The SFNano C'Nano joint meeting 2019

Abstracts

Poster Session

P8 - NANOPHOTONICS AND NANO-OPTICS

SFNano cnrs C'Nano

The SFNano C'Nano joint meeting 2019

Thematic Session: Nanophotonics & nano-optics
Keywords: Quantum optics, Quantum Dots, Photoluminescence, Collective effects

Fluorescence properties of self-assembled colloidal supraparticles from CdSe/CdS/CdZnS/ZnS nanocrystals at 4K

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Aggregating a large amount of CdSe/CdS nanocrystals (NCs) is a promising way of enhancing the NCs emission through collective effects. In this paper, we present the fluorescence properties at 4K of supraparticles with a diameter of about 150 nm, which consists in encapsulating a compact assembly of CdSe/CdS/CdZnS/ZnS NCs into a silica shell (10 nm thickness). The photoluminescence decays were analyzed by spectral filtering and with a photon counting setup associated to a confocal microscope operating at room temperature and at 4K.

The results at room temperature show Förster Resonance Energy Transfer (FRET) between the different emitters within the aggregates. At 4K, additional effects are demonstrated. Using inverse Laplace transforms, a large distribution of exponential decay components is evidenced. The fast components are due to FRET as at room temperature. Very long decay components also appear. They are first related to the well-known blinking of the NCs, which can induce such long decays linked to the power law distribution of the low emitting periods. However, the different mathematical models corresponding to the blinking do not fully describe the experimental data. These results suggest that other phenomenons are involved.

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Thematic Session: Nanophotonics & nano-optics
Keywords: Nanolaser, Photonic Crystal, Excitability, III-V on SOI

Proposal for a spiking nanolaser

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Artificial neural networks proved to be efficient for signal recognition and especially image recognition. Although their software implementation through conventional Von-Neumann processors has been extremely successful, efficiency considerations in training have recently motivated direct hardware approaches taking direct inspiration from the mode of operation of the brain to process information.

We focus on a possible photonic implementation of a spiking neuron. The response is based on the excitability that is possible in semiconductor lasers when they are configured with a saturable absorber [1]. This has been demonstrated experimentally in a vertical-cavity surface-emitting laser [2]. To implement an all photonic network equivalent to the one of biological neurons the issue of interconnectivity has to be addressed.

This is why in the work presented here, we numerically study the spiking mechanisms in a new technology of hybrid InP on SOI photonic crystal nanodiode laser [3] which are extremely interesting with their compact size and low energy consumption to develop efficient optical neural networks. This technology is modified by creating a gain and a saturable absorber section by selectively pumping a specific region of the photonic crystal wire cavity. We adapt the Yamada model [4] for a bisection nanolaser and predict an excitable dynamics mimicking a neuromorphic response. The energy efficient operation (fJ excitation energy, µW pump power), compactness (10 µm) and speed (100 ps) of the technology considered here would allow the creation of a highly scalable neuromorphic photonic system.

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The SFNano C'Nano joint meeting 2019

Thematic Session: Nanophotonics & nano-optics

Keywords: Quantum dots, Gold nano-shell, Plasmon

Synthesis and fluorescent properties of self assembled colloidal superparticles from CdSe/CdS/ ZnS nanocrystals and their encapsulation in gold nanoshells

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Colloidal semiconductor nanocrystals, also called quantum dots (QDs), have exceptional optical properties, such as high absorption cross section and quantum yield, as well as emission spectra that are tunable by changing their size, shape or composition. They are finding numerous applications eg. in displays, imaging… Recently, our group reported the plasmonic coupling of single QD emitters embedded in silica coated with a gold nano-shell with a Purcell factor of 6. The resulting emitters showed enhanced photostability and reduced blinking rates.[1] Here we explore the optical properties of similar objects containing not one but hundreds of QDs in their core. We first synthesize CdSe/CdS/ZnS core/multishell QDs and assemble them into aggregates of controlled sizes (typically 130 +/- 20 nm in diameter) by emulsion/evaporation. The aggregates are then coated with a ca. 10 nm silica shell, functionalized and coated with gold seeds. A ca. 30 nm continuous gold shell is then grown using reduction of gold salts in solution.

