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New characterization methods developed to identify light elements

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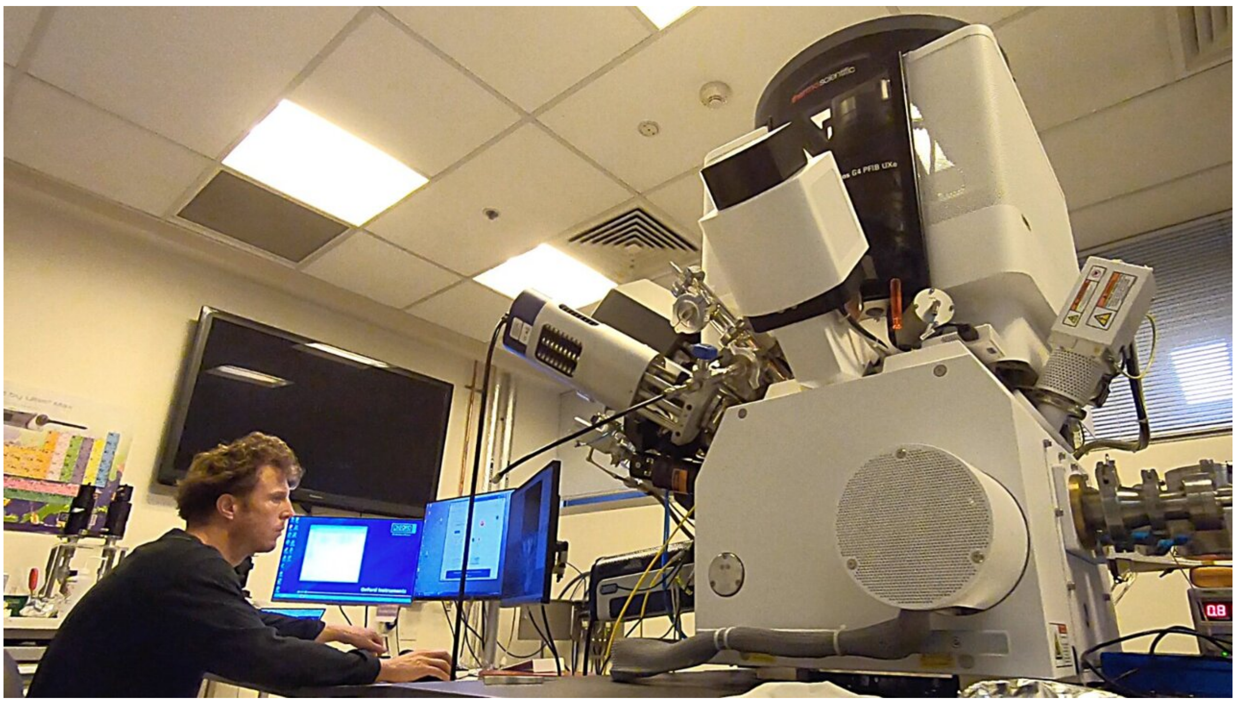

Dr. John Scott, University of Technology Sydney with the plasma FIB dual beam microscope. Credit: Milos Toth

In research published today in *Nano Letters*, physicists have delivered an unexpected boost for researchers with a new technique for 3D nanoscale elemental analysis for ion-electron microscope systems that allows the scientific community to take their work to the next level—particularly in the fields of energy storage and sustainability

Scientists from leading scientific instrumentation company Thermo Fisher Scientific worked with the ARC Centre of Excellence for Transformative Meta-Optical Systems (TMOS) to create a device that can be retrofitted to existing focused ion beam systems (FIBS). This device reimagines how the FIB is used—moving it beyond a tool for sputtering to an engine for elemental characterization, collecting and analyzing the photons emitted during the sputtering process.

This new method offers a number of improvements to other characterization methods. In particular, it offers a resolution of 15 nanometers, a significant improvement on the 1-micron resolution of electron-based EDX technique. Additionally, it can detect hard-to-characterize elements such as hydrogen and lithium.

Lead author and Senior Scientist at Thermo Fisher Scientific Garrett Budnik says, "the characterization of light elements has always been a challenge. This new device fills what was previously a gap in technology, paving the way for further scientific advancement.

"When that happens and researchers can investigate their problems with new techniques, new discoveries are made."

University of Technology Sydney (UTS) post-doctoral researcher and co-author John Scott says, "This research was geared toward enabling other researchers to solve problems in an efficient way. Integrating elemental analysis as part of the sputtering process optimizes the characterization workflow, creating a better experience for all involved. We've developed this new technique so others can develop new technologies in a range of fields."

Budnik is the third Thermo Fisher Scientific employee to engage with the university in an industry-relevant Ph.D., working on projects designed by Thermo Fisher Scientific based on their deep understanding of gaps in the commercial market and industry-leading technology development.

TMOS Chief Investigator Milos Toth, who worked at Thermo Fisher Scientific as a research scientist before joining UTS as a professor, says, "Shared research between industry and academia are successful because they result in commercially-driven research. On their own, academic researchers might invest their energy in research that has little market appeal. Industry might develop rigorously-tested technology without fully understanding the fundamental science behind it. Together, they can make a significant contribution to society."

Scott says, "This research was only possible because we had access to Thermo Fisher's engineers. Our FIB is probably the most heavily modified microscope anyway and that's because we could tap into the people who designed it, people who could help us tear it apart and put it back together."

Discussing the future of their research, Budnik says "We've pushed this detection system to its classical limit. It has been optimized to the point where the only place to go next is using metasurfaces. That's the natural next step."

More information: Garrett Budnik et al, Nanoscale 3D Tomography by In-Flight Fluorescence Spectroscopy of Atoms Sputtered by a Focused Ion Beam, *Nano Letters* (2022). DOI: 10.1021/acs.nanolett.2c03101

Provided by ARC Centre of Excellence for Transformative Meta-Optical Systems