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Simulation of a High Sensitive Surface Plasmon Resonance Biosensor for Detection of Biomolecules : effect of metal index

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INTRODUCTION & AIM

➢Surface Plasmon Resonance (SPR) is a real-time, label-free technique for detecting biomolecular interactions.

➢The Kretschmann configuration is commonly used in SPR biosensors

Objective

➢Evaluate optical response of Au and Ag layers

➢Investigate sensitivity to refractive index changes

➢Use of simulation and experimental validation

MODELING METHOD

Numerical calculation method :

➢Finite element method

➢Software COMSOL.Multiphysics

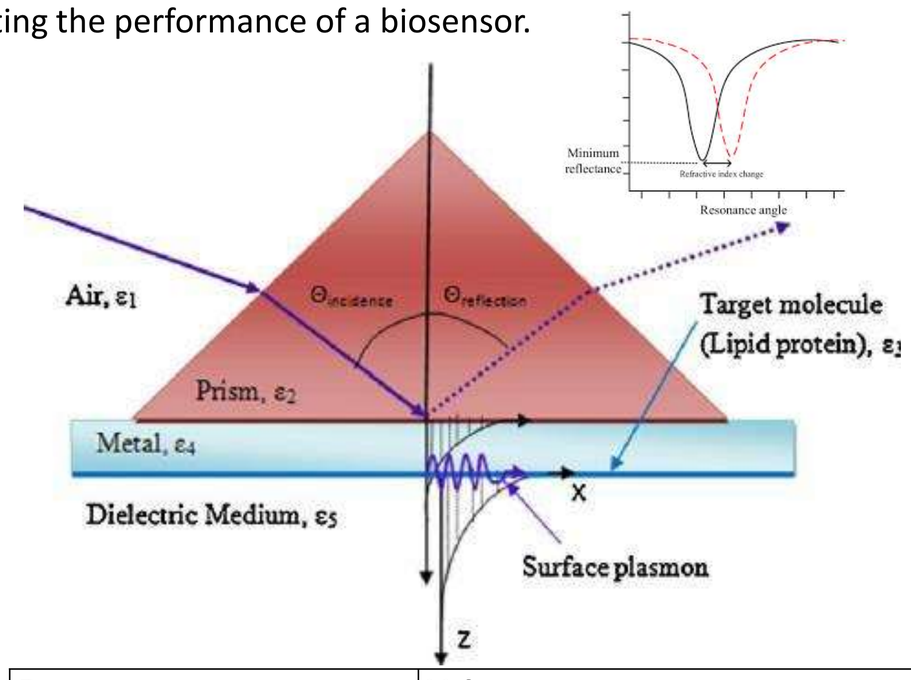
➢2D modeling purposes. In the Radio Frequency module(RF), Electromagnetic waves, Frequency Domain

➢TM polarized electromagnetic wave is incident on a KRETCHMANN configuration

Structure

The **Kretschmann** setup is used to excite surface plasmon resonance. A thin metallic film, is deposited on one face of the prism; its thickness is 50 nm. A laser beam with a wavelength of 633 nm passes through the prism and strikes the metallic film at a variable angle.

At a precise angle, called the **surface plasmon resonance angle**, the light is coupled to the plasmons at the metal-dielectric interface. Consequently, the reflected light is reduced; thus, if the reflectivity is measured as a function of the angle of incidence, a marked decrease is observed at the resonance angle. This decrease is the signature of the excitation of the surface plasmons. Any variation in the refractive index of the medium in the vicinity of the prism causes a shift in the position of the resonance angle. This shift is related to the **sensor's sensitivity**, which is an important parameter for evaluating the performance of a biosensor.



