MASTER'S THESIS

Study of biomolecules with gold nanoparticles

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ABSTRACT

Gold nanoparticle (AuNP) is used for the detection of biomolecules and study of the interaction between bio-molecules with the aid of dark field microscopy (DFM). AuNP exhibits unique optical properties and ability to conjugate with different biomolecules either by covalent binding or physical absorption, which allow the AuNP possessing a variety of biological application.

We reported a sensitive detection system for measuring DNA–protein interaction at single plasmonic metal nanoparticles level by Localized Scattering Plasmon Resonance (LSPR) spectroscopy. As a proof of concept, DNA molecules were conjugated to gold nanoparticles (AuNPs) through gold–thiol chemistry and the resulted complex was served as single-particle probes of human topoisomerase I (TOPO). By recording the changes in Rayleigh light scattering signal of the individual nanoparticles upon protein binding, DNA–protein interaction was monitored and measured. The λ_{max} shifts in LSPR spectrum of individual AuNP was found to be highly correlated with the amount of TOPO that bound onto.

We presented an immunosensing platform to detect cancer biomarkers by collecting the LSPR signal of immune-target conjugated gold nanoparticle (AuNP). Prostate specific antigen (PSA), which is a FDA-approved biomarker for prostate cancer, was chosen as an example. Herein, the immunoreaction of PSA, capturing PSA antibody (CHYH1) (Ab1), and detecting PSA antibody (CHYH2) (Ab2) was studied with a spectrometer coupled-dark field microscope. LSPR of immunotarget conjugated AuNP was directly measured. In brief, Ab1 and Ab2 were covalently conjugated with AuNPs separately, followed by addition of PSA for the formation of sandwiched immuno-complex in PBS solution. Then, the complex was immobilized on surface of glass slide for capturing dark-field images and LSPR spectra.

Besides, to study the ligand-receptor interaction, we prospect a detection system at single plasmonic metal nanoparticle level by LSPR spectroscopy. Glucocorticoid receptor protein (GR) was chosen as example with two ligands ginsenoside-Rg1 (Rg1) and dexamethasone (DEX). Herein, dsDNA molecules were covalently conjugated with AuNPs and the resulted complex was used as single particle probes of GR. The binding of GR to the dsDNA could be promoted by the agonistic ligands. DNA-GR interaction in the presence of ligands was monitored and measured by recording the changes of LSPR upon protein binding.

This technique provides a sensitive and high-throughput platform to screen and monitor accurately the specific biomolecular interactions. It is capable of revealing information such as particle–particle variations that might be buried in conventional bulk measurement.

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TABLE OF CONTENTS