Photonic crystal fibers platform for biosensing applications

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Abstract

Biophotonics represents a very attractive and promising field of interest for biosensing applications [1]. Hybrid optical fibers bearing specific probes for DNA detection are advanced tools in which the sensing element can be integrated in a microfluidic device for the generation of optical signals [2, 3]. In particular, Photonic Crystal Fibers (PCFs) have the unique feature of presenting a cross-section defined by air-hole arrays, allowing to perform internal functionalization [4, 5]. In this work, the feasibility of specific DNA sensing platform, based on the use of PCFs bearing a Bragg grating, is described, together with a strategy for the enhancement of the optical signal based on the use of gold nanoparticles (Au NPs). Very specific Peptide Nucleic Acid (PNA) probes, Oligonucleotide (ON) mimics that are well suited for specific DNA target sequences detection, have been used due to their highly favourable properties in DNA hybridization and chemical and biological stability.

Two different PNA-modified PCFs, where a Bragg grating (BG) was previously inscribed, were tested for optical DNA detection of targets of relevance in biomedical application and food-analysis. Measurements were performed monitoring the wavelength shift of the reflected bands, using an amplified stimulated emission (ASE) source as IR broadband light source and an optical spectrum analyzer (OSA) as receiver. The experiments were conducted by initially flowing the target solution through the fibers for 50 minutes, then the fibers were dried with a nitrogen flux. Subsequently, ON-AuNPs were infiltrated at the same conditions. Once data were collected, the fibers were dried again and finally washed with PBS.

Spectral measurements made in both fibers in reflection mode showed a clear wavelength shift of the resonant peaks for two different DNA targets (cystic fibrosis gene mutation, Fig. 1a, and genomic DNA from soy flour, Fig. 1b). Several experiments have been carried out using identical DNA concentrations and the same modulations have been observed, proving the reproducibility of the results. Measurements have also been made using mismatched DNA solution, containing a single nucleotide polymorphism, demonstrating the high selectivity of the sensors. A comparison between the results of the two MOFs will be presented, demonstrating the feasibility of using such an approach in biosensing.

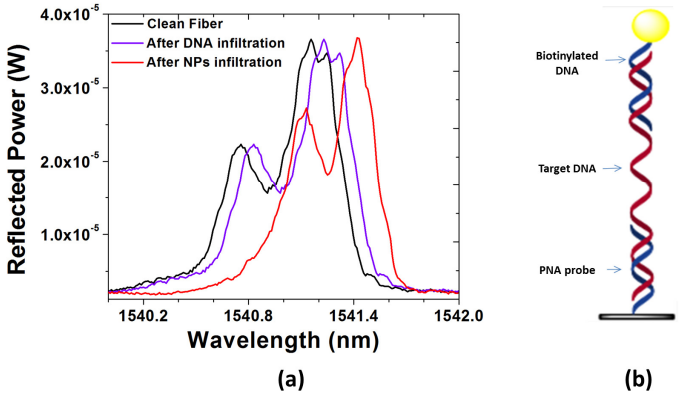

Fig. 1 a) Wavelength shift of the high order reflection mode obtained for the "grapefruit" geometry PCF after cystic fibrosis DNA sequence and ON-AuNPs infiltrations in the full-match DNA target experiment. b) Scheme of the final linkage of the peptide nucleic acid (PNA) probe to the fiber internal surface.

References

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