DNA Sensing with Hollow Core Fibers

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We report first results about the use of Hollow-Core Inhibited-Coupling Fibers as DNA sensors. Experimental results show these kind of fibers can be infiltrated with solutions containing the DNA generating a bio-layer on silica-air surfaces.
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1. Introduction

Photonic Crystal Fibers (PCFs) provide a flexible platform for the development of sensitive and cheap sensors for the detection of protein and DNA sequences [1]. All the inner surfaces of PCFs can be exploited as deposition surface for biological substances forming layers of biologic material on the air-dielectric interface which change the fiber properties. In particular, Hollow Core Inhibited Coupling PCFs HC-IC-PCFs can be exploited to design label free sensor, thanks to the peculiarities of their waveguiding mechanism [2]. In fact, the HC-IC-PCF transmission spectra are featured by an alternation of high and low transmissivity and the wavelengths where low transmissivity regions fall depend on thickness of the dielectric [3]. So by properly activating the dielectric-air interfaces, and by flowing a solution containing the biological target to be detected throughout the fiber, an additional dielectric layer is generated making the dielectric thicker and causing a red shift in the fiber transmission spectrum [2]. The feasibility of this approach has already been experimentally demonstrated by detecting streptavidin protein [4]. The same fiber processing can be applied for DNA detection. In this work we report on the first experimental results about the fiber activation procedure for DNA detection.

2. Sensor activation and experimental results

In order to allow the target to generate a bio-layer, before the sensing the fiber must be functionalized [1,4]. For DNA detection this step consists of depositing on the surface of the silica a layer of Peptide Nucleic Acids – PNA. PNA is the DNA analogue with polyamide backbone. It is particularly suited for their high affinity and selectivity for complementary DNA/RNA, and for their resistance to chemical and enzymatic degradation [5]. Since, the binding factor of PNA-DNA is much lower than the biotin-streptavidin one used in previous experiments [4], first of all tests about PNA-DNA binding inside a HC-IC-PCF have been performed. For the experiment, PNA complementary to a DNA sequence of the transgenic soybean has been laid on the HC-IC-PCFs shown in Figure 1. It consists on a Tube Lattice fiber – TLF where the cladding is composed by eight tubes with thickness of 600nm and external tube diameter of 13.6um. The inner core diameter is 39um. Then a solution containing DNA labelled with fluorophores has been flowed through the fiber. Figure 2 shows the fluorescence of three HC-IC-PCF samples. The top one has been infiltrated with mismatched PNA and DNA. The middle and the bottom ones have been infiltrated with two different concentrations of PNA, 1uM and 30uM, but the same concentration of the right DNA sequence. It is discernible the difference between the 30uM PNA sample and the 1uM one. So the feasibility of a sensor for DNA detection have been demonstrated and the fiber processing procedure is confirmed to work also for PNA-DNA systems. Future measurements will be performed to verify the presence of a red shift in the transmission spectrum with PNA-DNA systems.

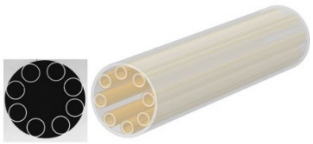

Figure 1: HC-IC-PCF used in the experiment

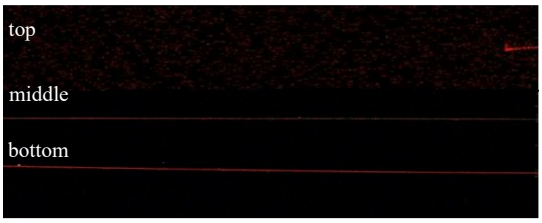

Figure 2: Three pieces of fiber infiltrated with fluorescent DNA. top: mismatched DNA and 30uM of PNA; middle: right DNA and 1uM of PNA; bottom: right DNA and 30uM of PNA.

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