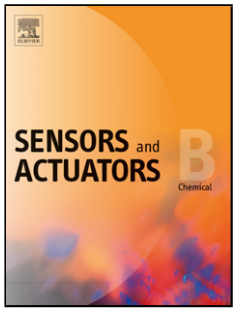

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Graphene oxide functionalized long period fiber grating for highly sensitive hemoglobin detection

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Research Highlights:

- Label-free biosensor based on graphene oxide (GO)-long period grating (LPG)
- GO-LPG configuration for strong light-matter interaction
- A new deposition technique for the cylindrical substrate
- Ultrahigh sensitivity with detectable concentration of 0.05 mg/mL, far below hemoglobin threshold value for anemia defined by WHO

ABSTRACT

We present graphene oxide (GO) nanosheets functionalized long period grating (LPG) for ultrasensitive hemoglobin sensing. The sensing mechanism relies on the measurement of LPG resonant intensity change induced by the adsorption of hemoglobin molecules onto GO, where GO as a bio-interface linkage provides the significant light-matter interaction between evanescent field and target molecules. The deposition technique based on chemical-bonding associated with physical-adsorption was developed to immobilize GO nanosheets on cylindrical fiber device. The surface morphology was characterized by scanning electron microscope, atomic force microscopy, and Raman spectroscopy. With relatively thicker GO coating, the refractive index (RI) sensitivity of GO-LPG was extremely enhanced and achieved -76.5 dB/RIU, -234.2 dB/RIU and +1580.5 dB/RIU for RI region of 1.33-1.38, 1.40-1.44 and 1.45-1.46, respectively. The GO-LPG was subsequently implemented as an optical biosensor to detect human hemoglobin giving a sensitivity of 1.9 dB/(mg/mL) and a detectable concentration of 0.05 mg/mL, which was far below the hemoglobin threshold value for anemia defined by World Health Organization. The proposed GO-LPG architecture can be further developed as an optical biosensing platform for anemia diagnostics and biomedical applications.

Keywords: Anemia; Biosensor; Graphene oxide; Hemoglobin; Long period grating; Optical sensor.

1. Introduction

For decades, a variety of efforts have been made to develop accurate and low expense chemosensors and biosensors for the applications in food safety, environmental monitoring, clinical analysis, and healthcare sectors. Anemia is a common concern in geriatric health with estimated prevalence increasing with advancing age [1,2]. Anemia is typically defined using the World Health Organization (WHO) criteria of hemoglobin levels lower than 130 mg/mL for men and 120 mg/mL for women [3]. Anemia has serious consequences for some clinical and functional outcomes in the elder population. Abnormal blood hemoglobin concentrations always relate to other diseases, such as thalassemia, stroke and diabetes [4,5]. It has been reported that an almost 2-fold increase in the occurrence