A NOVEL MAGNETIC FIELD SENSOR BASED ON FERROFLUIDS AND SPR-POF SENSORS

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A novel magnetic field sensor is obtained by a POF covered with ferrofluids connected in input to an SPR-POF-sensor. The magnetic field changes the light in input to the SPR-POF-sensor and modifying the SPR phenomenon.
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1. Introduction

Surface Plasmon Resonance (SPR) optical fiber sensors coupled with the magnetic fluids (specifically ferrofluids) as sensing element for magnetic field detection, recently have emerged. An extensive literature on fiber optic magnetic field sensors, such as those based on magnetic fluids combined with optical fiber grating, interferometry, Surface Plasmon Resonance (SPR), and other solutions involving tailored fibers (etched, tapered and U-shaped), is available [1]. In such solutions SPR optical fiber sensors are used to monitor the refractive index of the magnetic fluid which changes with the target magnetic field [2-4].

In this work, a novel methodology for the measurement of a static magnetic field, exploiting the optical characteristic of a multimode Plastic Optical Fiber (POF) SPR sensor and the magnetic fluid, is presented for the first time. The concept, the basic prototype and the preliminary experimental results demonstrating the viability of the proposed approach, are here described.

2. Sensor System and Experimental results

The sensor prototype is shown in Fig. 1. It consists of an SPR D-shaped POF sensor platform [5], a patch of POF covered by ferrofluid, a white light source, and a spectrometer. A white light source (HL–2000–LL, Ocean Optics) with a spectral emission of the lamp in the range from 360 nm to 1700 nm, has been connected to an SPR D-shaped POF sensor by a patch of POF covered with ferrofluid. A spectrometer FLAME-S-VIS-NIR-ES (Ocean Optics), directly connected to a computer, has been adopted for the monitoring of the SPR sensor's output. Measurements were performed in the range from 350 nm to 1000 nm. The patch of POF is based on a PMMA core of about 480 μm and a fluorinated polymer cladding of 10 μm (total diameter of 500 μm), covered by ferrofluid for about 2 cm in length. In order to trigger the SPR phenomenon a water-glycerin solution has been adopted. An Abbe refractometer was used to prepare and characterize this solution. The refractive index of the used solution is equal to 1.353. Fig. 2 shows how the resonance wavelength shifts when the magnetic field changes, by changing the position of a magnet with respect to the patch of POF with ferrofluid, for a fixed refractive index of the solution on the SPR platform (n=1.353). These Preliminary results have demonstrated the viability of this approach, showing the possibility to obtain higher sensitivities, compared with the state of the art on SPR optical fiber magnetic field sensors exploiting magnetic fluids [1]. The obtained preliminary results will be used to explore this approach for developing a novel kind of highly sensitive magnetic field sensor based on SPR-POF platforms.

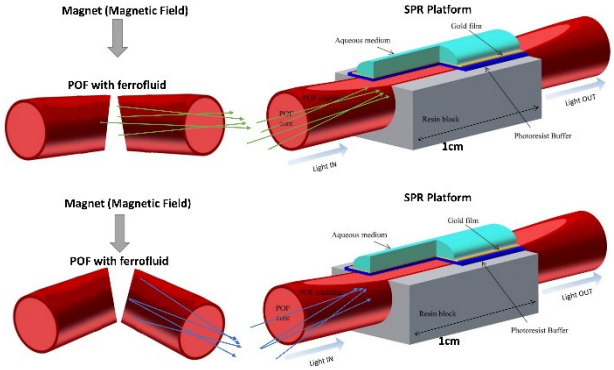

Fig. 1 Outline of the magnetic field sensor based on SPR-POF platform.

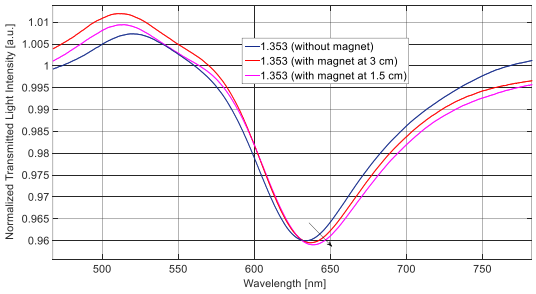

Fig. 2 SPR spectra experimentally obtained by the SPR-POF sensor, in case of a fixed solution (n=1.353), for different magnetic field values (0mT, 0.2mT, and 1mT), obtained by a permanent magnet at three different distances with respect to the POF with ferrofluid.

References

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