We have investigated the optical properties of QD assemblies with and without gold nanoshells. These objects display high quantum efficiency, stable and Poissonian emission at room temperature. In addition, enhancement of the photoluminescence decay rate through Förster resonance energy transfer (FRET) is observed from bluer to neighbouring redder QDs within the assemblies. We are currently examining the effects of coupling of the emission from the QD assembly with the gold nanoshell plasmonic resonator.

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The SFNano C'NANO joint meeting 2019

Thematic Session: Nanophotonics & nano-optics

Keywords: nonlinear plasmonics, surface plasmon polaritons, nanowires, nanoantennas, N-PL

Electrical control of the nonlinear photoluminescence of metal nanostructures

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Engineered gold nanostructures sustaining surface plasmons have the ability to strongly enhance electromagnetic fields and consequently improve inherently weak nonlinear optical processes occurring at the nanoscale [1]. Additionally, optical and electrical operation can be performed simultaneously at the same support, thereby simplifying many optoelectronic processes [2]. Recent works highlighted that second-harmonic generation emitted from optical antennas loaded with a nonlinear material can be controlled by electrostatic means [3].

Here, we investigate the influence of a time-varying electric field on the intrinsic incoherent nonlinear response of plasmonic antennas. In particular, we are interested at modulating the yield at which incoming photons are up-converted by means of an electrical control of the surface charge density.

In our experiment, gold optical antennas are excited with a tightly focused near-infrared femtosecond laser beam resulting in the broadband emission of nonlinear photo-luminescence (N-PL) [4,5]. Applying an electric field on the optical antennas creates localized regions of electron accumulation and electron depletion changing the optical response.

We show that the evolution of the nonlinear response is directly influenced by the charge density which depends on the electron gas temperature at the surface. Hence, the precise location of the laser beam on the antenna with respect to the polarity and the strength of the controlled field completely modify the optical response. Large modulation depths are observed in the N-PL signal for a few volts. We will discuss the mechanisms at play and their effects on the bandwidth at which the nonlinearities can be modulated.

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The SFNano C'Nano joint meeting 2019

Thematic Session: Nanophotonics & nano-optics

Keywords: Modal plasmonic cavities, Nonlinear photoluminescence, Reconfigurable logic gates

Nanofabrication and optical characterisation of modal plasmonic cavities

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We are interested in complex information processing using plasmonic device[1]. We used a Focus Ion Beam technique to engineer modal plasmonic cavities in 2D crystalline Au flakes. Specifically, we designed structures sustaining a rich plasmon modal landscape (Fig. 1) enabling the realisation of universal and reconfigurable logic gates. Addressing optically the logic gate necessitates the implementation of a number of controllable excitations channels equivalents to the number of inputs defining the Boolean function to realize. For instance, a 2-bit optical logic gate must be fed by two optical stimuli carrying the Boolean values. We implemented a spatially steerable diffraction-limited 2-way excitation nodes capable of accommodate any non-trivial device geometry, hence allowing for an agile reconfiguration of truth table of the logic gate. The Boolean values are encoded on the input nodes by exploiting the polarization state of the excitation field[2]. Our characterization of the gate response is performed by detecting the nonlinear photoluminescence (NPL) created when the input nodes are fed by a femtosecond pulse laser[3]. NPL is a sensitive probe for the local electric field carried by the plasmon modes. We observe coherent effects when the input nodes are temporally synchronized indicating the output of the gates can be controlled by engineering selectively the modes distributed in the 2D structure. This kind of process is required to achieve non trivial logic operation such as XOR function.

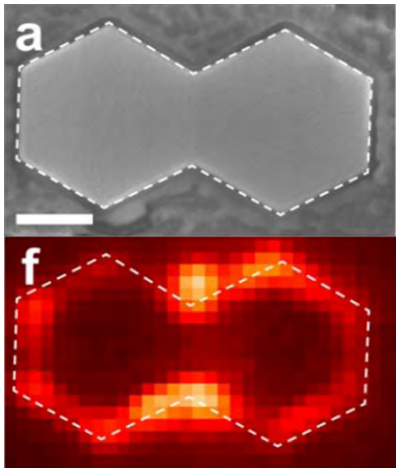

Figure 1 : SEM image of double hexagon-shaped gold platelet, scale bar 500 nm and experimental NPL image collected when two input nodes are excited.

