Optical Studies of Nanostructures for Biosensing Applications

Pant, Aniket (School: Jefferson County International Baccalaureate)

We hypothesize there exists an optimum nanostructure size and material to detect changes in the environment via optical responses. We perform this study to build the foundation for more extensive real-time in vitro biosensing applications. In the past, plasmonic nanostructures have shown promise in small-scale sensing, solar-energy technologies, and biomedical applications including cancer detection and treatment. We apply Mie Theory to study the nanostructures optical properties, employing a computational method through Lumerical's Finite Difference Time Domain (FDTD) solver as well as an analytical method using the Python scripting language to corroborate computational results. In this study, we consider homogeneous Gold and Silver nanoparticles over a range of 20nm to 200nm diameter. We examine the optical spectrums for scattering, absorption, and extinction of the nanoparticles. Major findings include an upwards redshift trend in extinction values for both Gold and Silver as nanoparticle diameter is increased. This can most likely be explained through nanostructure electron count and volume. This research yields important results because it helps us gain a better understanding of Mie solution variation for different plasmonic metals and allows us to select optimal nanostructure constraints for future research applications. In the future, we look to optimize material performance based on a performance to cost heuristic, as well as provide Machine Learning models for the classification and spatial-temporal mapping of plasmonic nanostructures in various biological areas of study, such as cancer cells.