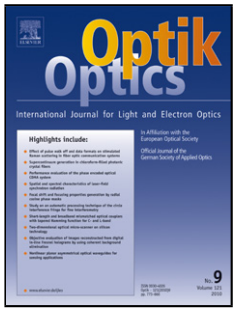

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A Surface Plasmon Resonance Sensing Method that can Improve Sensitivity

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Abstract: Based on surface plasmon resonance sensing theory, composite films of gold (Au) and silver (Ag) are used to improve sensing properties. A differential intensity detection method is also presented. Composite films with different thicknesses of Au and Ag are used for detection. Two light sources are used for differential detection, and the reference light path is determined to eliminate fluctuation of the light source. Detection theory is analyzed, and experiments are conducted to detect the refractive indices of glycerin solutions. The sensitivity of the differential-wavelength and single-wavelength methods is simulated. Results show that the use of composite film and the differential-wavelength method can enhance detection sensitivity. The rotating angle detection device and the spectrometer are not used in the experiments. The proposed detection device is small and cheap. The detecting range can be adjusted on the basis of the incident angles and wavelengths of the light sources. Thus, the proposed system can be extensively applied to detection.

Keywords: Composite film, Differential Detection, Intensity detection, Surface Plasmon Resonance

1Introduction

Excitation conditions of surface plasmon resonance (SPR) are sensitive to the optical properties of the medium on the metal surface. The SPR sensor has been extensively used in the chemical, biological, and environmental monitoring fields[1–6]because of the aforementioned feature. The angle, wavelength, intensity, and phase modulation methods can be used for SPR sensors using prism coupling[7-10]. The angle detection method needs expensive and precise angle rotation device and control system. The wavelength modulation method requires complex and expensive spectral analysis device of light intensity. The phase detection method needs a series of high-frequency circuits. These requirements limit the application the aforementioned methods. By contrast, the intensity modulation method has the advantages of simple structure and low cost, but has poor sensitivity and large detection error. Therefore, this study proposed a dual-wavelength SPR sensing differential detection method using composite film. The silver (Ag) film has better sensitivity, but is easily oxidized. The gold (Au) film is stable, but its sensitivity is poor. Thus, composite films of Au and Ag are used to improve sensing properties. The differential values of the reflected intensity in two different wavelengths are used to sense the variation of the refractive indices. The experimental results show that this method can double the sensitivity.

2The basic principle

In the Kretschmann structure, the wave number of the surface plasmon wave (SPW), which propagates on the surface of the metal film, and the measured dielectric can be written as follows:

$$k_{sp} = \frac{2\pi}{\lambda}\sqrt{\frac{\varepsilon_r^m(\lambda)\varepsilon_r^f(\lambda)}{\varepsilon_r^m(\lambda)+\varepsilon_r^f(\lambda)}} \tag{1}$$