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The SFNano C'Nano joint meeting 2019

Thematic Session: Nanophotonics & nano-optics

Keywords: Nano-antenna, single photon source, efficient coupling, hybrid plasmonic-photonic platform

Plasmon mediated single photon source coupling to photonic waveguide

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Abstract

Enhancing the light-matter interaction at single photon level is required for quantum technologies. We work on demonstrating efficient coupling of a single photon source into photonic waveguide by the assistance of plasmonic nano antennas.

Yagi-Uda antenna is a good candidate for such purpose[1]. Yagi-Uda antennas were designed for efficient and directive coupling of single photon emission into nano photonic TiO_2 waveguide. We fabricated Yagi-Uda antenna onto TiO_2 planar waveguide and characterize its optical response. We are developing a controlled deposition technique for individual CdSe quantum dots. Next step, we will investigate single photon emission coupled to the guided mode mediated by nano-antenna. In the long-term plan, an indistinguishable photon source could be integrated to the platform, then a quantum CNOT gate based on linear photonics could be realized as well.

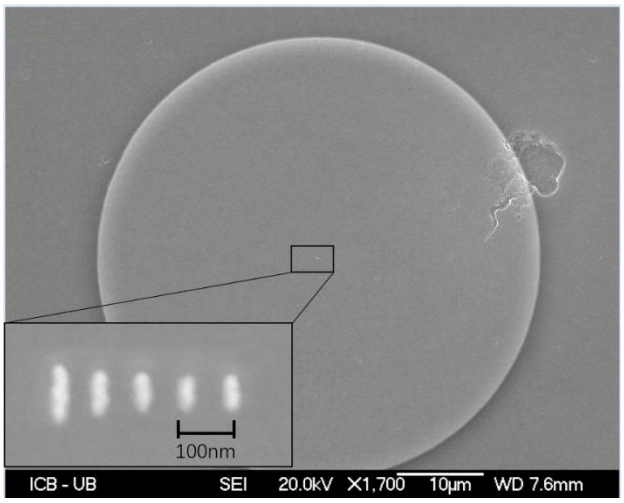

Figure 1: SEM image of gold Yagi-Uda antenna lithographed on top of TiO_2 planar waveguide.

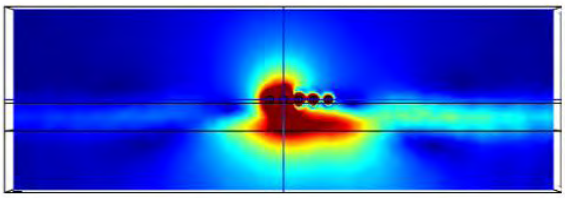

Figure 2: Simulation of directive dipolar emission into TiO_2 planar waveguide.

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Thematic Session: Nanophotonics & nano-optics

Keywords: Quantum dots, Whispering Gallery modes, Resonance energy transfer, Bio-detection

Bio-detection With Whispering Quantum dots

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Phenomenon like resonance energy transfer is widely utilized for many bio-detection schemes where biomolecules actively bind to optical donor and acceptor labeled antibodies to form “sandwich complexes” but the large size of these complexes limits the efficiency of energy transfer, preventing sensitive detection which leads to false outcomes of the tests. In our project we propose to improve the efficiency of the energy transfer through the use of solution phase optical microcavities.

We have designed a novel optical donor that should be capable of performing the energy transfer efficiently over larger distances than the traditional resonance energy transfer limit. We have designed structures where fluorescent colloidal quantum dots (QDs) are precisely located inside dielectric microspheres. Some of the fluorescence from the quantum dots remains confined inside the dielectric microspheres via total internal reflections, leading to optical resonances known as whispering gallery modes (WGM). We have then introduced highly absorbing dye nanoparticles as optical acceptors in the evanescent field of the microcavities. Acquisition of the emission spectrum of these assemblies at the single microcavity level enables us to evaluate the quality factor of each WGM mode and the efficiency of the energy transfer from WGMs to the nanoparticles. In addition, we have developed a copolymeric ligand to functionalize the dielectric microspheres with biomolecules to impart specificiy towards a designated biomolecular target.

