Tailoring a Nanoplatform for Surface Enhanced Detection of Chlorophyll-Like Pigments by Langmuir Technique

The technique of monolayer formation at the aqueous solution-air interface, known as the Langmuir method of producing Langmuir (insoluble, spread or floating) monolayer is based on spreading an aliquot of an amphiphile of interest in organic or other hydrophobic material, volatile and water-immiscible solvent on water surface. After solvent evaporation, the free surface is entirely covered with a monolayer of the amphiphile or other hydrophobic material used, which can be compressed to the desired surface pressure or mean molecular area, using the Langmuir trough.

Delocalized electrons in metallic nanoparticles (NPs) can oscillate easily under the impact of a proper light frequency. Surface-charge-density oscillations cause electric field enhancement near the surface of the NPs. When a molecule is in close proximity to the surface of the NPs it can absorb or sometimes radiate more light. This is due to the fact that both absorption and emission occur with certain probabilities which are modified by NPs. This phenomenon is widely used for the development of functional nanoplatforms for biosensing applications. The goal of this project is to fabricate tailorable two-dimensional lattices of NPs which will be used in metal enhanced detection of chlorophyll derivatives. In the frame of this project very interesting question will be addressed: is it possible to design and tailor plasmonic platform for metal enhanced spectroscopies (nanoplatform), using Langmuir technique, for practical biomedical diagnostics. Recently different methods have been proposed to control the self-assembly of NPs, however they have a lot of drawbacks. Therefore it is planned to tailor a nanoplatform for surface enhanced spectroscopy by simple general protocol in which the Langmuir monolayer of NPs is directly tuned to optimize NPs performance. The use of Langmuir technique will allow further tuning of fluorophore-nanostructure separation enabling practical applications for enhanced biomedical assays. The project will engage a large variety of methods, encompassing chemical synthesis, spectroscopic and microscopic investigation, and theoretical calculations.

This project assumes a few fundamental steps. In the first step the procedure for the synthesis of NPs with sharp edges will be optimized to obtain nanoprism and decahedrons with desired optical properties. Next, the obtained NPs will be functionalized to make them hydrophobic and soluble in non-polar solvents. In the second step the method for creation of a nanoplatform for surface enhanced detection of chlorophyll-like pigments by Langmuir technique will be proposed. The composition of the nanoplatform for the surface enhanced detection of chlorophyll derivatives, one of the most intelligent light-harvesters in nature, will be optimized.

The proposed nanoplatform will be produced using the Langmuir technique. The analysis of properties of the NPs monolayers is expected to bring detail information on organization, packing, type of phases. Moreover, Langmuir monolayers of NPs and their mixtures with photosynthetic pigments will be subjected to observation at the Brewster angle and to absorption *in-situ* studies. The surface enhanced spectroscopy response of the nanoplatform will be analyzed using confocal Raman and fluorescence microscopies.

Within the proposed project it will be shown how solar energy can be utilized more efficiently when the tailored nanoplatform works together with chlorophyll derivatives. It will be achieved by integrating the Langmuir technique and the use of photosynthetic pigments for nanoplatforms design. In the short term, this project will be focused on developing methods for creation and optimization of a nanoplatform. In the long term, incorporation of a highly enhanced nanoplatform may give a breakthrough in biomedical diagnostics, including antibody and DNA based detection.