

Rice scientists make first nanoscale pH meter

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Using unique nanoparticles that convert laser light into useful information, Rice University scientists have created the world's first nano-sized pH meter.

The discovery, which appears online this week in the journal *Nano Letters*, presents biologists with the first potential means of measuring accurate pH changes over a wide pH range in real-time inside living tissue and cells.

"Almost every biologist I speak with comes up with one or two things they'd like to measure with this," said lead researcher Naomi Halas, the Stanley C. Moore Professor of Electrical and Computer Engineering, professor of chemistry and director of Rice's Laboratory for Nanophotonics (LANP).

For example, pH may be useful in determining whether or not some cancer tumors are malignant. With current methods, a piece of the tumor would need to be physically removed via biopsy - a painful and invasive procedure - and visually evaluated under a microscope. Halas said LANP's new nano-pH meter could be used instead as an "optical biopsy" to measure the pH inside the tumor with nothing more invasive than an injection.

Halas's LANP team created the pH sensor using nanoshells, optically tuned nanoparticles invented by Halas. Each nanoshell contains a tiny core of non-conducting silica that's covered by a thin shell of metal, usually gold. Many times smaller than living cells, nanoshells can be produced with great precision and the metal shells can be tuned to absorb or scatter specific wavelengths of light.

To form the pH sensor, Halas' team coated the nanoshells with pH-sensitive molecules called paramercaptobenzoic acid, or pMBA. When placed in solutions of varying acidity and illuminated, the nanoshell-molecule device provides small but easily detectable changes in the properties of the scattered light that, when "decoded," can be used

to determine the pH of the nanodevice's local environment to remarkably high accuracy. Inspired by techniques normally applied to image recognition, the team formulated an efficient statistical learning procedure to produce the device output, achieving an average accuracy of 0.1 pH units.

The term "pH" was coined by the Danish chemist Søren Sørensen in 1909 as a convenient way of expressing a solution's acidity. pH ranges from one - the most acidic - to 14 - the most alkaline.

Co-authors on the paper include postdoctoral researchers Sandra Bishnoi, now an assistant professor at the Illinois Institute of Technology, and Muhammed Gheith; graduate students Christopher Rozell and Carly Levin; Bruce Johnson, distinguished faculty fellow of chemistry and executive director of the Rice Quantum Institute; and Don Johnson, J.S. Abercrombie Professor of Electrical and Computer Engineering and Statistics.

Source: Rice University

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