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Thematic Session: Nanophotonics & nano-optics

Keywords: hot electrons, photon statistics, nonlinear photoluminescence, gold nanoparticle

Study of the photon statistics emitted by optically pumped gold nanoparticles

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Abstract: Shining pulsed laser light on gold nanostructures leads to the emission of light with a broad spectrum, including photons with higher frequencies than the incoming light. Here we study the second order correlation of those upconverted photons.

When focusing a femtosecond pulsed laser at infrared wavelengths onto gold nanoparticles, one observes the emission of visible white light. These photons clearly have higher energy than the incoming excitation, [1]. The mechanism of this nonlinear photoluminescence is still debated, different hypothesis have been advanced, such as multiple photon absorption and thermal emission by a hot electron gas, see [2], [3]. In order to gain further understanding, we measure the second-order photon correlation function ($g^2(0)$) of the emitted photons, by filtering the spectrum to match the bandwidth of our detectors and then perform a Hanburry Brown-Twiss experiment, [4]. For a thermal emission mechanism we expect to observe bunching of photons, instead of the random photon arrival of the pump laser.

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The SFNano C'Nano joint meeting 2019

Thematic Session: Nanophotonics & nano-optics
Keywords: SERS, Plasmonics, gold thin film, grating, gold nanostructures

SERS signal optimisation of gold nanocylinder on gold film

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Abstract
Gold nanostructures deposited on gold thin film exhibit some specific optical properties with the observation of specific modes where the film propagating modes are resonantly excited by the array periodicity.[1] It has already been demonstrated that the surface enhanced Raman scattering (SERS) is higher in this configuration compared to the one recorded for gold nanostructures on dielectric substrates (glass or ITO).[2,3]
SERS studies have been performed on gold nanocylinders arrays deposited on a gold thin film, produced by electron beam nanolithography, using the 4-mercaptobenzoic acid (MBA) as probe molecule.
We demonstrate a strong variation of the SERS signal depending on the nanocylinder geometrical parameters (diameter from 50 to 250nm with a periodicity from 350 to 500nm, height of 50 nm), on the film thickness (from 20 to 50 nm) and the excitation wavelength (532nm, 638 nm and 785nm). We correlate these SERS variations with the plasmonic properties of the substrate.

This work is supported by the ANR Louise project (ANR-15-CE04-0001) and the International ANR Nanobiosensor project (ANR-15-CE29-0026).

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The SFNano C'NANO joint meeting 2019

Thematic Session: Nanophotonics & nano-optics
Keywords: Plasmonics, gold thin film, grating, gold nanostructures

Plasmonic properties of gold nanocylinder on gold film

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Abstract
In this poster, we propose a systematic study of the plasmonic properties of gold nanocylinder grating deposited on a gold thin film. Depending on the film thickness, we observe several plasmon bands. Using a simple analytical model of the plasmon in a gold film, we are able to assign all the modes and determine that they are due to the coupling of the grating diffraction orders with the SPP inside the film. With FDTD simulations, we demonstrate that large field enhancement occurs at the surface of the nanocylinders for these modes. By tilting the sample, we also observe the evolution of the position of these modes on nearly the whole visible range with the incident angle. Through the mode assignment, we are able to reconstruct the gold thin film dispersion relation depending on the film thickness. Such plasmonic substrates combining both advantages of the propagative and localised surface plasmons could have large applications in enhanced spectroscopies.

This work is supported by the grant PIRANEX project (ANR-12-NANO-0016), the Louise project (ANR-15-CE04-0001) and the Nanobiosensor project (ANR-15-CE29-0026) from the French National Research Agency (ANR).

The SFNano C'Nano joint meeting 2019

Thematic Session: Nanophotonics & nano-optics.
Keywords: gold nanoparticles, heat generation, absorption cross-section, thermo-plasmonic.

