New way of synthesis of uniform gold nanoparticles for the detection of few molecules

Controlled synthesis of metallic nanoparticles (MNPs), according to particular morphologies and dimensions, is an interdisciplinary field of research because of the new, varied, rich and complex physical properties of MNP. These properties are mainly governed by the collective oscillations of conduction electrons called plasmons.

This phenomenon is optically reflected by the sensitivity of the MNP to the change in the surrounding refractive index and by the shift of their plasmon resonance band. This feature, according to the morphology of MNP, is used in fairly modern applications such as cancer phototherapy and the development of the ultrasensitive sensors based on Surface Plasmon Resonance (SPR) or Surface Enhanced Raman Spectroscopy (SERS).

The sensitivity of MNPs as sensors is not only directly related to the chemical and crystalline nature of the metal but also to their ability to adsorb target molecules, absorb and / or confine and enhance incident light. This last property is generally more remarkable as the distance separating the MNP is small. Thus, the control of the size, shape and density of the MNP is of major interest. Therefore, the development of new synthesis methods of MNP is still relevant.

Moreover, the fabrication of uniform metallic nanoparticles is mainly achieved by colloidal synthesis particularly by "seed mediated growth". On the other hand, this method always has certain limitations in the preparation time and the control of the size and shape. In this context, we have, in this thesis, developed a new fabrication method of MNP of different shapes. The idea is to structure a polymer (PMMA) in the form of a nanoporous film and to use the nanopores as synthesis reactor for MNP. Thus, the objective of this thesis was to investigate the synthesis method thus proposed in order to develop new detection nanosensors based on SERS phenomenon.

The work in this thesis has been divided into three main parts: The first is to study the synthesis mechanism in order to optimize the formation process of uniform metallic structures. The second aims to change the shape of the MNP by playing on the parameters of synthesis. In parallel with these two aspects, an important task was devoted to morphological analysis using structural analysis techniques, and to the determination and the modelling of the optical responses of these MNP particularly by the technique of spectroscopic ellipsometry.