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Photonic Slotted Structures for Biosensing

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ABSTRACT

Monitoring of chemical and biological species dispersed in biologic fluids is one of the most promising research topics in the field of photonics due to the large number of practical applications that can result from it, ranging from the environment monitoring to biomedicine. Slotted structures typically enhance the light-matter interaction and their use in the context of biosensing is receiving a growing interest. The talk, after a short overview of the photonic biosensing, critically reviews some selected last achievements in the research field of slotted structures for biosensing. The physics describing the behaviour of light within them is in many ways analogous to the behaviour of electrons in semiconductors. In both cases, it is the periodicity of the structure that is most important: a periodic structure can only support certain wavelengths. In the case of semiconductors it is a periodic arrangement of atoms, and hence electric potential, that results in the formation of allowed electronic bands. Similarly, for photonic crystals the periodic arrangement of dielectric material results in the formation of allowed photonic bands. In its simplest form, the one-dimensional case, the photonic crystal is recognizable as a Bragg mirror.

Key words: Slotted photonic crystal, biosensor, photonic crystal

INTRODUCTION

Monitoring of chemical and biological species dispersed in biologic fluids is one of the most promising research topics in the field of photonics due to the large number of practical applications that can result from it, ranging from the environment monitoring to biomedicine. Slotted structures typically enhance the light-matter interaction and their use in the context of biosensing is receiving a growing interest. The talk, after a short overview of the photonic biosensing, critically reviews some selected last achievements in the research field of slotted structures for biosensing. The physics describing the behaviour of light within them is in many ways analogous to the behaviour of electrons in semiconductors. In both cases, it is the periodicity of the structure that is most important: a periodic structure can only support certain wavelengths. In the case of semiconductors it is a periodic arrangement of atoms, and hence electric potential, that results in the formation of allowed electronic bands. Similarly, for photonic crystals the periodic arrangement of dielectric material results in the formation of allowed photonic bands. In its simplest form, the one-dimensional case, the photonic crystal is recognizable as a Bragg mirror. Small optical biosensors form a substantial part of the growing 'lab-on-a-chip' (LOC) paradigm. LOC epitomises the main goal of much biosensor research, that being the ability to shrink down many of the analytical capabilities of a biomedical research lab into a small disposable chip. In one scenario, we can imagine a small chip into which a single drop of blood is placed. This drop is then rapidly screened by a multitude of different sensor elements on the device for many different diseases or other important factors.

The full breakdown of the sample is then read-out to the user (for example, a doctor), who can react accordingly. If the device could be made cheap, simple to use and disposable, then it could be kept sterile and would be suitable for rapid, high throughput testing rather than labour intensive laboratory tests, which require much experience, time and training. In essence, the goal is to make devices for detecting biomedical material that are similar to the home pregnancy tests available today: cheap and simple to use, and providing a clear result that can be obtained and read by a non-specialist.

Optical sensors work by noticing changes in some property of light as it goes through the substance of interest. Numerous optical sensors depend on an otherworldly element, typically a sharp pinnacle or plunge, which is shaped by a reverberation (e.g., a cavity).

Touchy refractive file estimations can be made by following the pinnacle frequency of the reverberation. To make the sensor more explicit to an objective biomolecule, the surface is covered with antibodies by means of synthetically enacted useful gatherings. These surface covered antibodies go about as explicit catch specialists: protein restricting to these surface receptors prompts a reaction from the sensor. Whenever an example is flown across such a functionalized sensor, notwithstanding a mass refractive record change, there will likewise be a surface refractive list change because of the antigen-neutralizer restricting. For this situation, the reaction bend of the gadget is formed by the presence of target atoms inside the example. As they diffuse in arrangement, a portion of the objective atoms will be caught by the functionalized surface receptors, until some immersion level is reached. Higher groupings of target particles incite more honed dissemination bends, with higher levels. The grouping of restricting antigens can subsequently be assessed from the state of this bend.

Different antigens can't tie to a specific neutralizer as they miss the mark on right math, and in this way don't incite the surface refractive file change. This way the sensor reaction can be ascribed to one antigen type alone and isn't befuddled by the presence of various antigens in a solitary arrangement. Optical biosensors are recognized from straightforward optical refractive list sensors by this instrument, and it is the limiting elements and the thickness of surface bound material we measure rather than only a mass refractive list change. Whilst the unique optical properties of slotted photonic crystals are advantageous in many applications, this uniqueness also creates additional challenges, for example relating to the coupling of light into these structures. As seen earlier, the even modes of standard and slotted photonic crystals have very different dispersive properties; most notably, the gradient of the dispersion curve is of opposite sign. When these differing structures are coupled together, the group velocity mismatch (from the difference in sign) results in coupling into a backwards-propagating mode, resulting in strong reflection at the interface. In addition, there is also a mismatch between the shape of the slotted photonic crystal mode and that of the ridge waveguides used to deliver light to them. To take full advantage of the slotted architecture, a suitable coupler must be found.

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