Size Effect on Photothermal Heat Elevation of Gold Nanoparticles: Absorption Coefficient Experimental Measurement of Gold nanoparticles

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Gold nanoparticles (GNP) are very suitable agents for thermal destruction of cancer cells due to their photothermal heating ability. In this work, photothermal properties of different sizes and shapes of GNP were studied regarding different parameters such as GNP concentration, laser excitation power and exposition time. By using the heat transfer theory, the temperature elevation in the GNP solutions was converted in temperature elevation at the GNP surface. This allow us to determine the absorption cross section (σabs) of two different sizes of spherical gold nanoparticles (GNS), which were compared with the theoretical calculations based on Mie theory and both results were in a good agreement. σabs was determined also for gold nano-urchins (GNU) with different sizes (50, 80 and 90nm) with high precision. The experimental results show that the absorption properties of branched particles are stronger than spherical ones. Otherwise, the temperature elevation speeds were experimentally measured for all GNP and we have demonstrated that they are proportional to the GNP surface area as demonstrated in the classical diffusive heat transport theory. The proposed approaches can be used to monitor the local heat generation around the GNP and pave the way to the optimization of the photothermal properties of GNP.

The SFNano C'NANO joint meeting 2019

Thematic Session: Nanophotonics & nano-optics
Keywords: Nanostructures, Strong Coupling, Energy transfer, Light-matter interactions

Plasmon mediated interactions between fluorescent emitters: from weak to strong coupling regime

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The spontaneous emission of a fluorescent emitter can be tuned by placing it in a nanostructured environment. While plasmonic structures have been widely exploited to control the emission properties of fluorescent emitters, either as ensembles or as single emitters, performing a plasmonic coupling between different quantum emitters remains an almost unexplored field.

We demonstrated that surface plasmons can be used to greatly enhance the range of energy transfer between fluorescent emitters, first on a thin silver film [1] and second over a silver nanowire at the single plasmon level [2]. In this poster we report about the study of the interaction between an ensemble of CdSe/CdS/ZnS quantum dot (QDs) and a strongly coupled exciton-plasmon system. This last consists on an organic semiconductor, namely, cyanide dye J-aggregates, deposited on a thin silver film.

The interaction between the layer of QDs and the hybrid exciton-plasmon system is monitored by exciting the QDs and by performing luminescence and absorption measurements, as well as decay rate measurements. The results obtained for the complete sample are then compared with the results obtained for the exciton-plasmon system alone [3]. In the presence of the QDs layer, we retrieve the strong coupling behavior for an efficient excitation of the dye molecules and observe a plasmon mediated energy transfer between the two species of emitters. The signature of such interaction can be also found in the measured decay rate of the QDs, which is enhanced by raising the number of strongly coupled J-aggregates in the surroundings.

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The SFNano C'Nano joint meeting 2019

Abstracts

Poster Session

P9 - SURFACE, INTERFACE AND NANOCONFINEMENT

The SFNano C'NANO joint meeting 2019

Thematic Session: Surface and interface at the nanoscale

Keywords: Electrical Characterization by AFM, ZnO nanowires, Pressure sensors

Electrical Characterization of Nanostructures by Atomic Force Microscopy Modes: Comparation and example of application

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Over the past few decades, real interest has been shown in various nanostructures like nanoparticles, nanowires due to their amazing parameters in nanoscale [1-2]. It was shown that nanomaterials can be effectively used in the construction of nano-devices such as generators, variety of sensors, transistors, resistive memory, etc. The study of properties of single nanoparticle makes a great contribution to optimization and the effectiveness of the device in general and makes an important contribution to improving future device technology production. However, due to the small size of the nanoparticles, determination of important parameters, that affect the efficiency of the device, is a challenging task. For devices in which electrical and piezoelectric parameters play an important role, characterization by atomic force microscopy (AFM) is one of the best solutions. Using various electrical modes that use different physics for characterization, it is possible to obtain the most accurate characterization results.

The purpose of this poster is to show well-known characterization methods such as scanning spreading resistance microscopy (SSRM) [3], scanning capacitance microscopy (SCM) [4] and scanning microwave microscopy (SMM) [5], as well as reveal their advantages and disadvantages. Using the example of a zinc oxide multi-structure, it will be shown how to determine important electrical parameters such as mobility, resistivity, concentration of free charge carriers and carrier type.

In the end, it will be demonstrated one of possible application of these methods to characterize a single zinc oxide nanowire as an example, which have a high demand for the project, that aims to create a material for a flexible pressure sensor to be used in a biological media.

