10.1063/1.4811652