Accepted Manuscript

Distributed fluorescent optical fiber proximity sensor: Towards a proof of concept

Ramona Gălăţuş, Paul Faragó, Piotr Miluski, Juan Antonio Valles Brau

PII:	S1386-1425(18)30161-6
DOI:	doi:10.1016/j.saa.2018.02.044
Reference:	SAA 15848
To appear in:	*Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*
Received date:	30 November 2017
Revised date:	3 February 2018
Accepted date:	12 February 2018

Please cite this article as: Ramona Gălăţuş, Paul Faragó, Piotr Miluski, Juan Antonio Valles Brau , Distributed fluorescent optical fiber proximity sensor: Towards a proof of concept. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Saa(2017), doi:10.1016/j.saa.2018.02.044

Distributed fluorescent optical fiber proximity sensor

Towards a proof of concept

Ramona Gălățuș[1], Paul Faragó[1], Piotr Miluski[2], Juan Antonio Valles Brau[3]

1. Technical University of Cluj-Napoca, str. Memorandumului nr. 28, Romania
2. Bialystok University of Technology, Wiejska 45D, 15-351 Bialystok, Poland
3. University of Zaragoza, Spain

Abstract: Fluorescent fibers are optical fibers which emit light as a response to an incident phenomenon, usually an incident light. Operation depends on the doping dyes, which determine specific fluorescence and optical characteristics useful in the development of optical sensors. In this work we propose a low-cost distributed proximity sensor implemented using a red fluorescent fiber, to provide a security option for a surface plasmon resonance system. Operation of the proposed sensor relies on having the incident illumination intensity varied by the presence or absence of an obstacle in the vicinity of the sensing element. This will influence the radiated fluorescence accordingly. The proposed setup for the implementation of the optical proximity sensor assumes having a high brightness LED deployed for axial fiber illumination and a blue LED for side illumination. Electronic processing then accounts for gain and digitization. Measurement results of the prototype validate the proposed concept.

Keywords: optical fibers, fluorescence, proximity distributed sensing.

* Ramona Gălățuș, E-mail: Ramona.Galatus@bel.utcluj.ro

1. Introduction

A fluorescent optical fiber is an optical fiber which emits light as a response to an incident phenomenon, e.g. fiber sensitive to molecular oxygen reported by a group of AT&T Bell Lab in 1989, high energy particles, UV or visible light, etc. [1, 2, 3]. The molecules of the organic dyes can be effectively excited due to their wide absorption band. The fluorescence intensity and lifetime in polymeric host strongly depend on the environmental conditions e.g. local molecular bindings, acidity, temperature and non-radiative excited state deactivation in the presence of quenchers. Numerous sensor have been developed based on fluorescence intensity modulation. Moreover, guiding properties of optical fiber can be used for transferred light modulation e.g. intensity and spectrum shape. This paper considers fluorescent fibers which emit light as a response to side illumination in the visible spectrum. One of the main benefits of fluorescent optical fibers is the increased flexibility of side illumination vs. traditional axial illumination [4]. Whereas axial illumination requires complicated and expensive coupling optics for confining the light radiation into the fiber core, side illumination is simply performed by illuminating the fiber cladding from an LED. Moreover, the advent of doping materials sensitive to light in the visible spectrum allowed for the employment of color LEDs in comparison to more expensive UV excitation sources as was the case in the past. These advantages motivate the employment of fluorescent optical fibers in the development of optical sensors.

Fluorescent fibers are a very attractive medium for the development of optical sensors. Indeed, sensitivity towards an incident phenomenon makes the fluorescent fiber readily a sensing element. One conclusive example is a position sensor proposed by M. F. Laguesse in [5], where side illumination is employed to induce fluorescence into the fiber, and the position of the illumination point is determined by measuring the illumination power at the two fiber ends. The author compares the proposed solution to an optical potentiometer. A similar approach was employed by J. D. Weiss in [6] for the implementation of a long-distance position sensor aimed for industrial applications. The optical potentiometer principle was also applied by Aiestaran et al. in [7] for the implementation of position sensors, after comparing different fiber colors to evaluate their applicability to position sensing.

Another application of fluorescent fibers is the nuclear particle detector proposed by A. D. Bross in [8]. In this application, scintillation radiation is produced within the fluorescent fiber as a result of exposure to nuclear particles. Other examples of fluorescent fiber optical sensors for particle detection account for molecular oxygen in [9], detection of UV radiation in [10], X-ray beam detection in [11], chloride ion detection in [12] or chemical species