Surface Plasmon Resonance as a biosensing technique for possible development of a point of care diagnostic tool

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Abstract: Surface plasmon resonance is an optical sensing technique with the ability to monitor molecular binding in real time for biological and chemical sensing applications. This study characterised, optimised and detected biological analytes using SPR system.

Summary

Surface plasmon resonance (SPR) is a powerful optical tool for real-time interactions monitoring of various chemical and biological analytes [1]. During SPR, charged density oscillations called surface plasmon polaritons (SPPs) are formed at the metal/dielectric interface when the electromagnetic field excites the free electrons in the conduction band of the metal [1-3]. An electric field decaying exponentially into its surrounding medium will be formed by the SPPs and its penetration depth will be in the nanometre range [3]. Consequently, the generated evanescent field is highly sensitive to refractive index changes of the surrounding medium [4]. There are several detection schemes that have been demonstrated in SPR based sensors and they include; intensity measurement [6-8], wavelength [7, 8] and angular interrogation [8].

In this study we built, characterised and optimised the SPR system following Kretschman configuration in which laser light at a wavelength of 640 nm was focused onto a gold coated surface through a glass prim. The gold coated slides which were used as the biosensor chips were coated with 40 nm of gold using e-beam evaporation system and 5 nm of titanium was used an attached layer for gold. The biosensor chips were functionalized with poly (ethylene glycol) (PEG) 2-mercaptoethyl ether acid before activation through EDC-NHS. After activation of the surface, the chips were incubated with mouse IgG antibody before adding goat anti-mouse IgG conjugated to gold nanoparticles. Scanning electron microscopy (SEM) was used to characterise the surface of the SPR biosensor chip functionalized with antibodies.

The results showed that we were able to characterise and optimise our SPR system (Fig.1.) which was indicated by an angular shift when the gold coated substrate was used. Gold is a good conductor of electrons that are capable of resonating with light at a suitable wavelength, and produces a strong, easy to measure SPR signal in the visible light range. Absorbance spectroscopy showed that the 40nm layer thickness was the ideal thickness required for SPR sensing, since it exhibits higher spectra within the wavelength of 560nm and this result correlated to transmission spectroscopy (results not shown). Fig.2. depicts SEM morphology structures of the gold coated substrates with and without antibodies conjugated to gold nanoparticles. Fig.2a shows the deposited coating of the bare gold exhibited a smooth uniform surface structure while Fig.2b shows antibodies conjugated to gold nanoparticles. In Fig.2a, there is no gold nanoparticles while in fig.2b, there was a homogenous distribution of gold nanoparticles across the surface of the biosensor chip. The results show that the goat anti-mouse IgG antibody was able to bind to its complementary mouse IgG antibody.

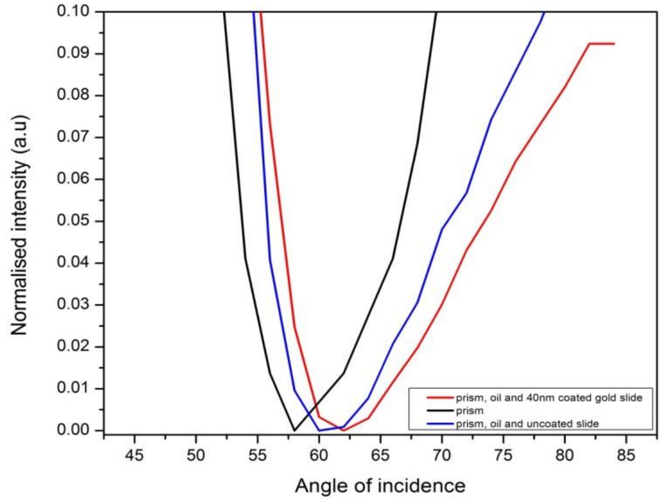

Fig.1.Diagram shows the plot of the SPR angle shift using the prism only;prism,oil with an uncoated slide and prism, oil and 40nm coated gold slide.

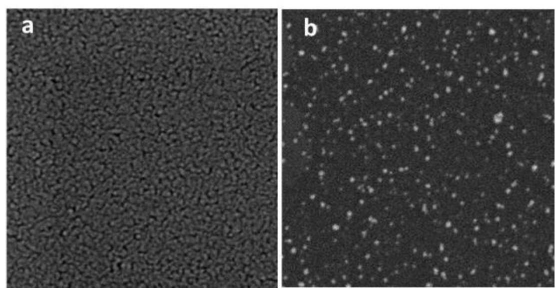

Fig.2.SEM images of the **a**. bare gold coated substrate, **b**. gold coated substrate with antibodies conjugated to gold nanoparticles.

In conclusion, we observed that the quality measurements of the SPR signal system, is highly dependent on the metal thickness of the gold which has a high influence on the SPR angle signal. And also that gold plays a crucial role in SPR systems due to its excellent optical properties which results in high and improved SPR sensing characteristics. The home-built SPR system was successful in detecting biological analytes thereby paving a way into designing a label-free point-of-care (POC) diagnostic tool.

References

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