Functionalization of a long period grating coated with gold nanoparticles for glyphosate detection

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ABSTRACT

This work describes a method for producing a nanostructured fiber optic device for sensing of pesticides in water environment. The device consists of a long period grating with a coating of gold nanoparticles functionalized with cysteamine. The LPG shows attenuation bands near the phase matching turning point at the visible spectral range. A bottom-up production route was used to deposit gold nanoparticles on the fiber surface. Sensitivity to the refractive index of the external medium was measured before and after the layer deposition. Cysteamine was used as a ligand for glyphosate present in water at a concentration of 100 μM.

Keywords: Plasmonic sensor, long period grating, gold nanoparticles, selective sensor

INTRODUCTION

Among all the interesting properties of gold nanoparticles is their intense absorbance at the visible spectral range. This absorption is related to the plasmon resonance band generated by the collective oscillation of the conduction electrons at the nanoparticle surface induced by the interaction with the electromagnetic field of the incident light. The size, shape and distance between the nanoparticles influences the spectral characteristics of the resonance band[1]. Additionally, the resonance is also dependent on the medium surrounding the nanoparticles. This unique optical property of metallic nanoparticles has been explored for chemical and biological sensing applications[2]. Sensitivity of the plasmon resonance band to the refractive index of the surrounding environment allows the use of metallic nanoparticles in many different configurations of optical sensing. The versatility of the nanoparticles led to the development of new optical devices combining nanoparticles and optical fibers. In these sensors the optical fiber is used to excite the plasmon resonance band of the nanoparticles providing sensors with improved sensitivity and dynamical range[3,4].

Nevertheless, for many applications the sensor element must be designed not only to provide high sensitivity but also selectivity. In these cases, nanoparticles must be previously functionalized to efficiently react with a specific analyte. For this purpose, gold nanoparticles are advantageous when compared with other nanoscale materials, as they are more chemically stable and can be functionalized in different ways according to the application. Additionally, gold nanoparticles can be easily assembled on the surface of optical fibers providing uniform and resistant nanoscale films. Recently was proposed the use of a colloidal dispersion of gold nanoparticles functionalized with cysteamine for the detection of glyphosate in water[5]. Electrostatic interaction between cysteamine and glyphosate provides a spectral shift of the plasmon resonance band that can be measured by UV-VIS spectroscopy. However, despite the high sensitivity, the limit of detection is impaired by the large bandwidth of the resonance band.

This work shows preliminary results obtained with a long period grating (LPG) coated with gold nanoparticles which were functionalized with cysteamine. The LPG sensitivity to the surroundings refractive index was measured before and after the fiber functionalization with gold nanoparticles plus cysteamine. The ability of the device in detecting glyphosate was tested with a water sample deliberately contaminated with 100 μM of glyphosate.

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