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Metallic particles display extraordinary optical properties when their sizes are reduced below few hundred of nanometers. Despite their small size nanoparticles can efficiently scatter or absorb light at specific wavelengths due to the resonant interactions between the electrons confined in the nanoparticle and the incident light. This phenomenon is known as Localized Surface Plasmon Resonance. Such plasmonic resonances are tunable by the size and shape of the nanoparticle and their spectral position is highly sensitive to the local refractive index of a surrounding medium. Therefore the nanoparticles can be used for efficient detection of biomolecules, as the binding event of a molecule to the nanoparticle change the local environment and causes the shift of resonance which can be easily detected by optical spectroscopy. Such shifts for a naked eye would appear like the change of a biosensor's color.

Nowadays there is a great need for portable, easy-to-use and cost effective biosensors for environmental monitoring and medical diagnosis. Such sensors could for example replace current complicated and expensive medical procedures and allow for widespread diagnosis of many diseases, including cancer and Alzheimer's disease, by detecting their specific biomarkers from blood.

We have recently discovered that remarkably uniform arrays of silver nanoparticles can be produced by a simple, low-cost and reliable self-assembly method consisting in thermal treatment of a few nanometers thick silver film in oxygen atmosphere. The counterintuitive addition of oxygen greatly improves the uniformity, which is important to obtain narrow resonant characteristic of the whole structure. We hypothesize that such particles, due to the improved uniformity, are highly suitable for biosensing applications. Thus our primary goal is to investigate the optical properties of self-assembled nanoparticle arrays and evaluate their biosensing performance. Such approach is highly advantageous to simplify and reduce the production costs of sensing nanostructure while retaining high sensitivity.

According to another recent discoveries the shifts of plasmonic resonance can be detected by simple measurements of electric potential in the nanoparticles under illumination with monochromatic light instead of using complicated setup for optical spectroscopy. This novel phenomenon is known as plasmo-electric effect. Our secondary objective is to investigate the plasmo-electric effect and use it develop a new class of plasmo-electric biosensing system. Such biosensor would bring substantial simplifications of the biosensor's architecture as it would only require a simple light-emitting diode (LED) and simple electronic circuit for electric measurements.

In conclusion our study may ultimately transom the way how modern biosensors will operate. It will also provide a pathway to ultrasensitive biodetection experiments with extremely simple, small, light, robust, and low-cost instrumentation that will greatly facilitate applications in environmental monitoring and point-of-care medical diagnostic. Such cost-effective diagnostics technologies are particularly appealing for developing countries, which cannot afford for current medical technologies requiring bulky instrumentation, advanced medical infrastructure and trained laboratory professionals. In addition portable biosensors are highly important to monitor environmental pollution and in particular to detect the contamination of drinking water.