Development, Characterization and Evaluation of Surface Plasmon Resonance Optical Sensors

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Introduction

A surface plasmon is an electromagnetic wave propagating along the surface of a thin metal film. Optical excitation of the plasmon can be observed if a p-polarized, collimated light beam undergoes total internal reflection at a glass/metal/dielectric interface[1]. The effect is observed as a sharp minimum of the reflectance when the angle of incidence is varied. The resonance condition includes the following parameters: wavelength and angle of incidence of light, dielectric constants of the metal and media on its both sides, and thickness of the metal film. Thus for monochromatic light and fixed metal layer, the angle at which the resonance occurs depends critically on the dielectric constant (refractive index) of medium adjacent to the metal surface. By covering the metal layer with a chemically active thin membrane, a very sensitive sensor can be obtained, depending on the chemistry of the membrane. The above concept can be modified in another way. Instead of the chemically active membrane, a thin film sensitive to gas mass flow is used. If gas flow influence surface plasmon resonance condition, e.g. by introducing changes in thickness or refractive index of the film, then even small flows could be monitored.

Materials and Methods

The experimental apparatus for the present work is based on prism coupling using Kretschemann configuration. Thin metal films were prepared by thermal evaporation technique (Edward 306) at base pressure down to 10^{-5} torr. A laser beam from a He-Ne laser source operating at a wavelength 632.8nm passed through a polarizer before striking the prism/sample. A rotating stage having minimum resolution 0.01 degree is used to rotate the prism in a step of 0.1 degree. The reflected beam and reference beam are detected by large area photodiode and processed by lock-in amplifier.

Results and Discussion

We have tested several metal films as an active layer and we found that the gold coated with very thin polyaniline film is the most suitable for sensors[2][3][4]. We have used this type of sensor for detecting the small amount of ethanol, honey, latex, glucose, blood in water. We have also tested the method for the sample in the powder form and for scattered media. However, in order to evaluate the ability of the method, we have carried out measurements to characterize the surface plasmon for various metal films, such as gold, silver, gold alloy, and aluminum. We are able to determine the refractive of those metal films up to the 10^{-3} RU.]. The details of the findings are listed in our publications.

Conclusions

Depending on specific system design, SPR has numerous applications for commercialization such as monitoring real time biological and chemical reaction, monitoring production process, determine chemical concentration food additive testing, refractive index detector for liquid chromatography, process control microsensor, corrosion monitoring device, polarization device, environmental monitoring system, and medical diagnostics. In this respect, our refractive index measurement scheme can be tailored into meeting specific needs of biophysical and biochemical researches, and also industrial processes.

Benefits from the study

SPR also has an extensive range of applications in the analysis of metals because the resonance condition depends upon the physical properties of the metal surface on which the plasmon is excited. This inherent property makes SPR well suited for nondestructive studies of surfaces, interfaces, and very thin layers. The work we have pioneered on characterizing conducting polymer, namely polyaniline is at a very early stage. However this has a very promising future in the development of optical sensor based on the thin layer polyaniline films, as well as photonic devices such as polymer-based light emitting diode.

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