Investigating the Kinetic Interactions between Protein and Nanoparticles via Mie Scattering Spectroscopy and Optical Trapping

G. Doyle, D. Zerulla.

Molecular Biophysics, School of Physics, University College Dublin, Belfield, Dublin 4, Ireland

The basis of the research is the kinetic study of the interaction between nanoparticles and protein by means of surface plasmon polariton enhanced scattering spectroscopy. Mie scattering spectroscopy for fast kinetic studies will be employed as the method of measurement. One of the most desirable properties of a surface plasmon is its strong electromagnetic field that is confined and localised near to the metal surface. The evanescent field of the surface plasmon carries the information regarding the molecules within the strong plasmon field. Two approaches are used; the first uses a sample containing a large number of particles [1]. This produces a broad resonance peak in the visible range due the presence of particles of different sizes. The second method uses an optical tweezers setup, for single particle spectroscopy. Although the intensity of the signal is naturally reduced, this technique eliminates broadening of the Surface Plasmon resonance peak due to the absence of size distribution. The interactions between the nanostructures and the protein are powerfully indicated by the corresponding shift in wavelength of the resonance peak as the local refractive index at the surface of the nanoparticles changes with progression of protein binding. This system can be used with a large number of proteins, provided the proteins themselves have an affinity for the metal from which the nanoparticles are constructed.

The methodology also involves using different geometrical formations of the nanostructures for example; rod-shaped and spherical-shaped particles in addition to experimenting with different types of metals. The rod-shaped particles are of particular interest because of their enhanced sensitivity. The presence of two resonance peaks in their spectra allows us to distinguish between the two geometrical axes – the longitudinal and transverse axes. Manipulation of the excitation wavelength offers an opportunity to investigate coupling between the Surface Plasmons excited along their respective axes.

The research ultimately aims to provide a novel method for the detection of conformational changes that occur in molecular systems by the observation and analysis of the SPP enhanced interaction between the nanoparticle and the protein via spectroscopy. This simultaneously provides information regarding the characteristic behaviour exhibited by Surface Plasmons in different geometrical environments.

[1] G. Doyle, B. Ashall, M. Galvin, M. Berndt, S. Crosbie, D. Zerulla, Appl. Phys. A 89 (2007) 351-355.