Parameter	Values
Prism	BK7,n_{prism} : 1.5216
Metal	Ag&Au (n_{metal} : J&C)
Sensing medium	$n_{sensing\ medium}$: 1.33 (water), 1.38 (blood)
$E_{Ag/Au}$	50nm
λ	632nm (HeNe laser)

RESULTS & DISCUSSION

Au resonance angle :

68° (water), 75.23° (blood)

Angular sensitivity :

110.85°/RIU (Au)

Ag resonance angle:

65.5° (water), 71.88° (blood)

Angular sensitivity :

127°/RIU (Ag)

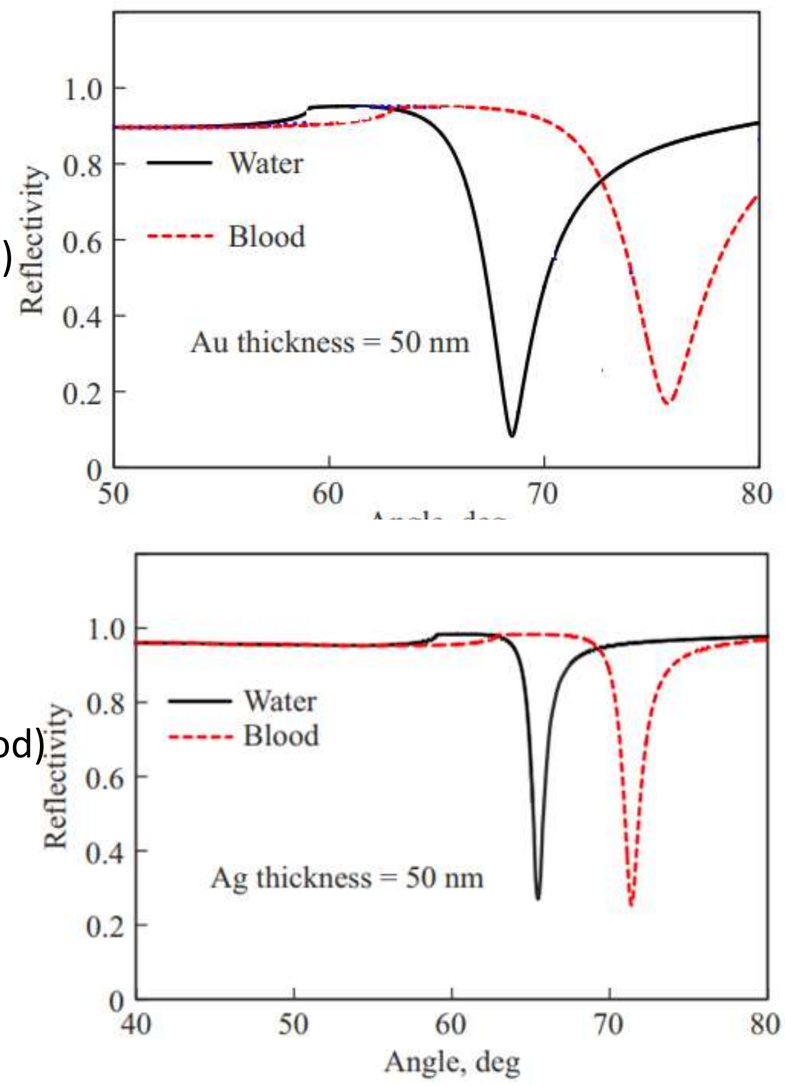


Figure 1: Reflection spectra of a 50 nm thick Au, Ag film in two different surrounding media: water and blood.

✓The sensing characteristics of the devices are examined using two different materials: water and blood, with refractive indices of n_{water} = 1.33 and n_{blood} = 1.38, respectively The resonance angle of the Ag sensor shifts to a higher value as the refractive index of the surrounding medium increases; θ_R is 65.5◦ for pure water and 71.88◦ for blood in the case of A Silver. We obtain the angular sensitivity of the Au sensor is 110.85◦ /RIU and 127◦ /RIU for Ag sensor.

CONCLUSION

➢Gold offers better chemical stability.

➢Silver provides higher sensitivity.

➢The choice depends on the application requirements.

FUTURE WORK

✓For optimal sensitivity, Silver (Ag) is the best choice; due to its lower optical losses (resulting from its lower permittivity).

✓we are continually working to improve its sensitivity du biocapteur proposé by adding different materials, such as SiO_2 and ZnO, particularly above the metal layer, which increases the resonance angle shift.