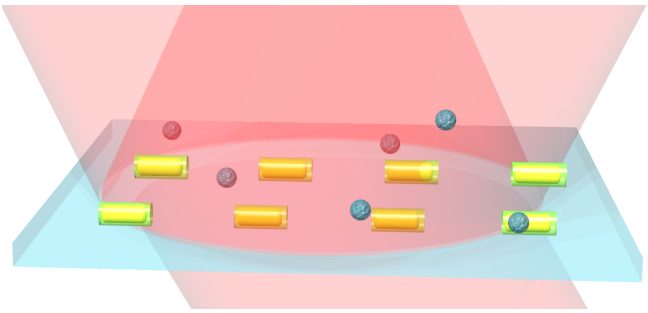
Master Thesis

Research-related and Interesting

Core-Shell Plasmonic-Quantum Dot Nanoparticles as Optical Biosensor with High Sensitivity



Optical biosensors due to their sensitivity, specificity, small size, as well as cost effectiveness are an attractive form of sensing, already established in biological studies and diagnosis. Plasmonic nanoparticles based biosensors are a subcategory of optical biosensors, which show great sensitivity to the variations of their background medium's refractive index. Plasmonic excitation within such nanoparticles is detected through a strong peak in their corresponding scattering cross-section, whose spectral position is sensitive to the background medium's refractive index. Accordingly the sensitivity of underlying biosensor is dependent on the half-width of the scattering cross-section peak. The desired sensitivity can be achieved through modifying the shape and size of the underlying nanoparticle, in order to shift the plasmonic peak in the required spectral position as well as narrowing the half-width of the peak.

As a part of a DFG research project aiming at developing an untra-sensitive biosensor for early stage cancer diagnosis, we intend to improve the sensitivity of plasmonic nanoparticle based biosensors through adding a quantum dot shell to the nanoparticle. The quantum dot shell shall be designed to show an excitonic resonance at the corresponding plasmonic mode of the nanoparticle, in order to achieve a plasmonic-excitonic coupling and correspondingly narrowing the scattering cross-section of the hybrid plasmonic-quantum dot core-shell structure. The sensitivity of the biosensor will then be evaluated through embedding a dielectric nanoparticle, mimicking the characteristics of a virus, to the vicinity of the hybrid core-shell structure.

The current master project will deal with matching the spectral position of the plasmonic peak of the nanoparticles to the excitonic mode of quantum dot shell, and hence narrowing the half-width of the plasmonic peak using the finite element based simulation software COMSOL Multiphysics. Afterwards, the sensitivity of the designed structure shall be determined through embedding a virus next to the biosensor and calculating the acquired spectral shift as the sensitivity's figure of merit. Through this work, the student will gain knowledge about modelling of electromagnetic systems, the field of bioelectromagnetics, as well as nano optics.

Got curious? simply contact us for an informal meeting discussing the topic or send a thesis request per email to us.

Requirements:	Knowledge of electromagnetic field theory, interest in modelling and simulation of electromagnetic systems and bioelectromagnetics, knowledge of numerical simulation is preferred.
Character of the project:	40% Theory / 60% Simulation
We offer:	An interesting master project at the edge of science in a friendly research environment.
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