C’Nano GSO Youth Meeting

ONLINE

November 17th, 2025

Programme & Abstracts

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PROGRAMME

14h00-14h05 : Ouverture

14h05-14h55 : Fabienne TESTARD *"The gold nanoparticles world: from synthesis to applications"*

15h00-15h15 : Lina EL AISSATI *"2D Particle assembly on surfaces for optical metasurface fabrication "*

15h20-15h35 : Benjamin LECARLATE FERNANDEZ
"Damping the bi-stability of a carbon nanotube mechanical resonator to improve sensitivity"

15h35-15h55 : Pause

15h55-16h20 : Sébastien MUCHA
"Carbon dots with bright one and two-photon excited fluorescence as promising biomarkers"

16h25-16h40 : Ali QASSEM
"From hybrid peptides to structured bioorganic-inorganic materials"

16h45-17h00 : Farah ABDEL SATER
"Iron oxide multifunctional nanoplatforms: towards temperature control in photothermia and magnetothermia"

17h05-17h20 : Clara CATROS
"NP-NP FRET with Fluorescent Organic Nanoparticles for Biosensing Applications"

17h25-17h40 : Guillaume BONIFAS
"Quantum Dots as Nanothermometers: Measuring Temperature at the Nanometer Scale"

2D Particle assembly on surfaces for optical metasurface fabrication

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Résumé

A metasurface is a 2D optical element composed of nanometric structures with a size on the order of the wavelength, which modulates light wave properties by inducing changes in phase, polarization, or amplitude. I am working on the 2D assembly of optically resonant particles organized on a structured surface, with the aim of tuning optical properties. These properties depend on the interaction between the light and the particles. Therefore, in order to control the wave propagation, it is essential to precisely manage the surface organization, as well as the size, nature, and spacing of the particles. We work in collaboration with a team in the LAAS in Toulouse, who designs the surface patterns using machine learning to optimize the structure. The ENS in Lyon are in charge of fabricating the resonant particles. As a first step, we fabricate a structured substrate with the appropriate arrangement and spacing of nanocavities using nanoimprint lithography via soft lithography. Then, using a custom-built microevaporator, these cavities are filled with carefully selected particles. My oral will present the fabrication techniques employed to create the surface and deposit the particles in the nanocavities.

Mots-Clés: Metasurface, Particle assembly, Optical properties, Patterned surface

*Intervenant

Damping the bi-stability of a carbon nanotube mechanical resonator to improve sensitivity

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Résumé

Carbon nanotubes as nanomechanical resonators are very promising systems due to their small size and mass as well as their stiffness that grant them great sensitivity as a sensor. As a result, ample research (1)(2) is oriented towards these devices in order to understand the sources of noise and reach better sensitivities. In this work, we are interested in the mass-sensing applications and will analyze their mechanics, both in the linear and nonlinear regimes.

The treatment of nonlinearities is particularly challenging because there is no unique solution to the equation of motion. In addition, even if we do not perceive its characteristic bi-stability at room temperature, we still enter the nonlinear regime where the well-known models are no longer accurate. However, it is not easy to distinguish between the two regimes, since the linear model is only an approximation of the nonlinear model for small drives. The benefit of the nonlinear regime is that the received signal is stronger.

There are several parameters to take into account (drive power, temperature,...), we studied some that affect the sensitivity to understand which are relevant for our system. We obtained a record-breaking sensitivity of 2x10^2 g.

We usually work at room temperature and cannot observe bi-stability, but we observed bi-stability when the temperature is lowered, which is in agreement with the theory that a small Q prevents hysteresis from appearing. With this in mind, it is interesting to have a low Q system at room temperature, as a sharper resonator would introduce additional noise due to bi-stability. We have therefore found a compromise between a large damping (3), which blocks hysteresis, and a sharp resonance, which gives precision.

We achieved a record-breaking sensitivity at room temperature of 0.2 yg which is promising for future applications, given that the previous record sensitivity was reached in a cryostat (4).

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Mots-Clés: Carbon nanotube: nanomechanics: sensitivity

From hybrid peptides to structured bioorganic-inorganic materials

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Résumé

Self-assembling peptides (SAPs) possess the ability to form a wide range of supramolecular structures and nanomaterials (1). However, these assemblies often suffer from limited structural stability due to the inherently weak non-covalent interactions that drive their formation (1). To address this limitation, we developed hybrid peptides by chemically modifying the peptide building blocks through silylation. That is to say, the introduction of alkoxysilane groups onto the peptides (2). Undergoing a sol-gel process, these silylated peptides create covalent Si–O–Si bonds between peptide sequences, thereby enhancing the stability of the resulting self-assembled structures (2).
Using silylated diphenylalanine-based peptides, this project focuses on creating stable and novel nanostructures. The morphology of the final nanostructures is guided by the peptide sequences and templating agents such as cetrimonium bromide. Twisted nanoribbons with a variety of dimensions were obtained from the bis-silylated form of the peptide H-L-Phe-L-Phe-NH-CH-CH-NH and characterized using scanning electron microscopy (SEM), cryo-electron microscopy (cryo-EM), transmission electron microscopy (TEM), atomic force microscopy (AFM), nuclear magnetic resonance (NMR), and Raman spectroscopy. These analyses revealed a layered peptide organization contributing to the overall architecture.