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The SFNano C'Nano joint meeting 2019

Thematic Session: (Nanoconfined liquids & gases)

Keywords: (Solid-state nanopores – Molybdenum disulfide MoS2 – Ionic conductivity – MD simulations)

Improved model of ionic conductivity in 2-D MoS_2 nanoporous membranes

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Solid-state nanopores made of two-dimensional (2D) materials such as molybdenum disulfide (MoS_2) have sparked great interest due to their unique properties and promising applications in membrane separation technology, such as ion filtration and biomolecule translocation. Controlled fabrication and tunability of nanoporous membranes require a better understanding of their ionic conductivity capabilities at the nanoscale. Here we developed a model of ionic conductivity for a KCl electrolyte through sub-5 nm single-layer (SL) MoS_2 nanopores using equilibrium all-atom molecular dynamics (MD) simulations. We investigate the dynamics of K^+ and Cl^- ions inside the pores in terms of concentration and mobility. We report that, for pore dimensions below 2.0 nm, which are of particular interest for biomolecule translocation applications, the behaviors of the concentration and mobility of ions strongly deviate from bulk properties. Specifically, we show that the free-energy difference for insertion of an ion within the pore is proportional to the inverse surface area of the pore and that the inverse mobility scales linearly as the inverse diameter. Finally, we provide an improved analytical model taking into account the deviation of ion dynamics from bulk properties, suitable for direct comparison with experiments.

The SFNano C'Nano joint meeting 2019

Thematic Session: Surface & interface at the nanoscale
Keywords: Self-assembled monolayer, chain length, terminal group, XPS, PM-IRRAS

Investigating effects of chain length and terminal group on the organization of thiolate Self-Assembled Monolayers (SAMs) on gold surface

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The first step towards biosensors development on both planar surfaces and metallic nanoparticles relies on surface functionalization through self-assembled monolayers (SAMs). SAMs are more or less ordered assemblies of organic molecules that form spontaneously on surfaces. [1]

One of the most studied system is thiolate molecules on metallic surfaces, more extensively on gold. Thiolate SAMs formation consists into two steps, a rapid adsorption and then a reorganization of the lateral chains which can be slower. Yet, the latter step is adsorbate dependent and is influenced by its nature: allegedly an ordered monolayer is obtained for a backbone composed of at least 10 methylene groups. In previous studies, it has been shown that depending on the nature of the adsorbates, different behaviors can be observed affecting the degree of organization: a single-molecule adsorption (short chain) vs. self-assembly phenomena (long chain). [2]

In this work the adsorption of thiolate molecules on gold surfaces to form various SAMs has been studied, therefore both chain length and terminal groups (R = NH_2, CH_3 and COOH) contributions were investigated. The resultant thiolate SAMs have been characterized through various methods: PM-IRRAS, XPS and WCA **(Figure 1)** to investigate the mechanism of assembly and link it to final properties of the resulting functional surface.

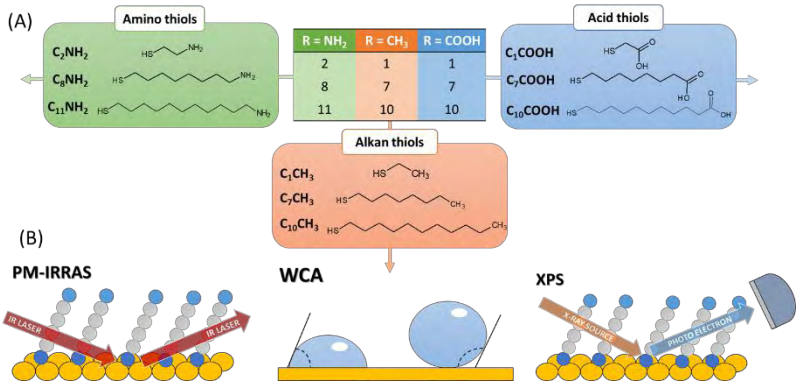

Figure 1. (A) Thiol molecules used to form Self-Assembled Monolayers (SAMs) on gold surface (B) Schematic representation of the Polarized Modulation IR Reflection-Absorption Spectroscopy (PM-IRRAS), Water Contact Angle (WCA) and X-Ray Spectroscopy (XPS).

