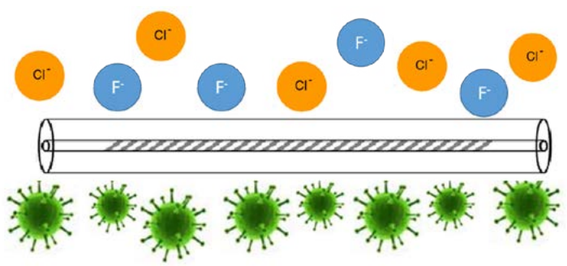
ANION

Optical Sensors and Nanomaterials for Anion Recognition

The abrupt development of several industrial sectors has led to an increase of pollution levels and other different hazards for the environment and humans. The project aims to develop new technologies based on magnetic nanoparticles supported on chemical species for water treatment and the production of optical fiber based sensors for anionic detection.



PROJECT WEBPAGE URL
https://www.it.pt/Projects/Index/1365

Main Project Team

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Funding Agencies

FCT-PTDC	**68,700€**
Start Date	15/04/2010
Ending Date	14/04/2013

Indicators

Journal Papers	1
Conference Papers	2
Concluded MSc	0

Two Main Publications

E. Malheiro, L. Melo, R. P. Pinto, J. Rodrigues, A. F. Farinha, N. Alberto, L. Bilro, T. Trindade, J. P. Tomé, R. Nogueira, **Silica-coated tilted fiber Bragg grating for anion recognition, European Optical Society Topical Meeting: Organic Photonics,** Annual Meeting da European Optical Society, Aberdeen, United Kingdom, September, 2012

L. Melo, J. Rodrigues, A. Farinha, C. Marques, L. Bilro, N. Alberto, J. Tomé, R. Nogueira, **Refractive index sensor based on standard deviation analyses of a tilted fiber Bragg grating spectrum for anions monitoring, submitted to Measurement Science and Technology** (03 May 2013)

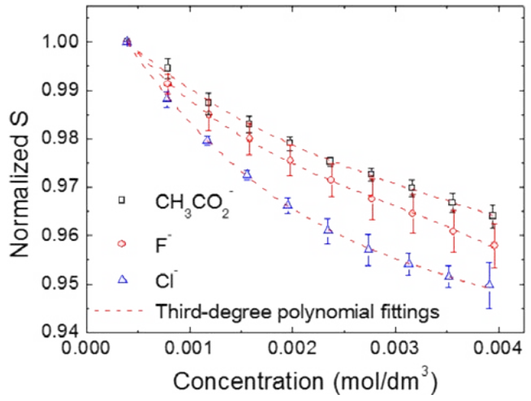

Fig. 1 Variation of the normalized standard deviation with the change of anion concentration.

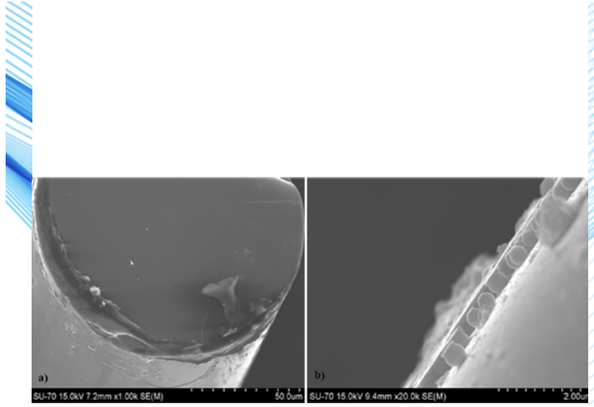

Fig. 2 SEM images of (a) transversal and (b) longitudinal cut of silica-coated TFBG.

GENERAL MOTIVATION AND OBJECTIVES

The rapid increase in world population implies a remarkable raise on food and energy production. Nevertheless, these human activities are responsible for major pollution hazards. Anthropogenic anions, such as phosphate and nitrate (fertilizers), and pertechnetate (radioactive waste), are responsible for eutrophication of watercourses and for major drawbacks in nuclear energy production, respectively. At the same time, in the diagnosing diseases such as osteoporosis, Alzheimer, and cystic fibrosis a minimum change of the anion flux across cell membranes can be an indicator of these diseases.

The objective of ANION is the design and synthesis of novel anion host families, in order to obtain compounds with higher specificity for anion species. Based on the interest in the development of an efficient technology for water treatment it was considered the possibility of supporting the most promising anion receptors on magnetic nanoparticles, allowing their recovery using external magnetic forces. Another goal is the development of a refractive index sensor based on a tilted fiber Bragg grating (TFBG) for anionic specific recognize.

CHALLENGE

Under this project, the IT team was responsible for developing an TFBG based sensor to detect the presence of anions through the refractive index variations that occurs due to the host/guest interaction. Collaboration with Prof. Tito Trindade is focused in the preparation of gold nanoparticles deposited on the fiber surface and QOPNA/ UA is responsible for the synthesis of the anion receptors and the immobilization of the anionic sensors. The team expertise work synergistically to efficiently translate fundamental chemical principles into sensor applications.

WORK DESCRIPTION

The immobilization of the most promising anionic sensors directly on the optic fiber or via gold nanoparticle deposited on the fiber surface was carried out. The final step consisted in a covalent coupling of the organic host. A variety of methodologies were employed to successfully prepare the novel sensors. Once a selective sensor was synthesized, the different anion affinities were determined based on refractive index variations. The TFBG was calibrated in order to convert the different optical signal collected into refractive index values.

ACHIEVEMENTS

A practical and accurate method to measure the surrounding refractive index with a TFBG sensor was developed. This method is based on calculation of the standard deviation between the cladding modes of the transmission spectrum and its smoothing function. Results show that the sensor is able to measure refractive indices from 1.341 to 1.462 with high accuracy. Additionally, the method is used to detect different anion concentrations in ethyl acetate, namely acetate, fluoride and chloride (Fig. 1). Distinct sensitivities were achieved in the presence of the anions at lower concentrations. The results showed a resolution of 1.92×10-4 mol/dm3 by detecting those anions within concentrations from 3.9×10-4 to 3.9×10-3mol/dm3.

Additionally, a silica nanofilm based coating was successfully in-situ deposited in a TFBG (Fig. 2). The spectral characteristics of the coated TFBG were investigated under several chloride concentrations and the results showed that the silica based coating increase the TFBG chloride sensitivity.