DESCRIPTION FOR THE GENERAL PUBLIC (IN ENGLISH)

In the last 20 years, researchers investigating nanomaterials have discovered a lot of new and fascinating characteristics not found in bulk materials. Particularly, the discovery of metal nanoclusters (NCs) (e.g., Pt, Au, Ag, Cu) has greatly extended the horizon of nanomaterials science. Especially silver nanoclusters (Ag NCs) are of great interest owing to their excellent physicochemical properties such as high biocompatibility, strong luminescence and excellent photostability. DNA-templated Ag NCs display bright fluorescence in solution and have generated huge research interest in the past decade.

The goal of this project is developing new bioanalytical systems using the fluorescent oligonucleotide probes (FOP) and fluorescent silver nanoclusters templated on amphiphilic oligonucleotide containing cytosine (C) domain (RONCx–Ag NCs), both incorporated in the Langmuir monolayer to study FRET process. The proposed FRET system consists of two components: one is the amphiphilic cytosine-rich oligonucleotide able to generate donor Ag NCs with high quantum yield via chemical reduction of Ag^+ ions with sodium borohydride, and the second is the fluorescent oligonucleotide probe (FOP) that serves as an acceptor and can undergo conformational transition (e.g., G-quadruplex formation). G-quadruplexes (G4 DNA) are defined by layers of stacked G-tetrads, each of them containing four guanine residues that interact through Hoogsteen hydrogen bonding interactions. G4 DNA formation and stabilization requires monovalent cations, in particular K^+ and Na^+. This tetraplex structure have recently received great attention because G-rich sequences are often found in genome and because of their potential links to mechanisms that relates to cancer, HIV, and other diseases. Beside the fundamental study concerning energy transfer process in these supramolecular systems that may be regarded as models for mimicking cell membrane interface, we want to verify the idea of an analytical usefulness of these fluorescent DNA–Ag NCs compounds embedded in Langmuir monolayer, LB films or even in liposomes for developing sensing devices. Specifically, a development of a heterogeneous model sensor for K^+ ion detection based on LB film approach and G-quadruplex-forming oligonucleotide FOP probe is planned. In case of promising results, assays for Hg^{2+} ion, HIV DNA, and/or ATP will be considered, both in a homogeneous and heterogeneous version.

We are planning to implement the Langmuir technique and fluorescence measurements as the main analytical tools to study FRET process and interactions between fluorescent oligonucleotide probes (FOP) and fluorescent DNA–templated silver nanoclusters (DNA–Ag NCs) embedded in the lipid membrane and LB films. The most important component of the system is amphiphilic oligonucleotide possessing lipophilic tail (R) and cytosine-rich oligonucleotide head group (ONCx) that serves as a template to generate silver nanoclusters. Taking Ag NCs as energy donors and fluorescent oligonucleotide probes (FOP) as acceptors, energy transfer based biosensing platforms can be constructed utilizing either the alteration of the acceptors emission or the ratio of donor-to-acceptor emission. Spectral properties of obtained nanocluster systems and FOP probes will be studied both in bulk solution (UV-Vis spectroscopy, fluorescence spectroscopy, circular dichroism) and incorporated in monolayer (recording π-A isotherms, π-time profiles for DODAB or DPPC monolayer and fluorescence spectra recording at the fluorescent lipid monolayer/subphase interface using optical fibers accessory). Results of the circular dichroism (CD) and UV absorption melting experiments can be helpful to determine stability of structures of G-quadruplexes. Due to these studies, development of the probe for K^+ ions detection is expected (as well as the probes for DNA related to HIV, ATP or Hg^{2+} ion detection), but the optimization of sequences is indispensable. This research will provide the basis for future applications of the energy transfer properties of Ag NCs in bio/chemo sensing field.

It is believed that G4 DNA structures have a big potential in anticancer therapy and in biomedical diagnosis (telomeric DNA, promotor regions of oncogenes). Therefore, investigation of G-quadruplex structures properties in the presence of Ag nanocluster and lipid aggregates that mimic cellular membrane is very interesting task and of importance. On the other hand, there is observed continuous interest in development of new molecular sensing devices for biomedical applications, such as biological probes. Moreover, the supramolecular system of fluorescent DNA–Ag NCs/G-quadruplex-based fluorescent probe possesses broad prospects for further applications (gene detection, microarrays on solid substrates for genetic assay, design of fluorescent probes for miscellaneous analytes, molecular logic gates, and molecular switches). Beside offering broad bioanalytical potential, this novel FRET system may also provide interesting data concerning photophysical properties of Ag NCs in organized media (monolayer, LB films). Although many silver nanoclusters (Ag NCs) have been developed, the structures and fundamental understanding of fluorescent nanoclusters are still in their early stage and the stability in cells or *in vivo* is still a challenging issue. We expect that the rapidly growing interest in Ag nanocluster in applications such as biosensing, bioimaging and biomedical, will certainly not only fuel the excitement and stimulate research in this highly active field, but also inspire broader concerns across various disciplines.