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The SFNano C'Nano joint meeting 2019

Thematic Session: Nanomaterials, Surface and interface at the nanoscale
Keywords: Characterization, Surface analysis, Thin films, Nanofabrication

Presentation of ICB laboratory technological platform

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To support ICB research activities, ARCEN platform (Applications, Researches and Characterization at Nanoscale) has been created in 2009 by mutualizing existing equipment and skills, with the support of the Regional Council of Burgundy and State and EU funds.
The platform consists of 4 centers which are: Micro-Nano Characterization Center (CMNC), Nano Fabrication Center (CNF), Electronic and Informatic Development Center (CDIE) and Mechanical Resources Center (CRM).

The Micro-Nano Characterization Center (CMNC) gathers equipment of densified and divided materials characterization, such as transmission and scanning electron microscopy, surface analysis (XPS, SIMS) and X-ray diffraction.

The Nano Fabrication Center (CNF) owns a 40m2 clean room and runs thin films deposition, structuration and characterization equipment.

The Electronic and Informatic Development Center (CDIE) manages the computing network and data centers, develops specific software and also supports the research activities by prototyping and fabricating data acquisition systems and electronic cards.

The Mechanical Resources Center (CRM) designs, produces and adapts mechanical parts for vacuum chambers and mechanical systems by mobilizing high-precision machining and welding competences.

This equipment is available to the laboratory research teams, academic and industrial partners and regional Technology Transfer Accelerator Office through direct autonomous use after training, collaborations or services.

The SFNano C'Nano joint meeting 2019

Thematic Session: Nanoconfined liquids & gases

Keywords: Electrolytes, Carbon Nanotube, Conductance, Phase Transition, Statistical Physics

Role of low water dielectric constant on ionic transport in nanopores

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In this work, we focus on the conductivity of salt water flowing through a carbon nanotube. Recent experimental results (Fumagalli *et al.* 2018) show that the dielectric constant of water decreases tremendously under nanometric confinement. Using a variational approach to study ion penetration into water-filled spherical nanopores, we first show that a ionic liquid-vapor transition occurs due to dielectric exclusion. Then, we describe the impact of the confined water dielectric constant and the ionic finite-size (Born solvation energy) on this phase transition.

The SFNano C'Nano joint meeting 2019

Thematic Session: Surface & interface at the nanoscale.

Keywords: silver nanoparticles, deposition, pyrolyzed photoresist film, electroreduction, 4-nitrophenol.

Silver butyl amidinate complex: an original precursor to nanostructure a carbon based electrode.

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Electrochemical sensors modified with nanomaterials allow very high detection accuracy thanks to the nanoscale properties of their electrodes [1]. In recent years, great progress has been made to design novel electrochemical sensors taking advantage from nanomaterials: nanomaterials can increase the surface of the transducing area of the sensors and present catalytic behaviors which both allow a better detection and favor miniaturization [2].

Silver nanoparticles (AgNPs) have been studied due to their interesting properties, including electrical conductivity, optical and catalytic properties. Several methods have been developed for the functionalization of surfaces with AgNPs [3,4]. However, very few paths are based on the mild decomposition of metalorganic silver precursors, which enables an effective controlled deposition of AgNPs on surfaces.

Glassy carbon and gold are among the most used materials for electrodes in electrochemistry since they are robust, highly electrically conductive and present wide electroactive potential ranges. Among carbon-based substrates, ultra-flat carbon films formed *via* the pyrolysis of photoresist resins films (PPF) coated on a substrate have recently been highlighted [5].

In the present work, PPF substrates have been decorated with AgNPs *via* the liquid-phase thermolysis of metalorganic silver precursors [6,7]. AgNPs/PPF composite electrodes have been characterised by SEM and AFM analyses. These electrodes have been used as working electrode for the detection of 4-nitrophenol, used as a model pollutant.

