

DEVELOPMENT, CHARACTERISATION 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 achieved if a p-polarised, collimated light beam undergoes total internal reflection at a glass/metal/ dielectric interface. 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, 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.

Materials and Methods

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. 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. The experimental apparatus for the present work was based on prism coupling using Kretschmann 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 polariser 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.

Results and Discussion

The reflected beam and reference beam were detected by large area photodiode and processed by lock-in amplifier. We have used the sensor for detecting the small amount of: ethanol, honey, latex, glucose, and 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 characterise 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.

Conclusions

The method was found to be very sensitive and can be used to any form of the sample materials, such as liquid, thin film, solid, powder, scattered media and emulsion. By using micro-optical components, the instrument can be fabricated in small size and portable.