Experimental results from dielectric-metal grating coupled surface plasmon resonance device for novel low-cost biosensor

Introduction

- An optical prototype was fabricated to perform measurements of surface plasmon polaritons in light beams diffraacted at angles of less than 90°.
- Experiments were developed to identify the excitation resonant angle of surface plasmon polaritons by a diffraction grating with a pitch greater than the wavelength of the light signal.
- In the laboratory tests, measurements of the intensity curve of the diffacted light signal were carried out in the +1 and -1 orders. The experimental results were consistent with the theoretical approach.
- Based on this method, it is proposed a device for a low cost biosensor, using nanomaterial that can be functionalized with bio-material.

Theory

Wave vector of an Evanescent Electric Field (k_{spp}) for a Diffraction Grating.

\[ k_{spp} = n_a k_o \sin \theta_i + n k_g \]  

Wave vector of a Plasmon Polariton (k_x) for a Plane Wave in a Gold Flat Surface.

From the boundary conditions and using Maxwell equations:

\[ k_x = \frac{w}{c} \sqrt{\frac{\varepsilon_1 \varepsilon_2}{\varepsilon_1 + \varepsilon_2}} \]  

Prototype results

- A gold diffraction grating with a period of \( A > \lambda \) is illuminated by a laser beam (l. \( \lambda < 650 \text{nm} \)) at an angle of incidence \( \theta_i \), the incident medium is air (no analyte).
- \( \lambda \) is the fundamental design parameter needed to measure the diffraction orders (m) outside the boundary of the grating.
- Fig. 5(b) shows experimental results of the normalized intensity measured in the order \( m=1 \) (\( m=1 \)) when the incident angle \( \theta_i \) is swept from 10 to 22 degrees (red line).
- Using rigorous Coupled Wave Analysis Method, we calculate the normalized intensity when the grating has an analyte on its surface. It is possible to observe a shift of the minimum (at the resonant angle) intensity due to the analyte nature curve.

References