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The SFNano C'Nano joint meeting 2019

Thematic Session: Surface & interface at the nanoscale
Keywords: (Nanoparticles, Surface Functionalization, Protein-Corona, Biodistribution)

Role of protein corona on nanoparticles: influence of the surface chemistry

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As nanoparticles (NPs) are increasingly used in many applications their safety and efficient applications in nanomedicine have become concerns[1,2]. It is now well recognized that the surfaces of nanoparticles (NPs) are coated with biomolecules (e.g., proteins) in biological media. The surface chemistry is clearly playing a role in the NPs/proteins interactions (protein corona) and the protein coronae on nanomaterials' surfaces can also influence how the cell "recognizes" nanoparticles, as well as the *in vitro* and *in vivo* NPs' behaviors. In this study, the influence of surface chemistry on protein coronae was quantified and their role on NPs' circulation was observed.

Firstly, to mimic surface properties of different types of NPs, a core–shell of iron oxide nanoparticles (SPIONs) library was prepared by coating with different surfaces: polyvinyl alcohol polymer (PVA) (positive, neutral and negative), SiO_2 (positive and negative), titanium dioxide and metal gold[3,4]. The tightly bound proteins were quantified and identified to study the impact of many surface parameters (surface charge and chemistry) on protein adsorption.

Then, the *in vivo* protein coronae of PVA-coated SPIONs with various surface charges were also quantified[5]. The compositions of the corona at the surface of various SPIONs and their effects on the biodistribution of SPIONs were examined and compared with the corona compositions of NPs incubated for the same time in rat serum.

Finally we illustrated the importance of control and replicate experiments in protein corona studies to avoid biased results and to properly quantify the differences and similarities between comparable systems[6].

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The SFNano C'NANO joint meeting 2019

Thematic Session: Surface, interface & nanoconfinement

Keywords: Nanosensor, molecular dynamics, protein-surface interaction, 2D materials

Advanced simulations for the study of biological processes on the nanointerfaces of immunosensors

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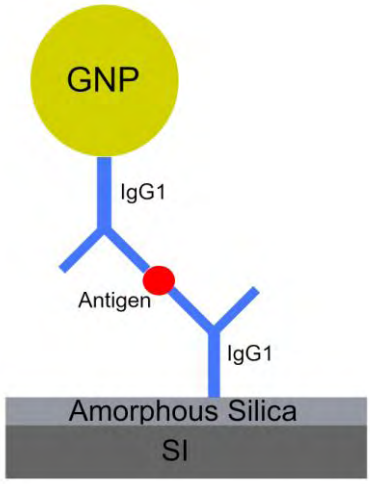
Blood transfusion is one of the most used treatments in order to heal people with different diseases, after taking several damages in accidents or after surgery. However, the window period of infection is a critical issue, especially in those most common diseases with big window periods such as the hepatitis and AIDS. Although it is hard to make the window period disappear, it can be reduced by improving the detection techniques. Nowadays, hyperspectral platforms based in plasmonic resonance are being used to improve the detection of active agents. Immunosensors allow detecting a wide range of analytes using antigen-antibody interactions. However there is a lack on the knowledge of the nature of the binding, which will allow us to infer the nature of stacking and adsorption of antibodies on the surface of sensors. In this work atomistic models of several interfaces have been performed within the Molecular dynamics (MD) and QM/MM approaches to study the orientation and interactions of a "sandwich" type immunosensor composed by Silica-IgG1-Antigen-IgG1-GNPs (gold nanoparticles), where the antigen detection is enhanced by plasmonic resonance due to the gold properties.



The SFNano C'Nano joint meeting 2019

Thematic Session: Surface and interface at the nanoscale

Keywords: Nanopore size; Conducting polymers; Density functional theory

Control of Surface Nanoporosity in Films of Polythiophene Derivatives

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The ability to easily control the porosity of nanoparticles could be used to load and release controlled drugs on the material surface. It is known that conducting polymers exhibit different oxidation states with an easily interchange among them by means of the application of an electrical potential. In this work, we present a theoretical and experimental study to regulate the pore size of poly(3,4-ethylenedioxythiophene) (PEDOT) films doped with ClO_4^- ions by controlling their oxidation state. It is observed an important size increment of 25.2% between the nanopores of the oxidized and reduced forms. Surface porosity variability is also corroborated theoretically by modelling of structural defects in 2D surface of PEDOT at quantum mechanics level. This superficial phenomenon can be potentially scaled up to retain and release controlled drugs through the application of different electric potentials.