SCIENCES SORBONNE UNIVERSITÉ

2020-2021

Master thesis proposal

Campus Pierre et Marie Curie
Tower 23 – 3rd floor – 23-22
Director: Massimiliano Marangolo

Title: Gold-based plasmonic nanosensing of biomolecules

Keywords: nanoparticles, gold, plasmon, sensor, biomolecules, optics, reactivity

Scientific description: Gold nanoparticles (AuNP) display localized surface plasmon resonances, which are collective oscillations of the conduction electrons confined within the AuNP. It gives a red or purple color to Au instead of the usual yellow color. This resonance is very sensitive to the immediate environment of the AuNP and is strongly affected when the particles interact with molecules or ions. Thanks to this very high sensitivity, biological sensors based on nanoparticles of gold [1] are being developed. (Fig. 1)

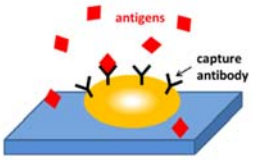

Fig.1 Principle of a bio-sensor based on AuNPs

We have developed an original optical technique, the reflectance anisotropy spectroscopy, which allows us to achieve a higher sensitivity than conventional plasmonic sensors [2,3], making it possible to probe very small quantities of biomolecules in a liquid. For this purpose, specific samples are prepared by oblique evaporation of gold on a glass substrate (Fig.2), leading to a strong dichroism (Fig 3).

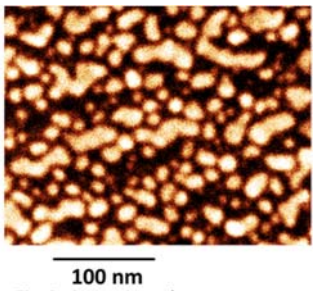

Fig.2. Scanning electron microscopy of Au NPs on glass

The aim of the internship is to investigate the detection of protein layers at ultimate concentrations, by monitoring the change of the plasmon resonance due to the biomolecular bindings on the AuNPs. The internship will combine physical evaporation and simple chemistry for the preparation of the samples, scanning electron microscopy studies and optical measurements. The modeling of the optical results will be also conducted.

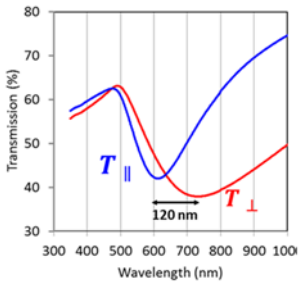

Fig.3 Transmissivity of a sample showing strong dichroism due to the plasmon resonances

1. Biosensing with plasmonic nanosensors, J.N. Anker et al, Nature Materials, 7, 442 (2008)
2. Mechanism of hydrogen adsorption on gold nanoparticles and charge transfer probed by anisotropic surface plasmon resonance, W. Watkins et Y. Borensztein, Phys. Chem. Chem. Phys. 19, 27397 (2017)
3. Ultrasensitive and fast single wavelength plasmonic hydrogen sensing with anisotropic nanostructured Pd films, W. Watkins et Y. Borensztein, Sensors and Actuators B: Chemical 273, 527 (2018)

Techniques/methods in use: scanning electron microscopy, optical spectroscopies, numerical modelling

Industrial partnership: N

Internship supervisor(s) Yves Borensztein, yves.borensztein@insp.jussieu.fr, 01 44 27 61 55, http://www.insp.jussieu.fr/-Borensztein-Yves-.html

Internship location: Campus P et M Curie, 4 place Jussieu, Tour 22-12, 4e

Possibility for a Doctoral thesis: N