SURFACE PLASMON POLARITON APPLICATION FOR FLUORESCENT DYE LABELLED BOVINE SERUM ALBUMIN DETECTION

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Fluorescence-based biosensors have become an essential tool in biomedical applications and the life sciences, primarily due to their multiplexing capabilities and high sensitivity [1]. However, despite these advantages, fluorescence-based biosensing often encounters diminished optical output at low analyte concentrations where fluorescence signal is weak, which typically necessitates the use of expensive and bulky instrumentation to achieve functional dynamic range [1]. To overcome these limitations, surface plasmon polaritons (SPPs), which are electromagnetic waves propagating along the boundary between a metal and a dielectric, are utilized [2, 3]. By generating intense localized field enhancement, SPP allows detection of minuscule changes in refractive index at the metal-dielectric surface [3]. This interaction results in metal enhanced fluorescence significantly improving the quantum yield, excitation rate, radiation pattern and photostability of nearby fluorophores [1].

The excitation of SPP requires specific momentum-matching conditions to be satisfied. This is typically achieved through various coupling schemes such as prism coupling, grating diffraction and waveguide coupling. Nevertheless, SPPs possess certain qualities that impose technical constraints, most notably the dissipation of energy as heat in the metal and finite propagation length caused by attenuation [2]. Additionally, the efficiency of SPP enhancement is strictly distance-dependent: to prevent non-radiative quenching fluorophores must be placed at an optimal range from the surface which is typically between 10 and 50 nm [1]. By utilizing these plasmonic interactions and overcoming signal limitations, researchers are moving toward developing ultra-sensitive, portable point-of-care testing devices with low-cost detectors for early disease diagnosis [1].

In this work fluorescence microscopy and total internal reflection ellipsometry (TIRE) are used to evaluate properties of bovine serum albumin (BSA) conjugated with fluorescent CF680 molecules. The optical response of a structure consisting of a thin microscopic slide covered with 45 nm Au was measured using TIRE. Real-time measurements of bovine serum albumin labelled with CF680 dye adsorption to Au surface were performed. Formed BSA-CF680 layer emission pattern was measured with fluorescence microscopy setup. A new approach in labelled biomolecule detection is demonstrated through reduced losses of the SPP excitation when a layer of labelled BSA is covalently immobilized on sensing surface.

Keywords: biosensing, surface plasmon polaritons, fluorescence microscopy, total internal reflection ellipsometry

[1] D. Semeniak, D. F. Cruz, A. Chilkoti, and M. H. Mikkelsen, “Plasmonic fluorescence enhancement in diagnostics for clinical tests at Point-of-Care: A review of Recent technologies,” Advanced Materials, vol. 35, no. 34, p. e2107986, Mar. 2022, doi: 10.1002/adma.202107986.

[2] W. L. Barnes, “Surface plasmon–polariton length scales: a route to sub-wavelength optics,” Journal of Optics a Pure and Applied Optics, vol. 8, no. 4, pp. S87–S93, Mar. 2006, doi: 10.1088/1464-4258/8/4/s06.

[3] J. Homola, “Present and future of surface plasmon resonance biosensors,” Analytical and Bioanalytical Chemistry, vol. 377, no. 3, pp. 528–539, Oct. 2003, doi: 10.1007/s00216-003-2101-0.