Porous Silicon Membrane Waveguide Biosensors for high sensitivity detection of low molecular weight biological or chemical targets

VANDERBILT UNIVERSITY
CTTC Center for Technology Transfer & Commercialization

Summary

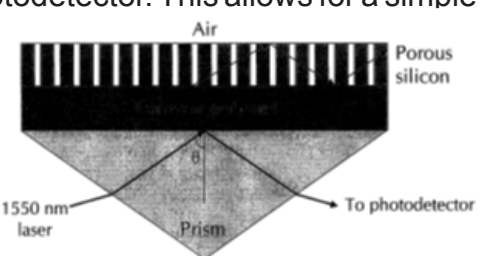
Vanderbilt researchers have developed a low-cost, high sensitivity sensor based on a porous silicon (PSi) membrane waveguide. This sensor is designed to be a cost-effective alternative to conventional fiber optic and SPR sensors for both biosensing and chemical sensing applications.

Challenges in Molecular Sensing

- Most current technologies rely on relatively weak interaction of evanescent fields with molecules on a flat surface.
- The limited surface area of these sensors, combined with their reliance on evanescent fields makes them unsuitable for high sensitivity detection of small molecules (low molecular weight), especially in situations of limited analyte availability.

Technology Description

In this sensor, receptors that can specifically bind with target molecules are fixed in the voids of a porous silicon membrane. Upon exposure to the target molecule, the target binds to the receptors in the silicon pores, thereby changing the refractive index of the silicon membrane. The change in refractive index of the membrane is detected and measured by a photodetector. This allows for a simple technique for the detection of low molecular weight species both qualitatively and quantitatively.



Dr. Weiss's group have demonstrated that the PSi waveguide sensor can selectively discriminate between complementary and non-complementary DNA. The advantages of the PSi waveguide biosensor include strong field confinement and a sharp resonance feature, which allow for high sensitivity measurements with a low detection limit.

Simulations indicate that the sensor has a detection limit of 50nM DNA concentration or equivalently, 5 pg/mm^2.

Unique Features and Competitive Advantages

- The porous silicon membrane used by this technology has a very large surface area, offers excellent field confinement and has demonstrated compatibility with current commercial sensor instrumentation.
- The design of the chip is conducive to low-cost fabrication.
- The chip can display lower detection limits for small molecules than current technologies.
- This technology has a wide range of potential markets including medicine, environmental monitoring, food safety and homeland security.

Intellectual Property and Development Status

- Issued US Patent 8506887 (Aug 2013)
- S. M. Weiss and G. Rong, "Porous silicon waveguides for small molecule detection in Nanoscience and Nanotechnology for Chemical and Biological Defense", edited by R. Nagarajan, W. Zukas, T. A. Hatton, and S. Lee (ACS Symposium Series Vol. 1016, Oxford University Press, 2010), Chpt. 14, pp. 185-194.
- Y. Jiao and S. M. Weiss, "Design parameters and sensitivity analysis of polymer-cladded porous silicon waveguides for small molecule detection," Biosens. Bioelectron. 25, 1535-1538 (2010).
- G. Rong, J. D. Ryckman, R. Mernaugh, and S. M. Weiss, "Label-free porous silicon membrane waveguide for DNA sensing," Appl. Phys. Lett. 93, 161109 (2008).
- Lab home Page with list of publications and ongoing research portfolio: http://eecs.vuse.vanderbilt.edu/research/vuphotonics/research.html

CTTC CONTACT:
Ashok Choudhury, Ph.D.
Phone: (615) 322-2503
ashok.choudhury@vanderbilt.edu

VANDERBILT LEAD INVENTOR:
Sharon Weiss Ph.D.
Associate Professor, Electrical Engineering
Vanderbilt University

VU REFERENCE: VU0908

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