This study presents a new strategy to enhance peptide-based nanomaterials through silylation and sol-gel chemistry. It also demonstrates the potential to program the shape and structure of the nanomaterial based on the chosen building blocks. The resulting hybrid nanoribbons exhibit improved stability and well-defined morphology, highlighting their promise as future functional nanomaterials.

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Mots-Clés: Self, assembling peptides, supramolecular structures, sol, gel reaction, nanostructures

*Intervenant

Iron oxide multifunctional nanoplatforms: towards temperature control in photothermia and magnetothermia

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Résumé

Over the past decades, inorganic nano-objects capable of generating significant heat when remotely activated by external stimuli have garnered considerable attention. For this reason, numerous nano-heaters with diverse compositions, sizes, and morphologies activated either by light irradiation (photothermal agents) or by the application of an alternating current magnetic field (magnetothermal agents), have extensively been reported.

Among these, iron oxide nanoparticles received a particular attention due to their capacity of generating heat when it is exposed to external stimuli. This characteristic offers promising applications in hyperthermia treatment, catalysis, and radical release. Yet, a better understanding and control of the temperature rise at the surface of the nanoparticles remains challenging.
In this study, we investigate a new class of multifunctional nano-objects designed to enable simultaneous temperature monitoring during photothermal heating. These hybrid nanostructures combine a magnetic core with a tailored luminescent shell, allowing simultaneous light-induced heating and ratiometric thermometry in aqueous media. Real-time luminescence-based temperature tracking under near-infrared irradiation demonstrates reproducible and stable thermal feedback, underscoring the potential of these nano-objects for precise, localized temperature control in future photothermal and theranostic applications.

Mots-Clés: Iron oxide nanoparticles/ Multifunctional nanoparticles/ Photothermia/ Thermometry

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NP-NP FRET with Fluorescent Organic Nanoparticles for Biosensing Applications

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Résumé

Developing highly sensitive and robust optical biosensors requires luminescent transducers with high brightness and strong photoresistance to lower the limit of detection and increase the observation time. Luminescent nanoparticles (NPs) such as quantum dots, upconversion and fluorescent organic NPs outperform traditional molecular organic dyes by offering superior brightness and photostability(1). In addition, their functionalizable surface constitutes a versatile platform to design multivalent biosensors.
A key mechanism for nanoscale sensing is Förster Resonance Energy Transfer (FRET)(2), a non-radiative energy transfer that arises from the interaction of the transition dipoles of a donor fluorescent species (D) and an acceptor (A) that absorbs energy. FRET efficiency depends strongly on the donor-acceptor distance (r), which typically ranges from 1 to 10 nm and decreases in 1/r. When FRET is combined with bioreceptors, it allows to build biosensors where the fluorescence spectra evolves with the analyte concentration(3). When NPs are used as tranducers instead of small molecules, their superior brightness permit to decrease the sensor's limit of detection(4). While FRET between molecular dyes or FRET with NPs as donors and molecular species as acceptors has been largely studied(1), only a few examples of FRET between NPs (NP-NP FRET) can be found in the literature, and are mostly described with quantum dots(5).

This work investigates NP-NP FRET using metal-free fluorescent organic NPs to develop ultra-sensitive nanosensors. The studied NPs possess a core-shell structure consisting of a hydrophilic functionalizable shell (carboxylic acids groups) and a hydrophobic fluorescent core (dye copolymerized with styrene), containing up to thousands of chromophores per NP for a high brightness(6). By fine-tuning their optical properties and functionalizing their surfaces with biomolecules, we aim to create efficient NP donor-acceptor FRET pairs for the development of a highly sensitive drug biosensor.
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Mots-Clés: Nanoparticles, Fluorescence, FRET, Biosensing

Quantum Dots as Nanothermometers: Measuring Temperature at the Nanometer Scale

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Résumé

Nanocatalysis (the use of nanoparticles (NPs) as catalyst) has been receiving recently an increasing attention and has emerged as a domain at the border between homogeneous and heterogeneous catalysis.(1),(2) An additionnal input compared to the classical approach, is the use of the physical properties of the catalytic NPs for self-heating (magnetic or plasmonic properties) during the catalysis process, whether homogeneous, in solution, or heterogeneous after deposition onto a support. Temperature measurement near the surface of the catalyst is mandatory since the catalytic reactions display precise temperature ranges, outside which they can follow alternative pathways. It is however not a trivial objective, especially above 200∘C. The pertinent information is the surface temperature of the particles since there will be a huge gradient of temperature between the heated particles and the environment(3). Thermometric probes have been described at low temperatures with fluorophores(4) as well as quantum dots (QDs)(5). However, using phosphors to determine high temperatures under harsh experimental conditions remains largely unexplored and highly challenging (6). At the nanoscale, QDs optical properties offer a rare opportunity to build an innovative complex nano-object integrating heating capacities, catalytic ability and thermal reporting property. Thus, the temperature-dependent emission of nanocrystals (NCs) have been investigated in this purpose. Different parameters such as the peak wavelength, the intensity, the area of emission and the full width at half maximum were completely characterized as a function of temperature. The range of temperature studied goes from room temperature to 300∘C (solution). NCs of InP@ZnS(7) were synthesized and investigated.

*Intervenant

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Mots-Clés: Nanothermometry, Quantum Dots