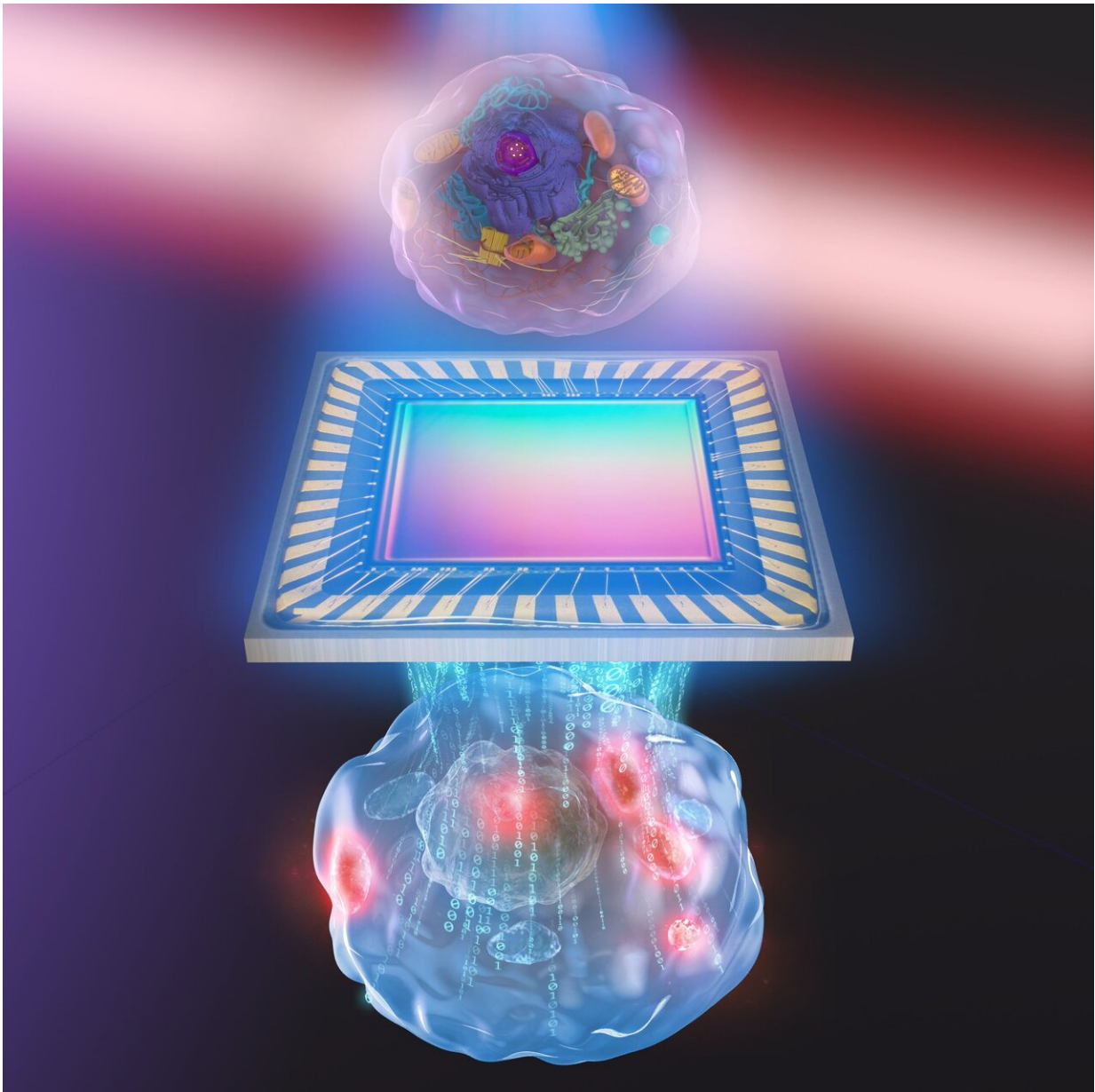


Unprecedented 3-D images of live cells plus details of molecules inside

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An artistic representation of the new imaging method called biochemical quantitative phase imaging with midinfrared photothermal effect, developed by a research team at the University of Tokyo. Credit: s-graphics.co.jp, CC BY-NC-ND

The insides of living cells can be seen in their natural state in greater detail than ever before using a new technique developed by researchers in Japan. This advance should help reveal the complex and fragile biological interactions of medical mysteries, like how stem cells develop or how to deliver drugs more effectively.

"Our system is based on a simple concept, which is one of its advantages," said Associate Professor Takuro Ideguchi from the University of Tokyo Research Institute for Photon Science and Technology. The results of Ideguchi's team were published recently in *Optica*, the Optical Society's research journal.

The new method also has the advantages of using [live cells](#) without damaging them via intense light, or artificially attaching fluorescent tags to specific molecules.

The technique combines two pre-existing microscopy tools and uses them simultaneously. The combination of these tools can be thought of simply as like a coloring book.

"We gather the black-and-white outline of the cell and we virtually color in the details about where different types of molecules are located," said Ideguchi.

Quantitative phase microscopy gathers information about the black-and-white outline of the cell using pulses of light and measuring the shift in

the light waves after they pass through a sample. This information is used to reconstruct a 3-D image of the major structures inside the cell.

Molecular vibrational imaging provides the virtual color using pulses of midinfrared light to add energy to specific types of molecules. That extra energy causes the molecules to vibrate, which heats up their local surroundings. Researchers can choose to raise the temperature of specific types of chemical bonds by using different wavelengths of midinfrared light.

Researchers take a quantitative phase microscopy image of the cell with the midinfrared light turned off and an image with it turned on. The difference between those two images then reveals both the outline of major structures inside the cell and the exact locations of the type of molecule that was targeted by the infrared light.

Researchers refer to their new combined imaging method as biochemical quantitative phase imaging with midinfrared photothermal effect.

"We were impressed when we first observed the molecular vibrational signature characteristic of proteins, and we were further excited when this protein-specific signal appeared in the same location as the nucleolus, an intracellular structure where high amounts of proteins would be expected," said Ideguchi.

Ideguchi's team hopes their technique might allow researchers to determine the distribution of fundamental types of [molecules](#) inside single [cells](#). The quantitative phase microscopy outline of major structures could be virtually colored in using different wavelengths of light to specifically target proteins, lipids (fats) or nucleic acids (DNA, RNA).

Currently, capturing one complete image can take 50 seconds or longer.

Researchers are confident that they can speed up the process with simple improvements to their tools, including a higher-powered [light](#) source and a more sensitive camera.

More information: Miu Tamamitsu et al. Label-free biochemical quantitative phase imaging with mid-infrared photothermal effect, *Optica* (2020). [DOI: 10.1364/OPTICA.390186](https://doi.org/10.1364/OPTICA.390186)

Provided by University of Tokyo

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