Functionalized optical sensors comprising diffraction gratings on porous silicon structures

VANDERBILT UNIVERSITY
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Summary

In this technology diffraction-based sensors made from porous materials are used for the detection of small molecules. The porous nature of the diffraction gratings that gives rise to an extremely large active sensing area enables a very high level of sensitivity. Specificity is achieved by functionalizing the porous gratings with selective binding species.

Challenges in Optical Sensing

- Many current optical bio- and chemical sensing systems rely on expensive and bulky equipment for high resolution detection of refracted light
- The current techniques in diffraction-based sensing have limited sensitivity due to low available binding surface area on solid gratings

Technology Description

Diffraction-based sensors operate by shining light on a grating and measuring the intensity of light diffracted from the grating. The intensity of the light depends in part on the refractive index and height of the grating, both of which can be modified when chemical or biological molecules are attached to the grating. This particular technology uses porous silicon to fabricate the gratings, and receptors for the target molecule of interest are functionalized on the surfaces of the silicon pores. When target molecules bind inside the porous silicon gratings, the effective refractive index of the gratings change significantly, which leads to a measurable change in the intensity of light diffracted from the gratings.

Unique Features and Competitive Advantages

- Diffraction-based biosensors operate at a fixed wavelength and therefore eliminate the need for an expensive light source or optical detector
- The use of porous material greatly increases the surface area of the sensor for molecular binding, which in turn increases the sensitivity of the device
- The use of porous gratings leads to more than an order of magnitude increase in sensitivity compared to nonporous gratings
- This technology uses a low cost, porous silicon diffraction grating
- In addition, Vanderbilt also employs a low cost, reproducible, and high-throughput stamping process (DIPS™) as one possible route to make the diffraction gratings

Intellectual Property and Development Status

- Issued US Patent US8349617 (Jan 2013)
- Pending Canadian Patent application
- J. D. Ryckman, M. Liscidini, J. E. Sipe, and S. M. Weiss, "Diffraction based biosensing with porous silicon," in Conference on Lasers and Electro-Optics/International Quantum Electronics Conference, OSA Technical Digest (Optical Society of America, 2010), paper CTuB4
- J. D. Ryckman, M. Liscidini, J. E. Sipe, and S. M. Weiss, "Porous silicon structures for low-cost diffraction-based biosensing," Appl. Phys. Lett. 96, 171103 (2010).
- Lab home Page with list of publications and ongoing research portfolio: http://eecs.vuse.vanderbilt.edu/research/vuphotonics/research.html

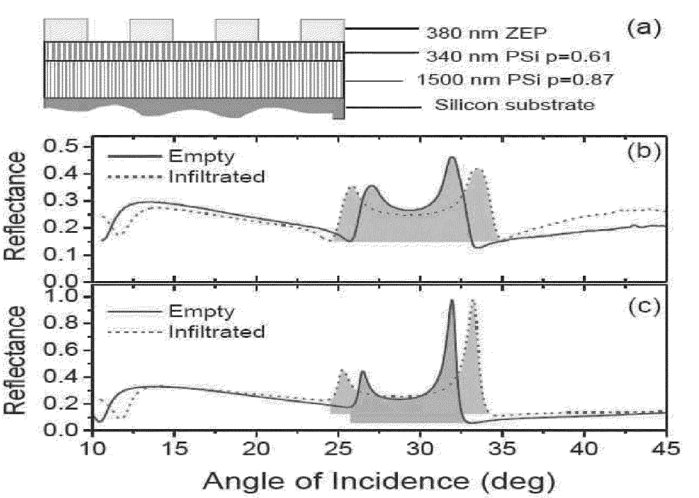

Figure shows (a) modified waveguide sensor of the invention and b) measured and c) calculated angle resolved reflectance shifts upon introducing 3-APTES.

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Link to Vanderbilt technologies available for licensing