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High sensitivity SPR sensor for liquid phase sample with Ag/PbS/Graphene hybrid nanostructure

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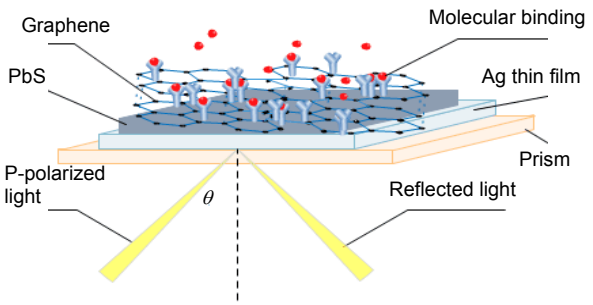

Schematic diagram of SPR sensor with Ag/PbS/GR hybrid nanostructure.

Abstract: Sensors based on surface plasmon resonance (SPR) are widely recognized as valuable tools for sensing of liquid phase samples. It can be used in real-time monitoring of various biomolecular interactions, such as DNA hybridization and protein bindings since it is a simple, direct, real time and sensitive optical sensing technique used for probing refractive index changes. In recent years, Graphene (GR) has been applied in SPR sensors to improve the sensitivity. However, the detection sensitivity and accuracy of the sensors are lower for the loss of the electromagnetic field in GR which leads to the damping field and broad resonance peak in the SPR curve.

Here, a surface plasmon resonance (SPR) sensor with Ag/PbS/GR hybrid nanostructure has been proposed for liquid phase samples. The Ag/PbS/GR hybrid nanostructure is designed as an asymmetric MIM waveguide for surface plasmon. Due to the guided wave SPR (GWSPR) modes, the index of the liquid phase samples can be measured more accurately than the conventional SPR sensor. We use two sample solutions (DI water and 10% glucose solution) to test properties of the sensors. Numerical results show that the sensitivity of the sensor is about 5 times higher than the conventional SPR sensor. The origin of the enhancement mechanism is the combination of GWSPR in the Ag/PbS/GR hybrid nano-structure which enables the surface plasmons to spread along the PbS layer. Corresponding to the GWSPR mode, in Ag/PbS/GR hybrid nano-structure, the electric field is concentrated mostly in the PbS layer at 50 nm~70 nm, just like a MIM waveguide. The counterpart to the sensor with only Ag nano-membrane is from 0 nm to 100 nm. Because most of the field is now in the dielectric layer, which is less absorptive than metal, it is expected that the surface plasmon propagates a longer distance along the surface thus increasing the sensitivity. In addition, the maximum of the E-field intensity is increased by 30% in the MIM wavegudie which leads to the higher interactivity between the surface plasmons and samples.

Keywords: surface plasmon resonance; surface plasmon waveguide; SPR sensor; sensitivity

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See page 198 for full paper.