ROBUST AND REUSABLE PLASMONIC PHOTOELECTROCHEMICAL ELECTRODES: INDIVIDUAL NANOPROBES IN LIQUID PHASE

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : Laboratoire de Chimie de Lyon, ICL-ENS Lyon

LEVEL : M2
TEAM(S) : AGNANO

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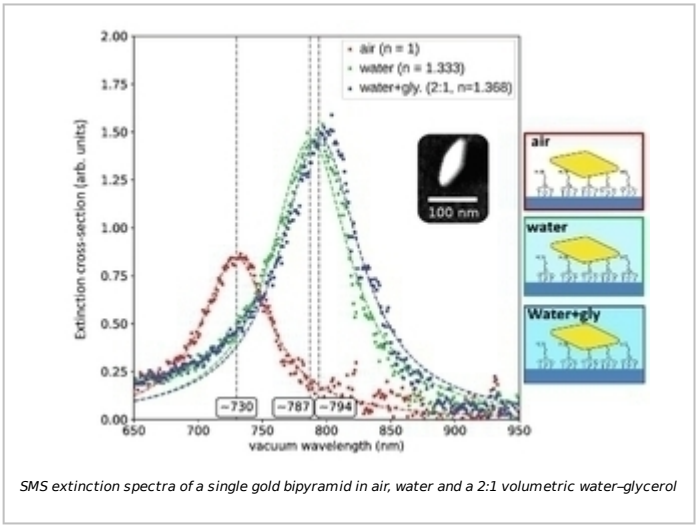
SCIENTIFIC CONTEXT :

Among the numerous environmental and societal issues the world is facing nowadays, air and water pollution are of major concerns. In that context, the development of novel, rapid and highly sensitive detection techniques becomes crucial. In this respect, metallic nanoparticles (MNPs) have been shown to be sensitive optical sensors thanks to their localized surface plasmon resonance (LSPR) whose characteristics depend on their composition and morphology (shape and size), but also on their local environment. More specifically gold nano-bipyramids (AuBPs) are very promising candidates as they display an LSPR with a high quality factor and thus a strong sensitivity to the environment.



SMS extinction spectra of a single gold bipyramid in air, water and a 2:1 volumetric water–glycerol

Our project aims to develop a device allowing to detect in dynamic regime and with a high sensitivity polluting substances like heavy ions in liquid environment. The technology will be based on an electrochemically triggered plasmonic detection allowing the real time monitoring of various physico-chemical processes at the scale of the single nanoparticle and on time scales allowing the realization of broad band spectra on times of a few seconds, thus allowing the monitoring of the reaction kinetics by plasmonic spectroscopy.

MISSIONS :

The Master student will be involved in both parts of the project (chemical synthesis and optical spectroscopy). The first part will concern the elaboration of the devices consisting in grafted AuBPs immobilized on a transparent and conducting glass substrate, allowing photo-electrochemical detection of specific heavy metals such as lead, mercury or cobalt. As concerns the optical spectroscopy part, the spatial modulation spectroscopy (SMS) technique in a liquid environment was shown to be highly sensitive to detect small variations of the optical index of the environment of single AuBPs (see Fig. 1). The combination of this SMS technique with electrochemical studies using a potentiostat will be performed without and with a given concentration of heavy metals in the solution. The sensitivity of single AuBPs to detect the presence of heavy metals will then be fully investigated. Thereafter, the possibility to perform dynamic measurements at the single nanoparticle level will be studied.

OUTLOOKS :

This projetc may open to a PhD work (funded ANR Project)

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[3]: J.-M. Rye, Spatial Modulation Spectroscopy Of Single Nano-Objects In A Liquid Environment For Biosensing Applications; Thèse de doctorat. Lyon1, 2017

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