11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Reflection-based Au surface plasmon resonance fiber optic sensor

Paula M. P. Gouvêa(1)*, Michael Fokine(2),
Isabel C. S. Carvalho(3), Marco Cremona(3) and Arthur M. B. Braga(1)

(1) Engenharia Mecânica, Pontifícia Universidade Católica do Rio de Janeiro, pgouvea@puc-rio.br
(2) Applied Physics, Royal Institute of Technology, Stockholm, Sweden, mf@laserphysics.kth.se
(3) Física, Pontifícia Universidade Católica do Rio de Janeiro, isabel.carvalho@puc-rio.br
* Corresponding author.

Abstract – Localized Surface Plasmon Resonance (LSPR) occurs when metal nanoparticles surrounded by dielectric material interact with light of wavelength in the plasmon absorption band, resulting in a strong extinction of the incident light. A reflection-based, all-fiber novel gold LSPR optical fiber sensor has been developed and built with standard multimode fiber. The device has been characterized in ambient air and in solutions with n = 1.33, n = 1.46 and n = 1.8, as well as compared to measurements made with a transmission configuration.

Localized Surface Plasmon Resonance (LSPR) occurs when metal nanoparticles surrounded by dielectric material interact with light of wavelength in the plasmon absorption band, resulting in a strong extinction of the incident light [1]. Changes in the refractive index of the surrounding medium lead to shifts in the plasmon band, allowing LSPR sensors to be used in sensing of specific liquids or gases, temperature or humidity, or in biosensing applications [2]. A few LSPR-based optical fiber sensors have been demonstrated [3].

A novel gold LSPR optical fiber sensor with several advantages over previous sensors has been developed and characterized. It is reflection-based and all-fiber, i.e. with no free space optics involved, providing versatility, portability, robustness, ease of handling, and the possibility for distributed and multiplexed sensor network architectures. The sensor is made with standard multimode fiber, therefore can be used with readily available standard multimode components and equipment, reducing its overall price.

The setup used is shown in Figure 1, where light from a white light source is coupled into Fiber 1 and propagates through the coupler into Fiber 2. Light is then reflected at the endface of Fiber 2 back into the coupler and into Fiber 3. The reflected signal is measured by the OSA at the output of Fiber 3.

The reflected spectrum was acquired with and without Au nanoparticles on top of the endface of Fiber 2 for different refractive indices surrounding the nanoparticles. The reflected signal shows strong dispersion near the LSPR, around 520nm, when measured in ambient air, n = 1.00 (black curve), and with n = 1.33 (blue curve), n = 1.46 (green curve) and n = 1.80 (red curve), respectively. The dispersion of the reflected signal changes significantly with a change in the refractive index of the surrounding media. For longer wavelengths (> 900nm), the intensity of the reflected signal tends to the same value as the normal Fresnel reflection without nanoparticles. Further results comparing these reflection measurements with transmission measurements will be presented, as well as a discussion on the origin of the LSPR-induced dispersion using the reflection configuration and the potential use as miniature fiber optic sensors.

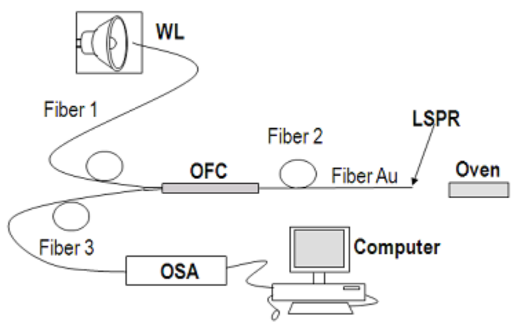

Figure 1: Experimental setup, where WL is the white light source, OFC is the optical fiber coupler and OSA is the optical spectrum analyzer.

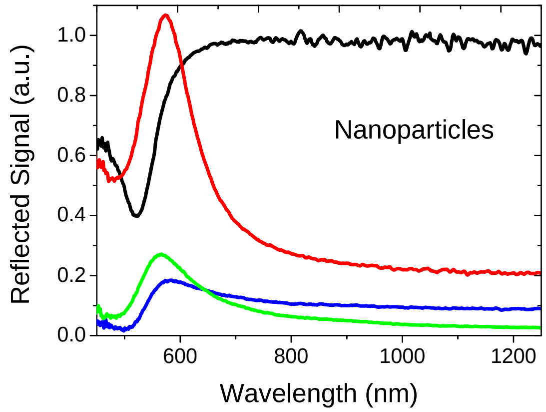

Figure 2: Reflected spectrum with Au nanoparticles for n=1.0 (black), n=1.33(blue), n=1.46 (green) and n=1.8 (red).

References

[1] G. Mie. Annalen Der Physik, 25 (1908) page 377 - page 445.
[2] Amanda J. Haes and Richard Van Duyne. Anal Bioanal Chem 379, 7-8 (2004) page 920 -page 930.
[3] F. Meriaudeau, A. Wig, A. Passian , J. P. Lauret and T. L. Ferrell. Opt. Eng. 40, 5 (2001) page 658 - page 660.