UC San Diego NEWS RELEASE University Archives. RSS 6020

Affordable, hand-held biosensor for diagnostics and other chemical tests developed by San Diego scientists

October 30, 1997

The Scripps Research Institute and University of California, San Diego

EMBARGOED BY SCIENCE: 4 p.m. Eastern Time, Thursday, October 30, 1997 Media Contacts: Warren R. Froelich, UCSD, (619) 534-8564, wfroelic ucsd.edu

Robin Goldsmith, TSRI, (619) 784-8134, rgoldsmi@scripps.edu

AFFORDABLE, HAND-HELD BIOSENSOR FOR DIAGNOSTICS AND OTHER CHEMICAL TESTS DEVELOPED BY SAN DIEGO SCIENTISTS

A portable, hand-held biosensor capable of detecting a wide range of medically important chemical reactions has been created by a team of researchers from The Scripps Research Institute of La Jolla, Calif. and the University of California, San Diego.

The biosensor which changes colors to signal the presence of specific molecules may represent a new type of practical and affordable device for a variety of medical applications. Potential uses range from the screening of chemicals for drugs to diagnosing illness at the bedside without having to send samples to the lab.

The work, "A Porous Silicon-Based Optical Interferometric Biosensor," was published in today's issue of the journal Science.

According to M. Reza Ghadiri, Ph.D., associate professor of chemistry at TSRI, and study co-author, "It is exciting to be able to adapt such inexpensive and readily available material for use in this new technology. We are hopeful that we will see commercial applications within two to five years."

"One can envision something like a Star Trek medical `tricorder' that a nurse might bring to the bedside of a patient," said Michael Sailor, Ph.D., professor of chemistry and biochemistry at UCSD, and coauthor of a study.

For non-trekides, a medical tricorder is a hand-held device that performs all the duties of clinical laboratory, capable of sampling, analyzing, reporting and otherwise diagnosing a patient's ailments.

"In the original television show, Dr. McCoy would point the device at a patient and it would take a sample and read out all his problems," explained Sailor. "Our device was inspired by that image of a small, sensitive diagnostic unit that is very easy to use."

Also collaborating in the study were Victor S.-Y. Lin, Kianoush Moteshari, researchers with TSRI; and Keiki-Pua S. Dancil, a graduate student in Sailor's laboratory at UCSD.

As reported in the Science article, the new biosensor is able to detect many of the classic biological reactions that involve the recognition and binding of one molecule to another partner molecule. In their tests, for example, the biosensor was able to match tiny concentrations of specific DNA sequences to its complementary strand, suggesting a potential role for a variety of genetic studies and tests, including DNA fingerprinting for clinical and forensic applications. Another biosensor proved sensitive to the binding of certain antibodies, manufactured by the body's immune system, to small amounts of their specific antigensa class of molecules produced by invading organisms that include viruses, bacteria, in addition to toxins and allergens.

The biosensor was able to detect DNA concentrations at levels of down to 9 femtograms per square millimeter. (A femtogram is a millionth of a billionth of a gram). By comparison, current technologies are only capable of detecting amounts about 100 to 1,000 times larger than the new biosensor.

"We have found nothing as simple or practical as this device with as much sensitivity," said Ghadiri. "The results show that we can sense very small molecules that in other systems do not produce a very big change. In our system, we see a huge change."

The new biosensor is based on work conducted during the past few years in Sailor's laboratory with porous silicon, small chips of silicon sculpted through a chemical etching process into a forest of tiny trees. When a one centimeter-square of this silicon forest is stretched out, its surface area would be about as large as a standard desktop.

"Picture a sponge," said Sailor. "If you can go inside and see all the internal nooks and crannies, and if you spread them all out on a flat surface, it would be really large. Same with porous silicon. Except part of what's in there is this silicon, and the other part is air, just empty space."

Shining light on this surface creates an interference pattern, seen as a rainbow of colors. Just as colorless oil makes a multicolor sheen on wet pavement, so will a thin film of porous silicon emit different colors, depending on its thickness and index of refraction the optical characteristic that affects the speed with which light passes through a material.

Seeding the surface of the silicon film with other molecules, such as strands of DNA, also will change its index of refraction causing a shift in the interference pattern, resulting in the emission of different colors.

That, in essence, is what the San Diego researchers have done with their new biosensor.

According to the researchers, they don't actually change the film, but rather what's inside the film that changes how light is refracted or how it bounces off the surface and gives rise to a certain color.

The researchers attribute this extra sensitivity to the discovery of some "new physics" inside the porous silicon film. Though not fully understood, the scientists speculate that the binding of molecules to the surface significantly alters the refractive index of the silicon matrix itself, resulting in a major increase in sensitivity.

"It's as if the color of the film itself is changing because we induce this change in the silicon nanoparticles," said Sailor. "So that's the amazing thing. That was the Eureka thing."

Funding for the research was provided by the Office of Naval Research and the National Institutes of Health.

(October 30, 1997)