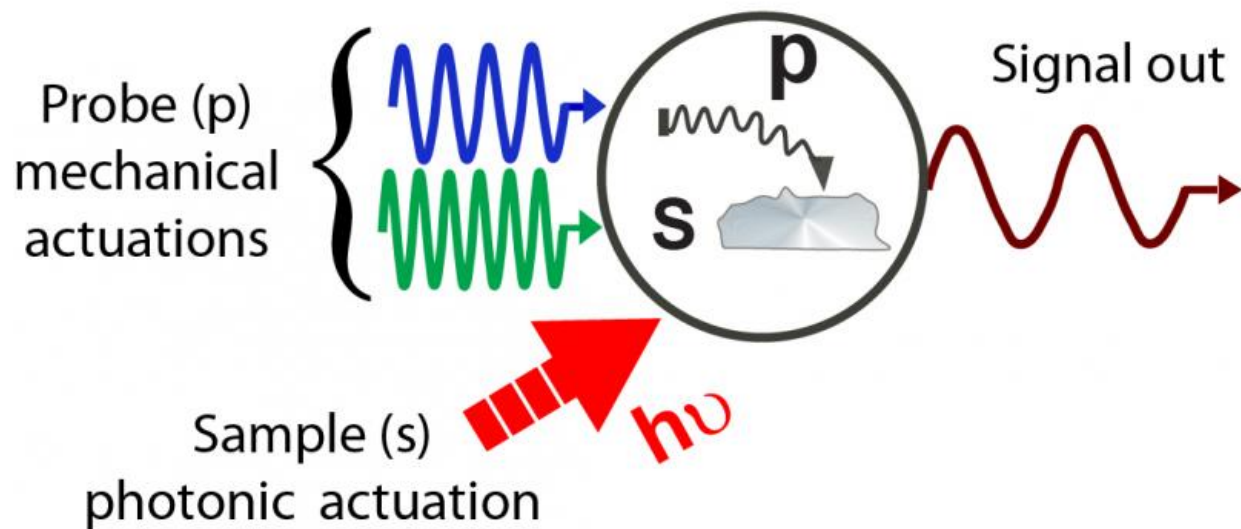


New hybrid microscope offers unparalleled capabilities

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A combination of carefully tuned mechanical and photonic excitations of the sample and probe allow for decoding of chemical and physical properties.

Credit: ORNL

A microscope being developed at the Department of Energy's Oak Ridge National Laboratory will allow scientists studying biological and synthetic materials to simultaneously observe chemical and physical properties on and beneath the surface.

The Hybrid Photonic Mode-Synthesizing Atomic Force Microscope is unique, according to principal investigator Ali Passian of ORNL's Quantum Information System group. As a hybrid, the instrument, described in a paper published in *Nature Nanotechnology*, combines the disciplines of nanospectroscopy and nanomechanical microscopy.

"Our microscope offers a noninvasive rapid method to explore materials simultaneously for their chemical and [physical properties](#)," Passian said. "It allows researchers to study the surface and subsurface of synthetic and biological samples, which is a capability that until now didn't exist."

ORNL's instrument retains all of the advantages of an [atomic force microscope](#) while simultaneously offering the potential for discoveries through its high resolution and subsurface spectroscopic capabilities.

"The originality of the instrument and technique lies in its ability to provide information about a material's chemical composition in the broad infrared spectrum of the chemical composition while showing the morphology of a material's interior and exterior with nanoscale - a billionth of a meter - resolution," Passian said.

Researchers will be able to study samples ranging from engineered nanoparticles and nanostructures to naturally occurring biological polymers, tissues and plant cells.

The first application as part of DOE's BioEnergy Science Center was in the examination of [plant cell](#) walls under several treatments to provide submicron characterization. The plant cell wall is a layered nanostructure of biopolymers such as cellulose. Scientists want to convert such biopolymers to free the useful sugars and release energy.

An earlier instrument, also invented at ORNL, provided imaging of poplar cell wall structures that yielded unprecedented topological

information, advancing fundamental research in sustainable biofuels.

Because of this new instrument's impressive capabilities, the researcher team envisions broad applications.

"An urgent need exists for new platforms that can tackle the challenges of subsurface and chemical characterization at the nanometer scale," said co-author Rubye Farahi. "Hybrid approaches such as ours bring together multiple capabilities, in this case, spectroscopy and high-resolution microscopy."

Looking inside, the hybrid microscope consists of a photonic module that is incorporated into a mode-synthesizing atomic force microscope. The modular aspect of the system makes it possible to accommodate various radiation sources such as tunable lasers and non-coherent monochromatic or polychromatic sources.

More information: Opto-nanomechanical spectroscopic material characterization, *Nature Nanotechnology* (2015) [DOI: 10.1038/nnano.2015.168](https://doi.org/10.1038/nnano.2015.168)

Provided by Oak Ridge National Laboratory

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