Available online at www.scholarsresearchlibrary.com

Scholars Research Library
Archives of Physics Research, 2021, 13 (12)
(http://scholarsresearchlibrary.com)

ISSN: 2231-3176

Recent progress on optical fiber biosensors based on long period gratings

Agostino Iadicicco*
Department of Engineering, University of Naples, Italy
***Corresponding Author:** Agostino Iadicicco Department of Engineering, University of Naples, Italy, E-mail: agostino.iadicicco@uniparthenope.it*

ABSTRACT

Fiber optic label-free biosensors are currently experiencing wide diffusion, as they combine the performance of optical measurements with the advantages of optical fiber. This paper presents a comprehensive review about the design, development and testing of biosensor solutions based on in-fiber long period gratings (LPG). The attention is focused on optical transducers and methodologies allowing a significant enhancement of the sensitivity. Moreover, we report here about the development of a novel fiber optic biosensor based on unconventional LPG. The sensing platform is based on a long period grating (LPG) inscribed into a specialty double cladding fiber, whose sensitivity is enhanced through the mode transition phenomenon by chemical etching of the fiber outer cladding. The LPG is further covered with a nanosized layer of graphene oxide, providing carboxylic functional groups for the covalent immobilization of a vitamin D specific antibody. The testing was conducted using the major circulating form of vitamin D3, i.e., 25-OH- D3 (molecular weight ~400 Da), for which concentrations within 10-1000 ng/mL in buffer solution were measured.

Key words: Optical fiber, biosensor, applications

INTRODUCTION

Fiber optic label-free biosensors are currently experiencing wide diffusion, as they combine the performance of optical measurements with the advantages of optical fiber. This paper presents a comprehensive review about the design, development and testing of biosensor solutions based on in-fiber long period gratings (LPG). The attention is focused on optical transducers and methodologies allowing a significant enhancement of the sensitivity. Moreover, we report here about the development of a novel fiber optic biosensor based on unconventional LPG. The sensing platform is based on a long period grating (LPG) inscribed into a specialty double cladding fiber, whose sensitivity is enhanced through the mode transition phenomenon by chemical etching of the fiber outer cladding. The LPG is further covered with a nanosized layer of graphene oxide, providing carboxylic functional groups for the covalent immobilization of a vitamin D specific antibody. The testing was conducted using the major circulating form of vitamin D3, i.e., 25-OH- D3 (molecular weight ~400 Da), for which concentrations within 10-1000 ng/mL in buffer solution were measured. A limit of detection of medical interest lower than 10 ng/mL was attained. Biosensor advancement is driven by the consistent requirement for straightforward, quick, and persistent in-situ observing methods in a wide scope of regions, for example clinical, drug, natural, protection, bioprocessing, or food innovation. Biosensors utilize organic parts to detect a types of interest (which without anyone else need not be a "biospecies").

On the opposite side, synthetic sensors not utilizing an organic part yet positioned in a natural lattice are not biosensors by definition. Natural frameworks (like tissues, miniature organic entities, catalysts, antibodies, nucleic acids, and so on) when joined with a physico-substance transducer (optical, electrochemical, thermometric, piezoelectric) structure a biosensor. Then again, the improvement of optical-fiber sensors during late years is connected with two of the main logical advances: the laser and current minimal expense optical strands. As of late, optical strands have turned into a significant piece of sensor innovation. Their utilization as a test or as a detecting component is expanding in clinical, drug, modern and military applications. Fantastic light conveyance, long collaboration length, minimal expense and capacity not exclusively to energize the objective atoms yet in addition to catch the transmitted light from the objectives are the central matters for the utilization of optical strands in biosensors. Optical strands send light based on the standard of complete interior reflection (TIR). Fiber optic biosensors are insightful gadgets in which a fiber optic gadget fills in as a transduction component. The typical point is to create a sign that is relative to the grouping of a synthetic o biochemical to which the natural component responds. Fiber optic biosensors depend on the transmission of light along silica glass fiber, or plastic optical fiber to the site of investigation. Optical fiber biosensors can be utilized in blend with various sorts of spectroscopic method, for example assimilation, fluorescence, brightness, surface plasmon reverberation (SPR), and so forth. Optical biosensors in view of the utilization of fiber optics can be ordered into two distinct classifications: characteristic sensors, where collaboration with the analyte happens inside a component of the optical fiber; and extraneous sensors, in which the optical fiber is utilized to couple light, normally to and from the district where the light pillar is impacted by the measurand.

Biosensors are alluring in light of the fact that they can be effectively utilized by non-expert staff and they permit exact assurance with one or the other no or insignificant example treatment. In this way, fiber optic biosensors might be particularly valuable in routine tests, patient home consideration, medical procedure and serious consideration, as well as crisis circumstances. Optical fiber gratings (OFGs), particularly extensive stretch gratings (LPGs) and scratched or shifted fiber Bragg gratings (FBGs), are assuming an expanding part in the compound and biochemical detecting in light of the estimation of a surface refractive file (RI) change through a name free arrangement.

In these gadgets, the electric field transient wave at the fiber/encompassing medium connection point changes its optical properties (for example force and frequency) because of the RI variety because of the cooperation between a natural acknowledgment layer stored over the fiber and the analyte being scrutinized. The utilization of OFG-based innovation stages takes the upsides of optical fiber idiosyncrasies, which are barely presented by the other detecting frameworks, for example, smallness, delicacy, high similarity with optoelectronic gadgets (the two sources and identifiers), and multiplexing and distant estimation ability as the sign is frightfully adjusted. During the last ten years, the developing solicitation in reasonable applications pushed the innovation behind the OFG-based sensors over its cutoff points through the affidavit of slim film overlays, nanocoatings, and nanostructures, overall. Here, we survey endeavors toward using these nanomaterials as coatings for elite execution and low-location limit gadgets. In addition, we survey the new advancement in OFG-based biosensing and distinguish a portion of the critical difficulties for functional applications. While elite execution measurements are beginning to be accomplished tentatively, there are as yet open inquiries relating to a compelling and solid identification of little atoms, potentially up to single particle, detecting in vivo and multi-target recognition utilizing OFG-based innovation stages.

REFERENCES

[1]. Wolthuis R., McCrae D., Saaski E., et al. Development of a medical fiberoptic ph sensor based on optical absorption. *IEEE Transactions on Biomedical Engineering*. **1992**;39: p. 531–537.

[2]. Wolthuis R. A., McCrae D., Hartl J. C., et al. Development of a medical fiber-optic oxygen sensor based on optical absorption change. *IEEE Transactions on Biomedical Engineering*. **1992**;39: p. 185–193.

[3]. Li Y., Fan Y., Zhang L., et al. Molecular recognition of functionalized polydiacetylene and its biosensor. Proceedings of SPIE - *The International Society for Optical Engineering*; **2000**. p. 242–245.

[4]. Piletsky S. A., Panasyuk T. L., Piletskaya E. et al. Polyaniline-coated microtiter plates for use in longwave optical bioassays. Fresenius' *Journal of Analytical Chemistry*. **2000**;366: p. 807–810.

[5]. Llobera A., Wilke R., Buttgenbach S. Optimization of poly(dimethylsiloxane) hollow prisms for optical sensing. *Lab on a Chip - Miniaturisation for Chemistry and Biology*. **2005**;5: p. 506–511.

[6]. Esteban O., Gonzalez-Cano A., Diaz-Herrera N., et al. Absorption as a selective mechanism in surface plasmon resonance fiber optic sensors. *Optics Letters*. **2006**;31: p. 3089–3091.