Rencontres Jeunes du C'Nano Ile-de France

Lundi 4 octobre 2021
Programme & Abstracts

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Rencontres Jeunes du C'Nano Ile-de-France

Date : lundi 4 octobre 2021 (14h – 18h)
Lieu : Campus Pierre & Marie Curie de Sorbonne Université, Paris 5ème

PROGRAMME

13h30 – Accueil

14h – Introduction

14h10 – Conférence de Juliette MANGENEY (CNRS – LPEN)
« Graphene Quantum Dots for coherent THz emission »

14h40 – Présentations des jeunes doctorant.e.s & post-doctorant.e.s du C'Nano IdF

- Aisara AMANOVA (Université Paris-Saclay – ICP) **:** *« Functional Nanoinks Based on Metal Nanoparticles for Printed Electronics »*
- Andrea GERINI (Université Paris Diderot – MPQ) : « *Electrically injected OPO : design and technology* »
- Elyes DHAOUADI (CNRS – LSPM) : « *Hight-quality monolayer graphene by inductive heating* »
- Mafalda JOTTA GARCIA (UMPhy – CNRS) : *« Réduction du Bruit dans des Capteurs à base de Vortex par la Dynamique de Transfert de Spin »*

15h40 – Remise du Prix C'Nano Ile-de-France :

- **Nicola CARLON ZAMBON** (Université Paris-Saclay – CN2) **:** *« Chirality and nonlinear dynamics in polariton microresonators »* - *visioconférence*

15h50 – 16h35 – Pause café & Session posters

16h35 – Conférence de Simona MURA (Université Paris-Saclay – IGPS)
« Nanomedicines: tracking their fate from site of administration to site of action »

17h05 – Présentations des jeunes doctorant.e.s & post-doctorant.e.s du C'Nano IdF

- Simon DELACROIX (Ecole Polytechnique – LPICM) : *« Développement d'un capteur SERS pour la détection de composés organiques volatils »*
- Davide ROMANIN (CNRS – INSP) « *The Landau-Peierls distortion in the linear acetylenic carbon chain: an ab-initio study of the interplay between electronic correlations and anharmonic lattice dynamics* »
- Pan pan MA (Université de Paris – UTCBS) : « *Biopharmaceutic properties enhancement of prednisolone by preparing and characterizing nanocrystal aqueous suspensions of the active ingredient* »

17h50 – Remise du Prix C'Nano Ile-de-France :

- **Kokoura MENSAH** (ESPCI Paris – Institut Cochin) **:** *« Détection d'acides nucléiques avec des réseaux de transistors à base de graphène »*

Abstracts disponibles ci-dessous.

Rencontres Jeunes du C'Nano Ile-de-France

Abstract de
Juliette MANGENEY

Laboratoire de physique de l'ENS
(LPENS, CNRS / ENS Paris / Sorbonne Université / Université de Paris)

Rencontres Jeunes du C'Nano Ile-de-France

First Name, Family Name: Juliette MANGENEY
Staut: Research Director
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City: Paris

GRAPHENE QUANTUM DOTS FOR COHERENT THz EMISSION

Terahertz (THz) radiation is extremely appealing for fundamental investigations of matter and emerging applications, such as security screening, medical imaging, astrophysics and atmospheric science. However, the THz spectral range remains one of the least technologically developed spectral regions mainly due to the lack of compact powerful sources. The development of the typical semiconductor-laser scheme emitting at THz frequencies has been seriously hampered by the absence of an appropriate material with a sufficiently small bandgap.

Graphene quantum dots are an excellent candidates for coherent THz emission and for a THz semiconductorlaser model at room temperature. Indeed, THz photons can induce interband transitions in graphene and related nanostructures, the optical phonon energy in graphene is very high (200 meV) and Auger recombination processes that are detrimental for THz lasing can be inhibited [1].

This talk will focus on the potential of large graphene quantum dots (d~100 nm) for THz coherent emission and lasing. I will present modeling of the electronic and optical properties of large graphene quantum dots, the recent technological developments for their fabrication and their quantum response to THz illumination [2,3].

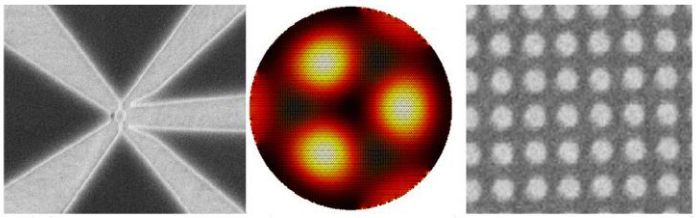

Figure 1: Left: Single electron transistor made of a graphene quantum dot. Center: Electron probability density for a bulk state of a large graphene quantum dot. Right: Array of graphene quantum dots.

References:
[1] P. Huang, *et al*. Nat Commun **11**, 863 (2020)
[2] E. Riccardi *et al*. Nano Lett. **20**, 7, 5408–5414 (2020)
[3] S. Messelot *et al*. submitted (2021)

Keywords : Graphene, Quantum Dot, Terahertz, Laser

Rencontres Jeunes du C'Nano Ile-de-France

Abstracts des jeunes doctorant.e.s & post-doctorant.e.s de la région Ile-de-France

Rencontres Jeunes du C'Nano Ile-de-France

First Name, Family Name: Aisara AMANOVA
Title (PhD student 1st, 2nd, 3rd year/ Post-doc): 3rd year PhD student
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Thesis supervisor(s): Hynd REMITA
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FUNCTIONAL NANOINKS BASED ON METAL NANOPARTICLES FOR PRINTED ELECTRONICS

Conductive inks are recent progress in the electronics industry and widely used for the fabrication of flexible printed electronics. Silver is the commonly used metal for conductive inks due to its excellent electrical conductivity (6.3 x 107 Ω-1 m-1) and stability to oxidation. However, the high price of silver and low resistance to electrochemical migration limits wide industrial applications. In this regard, copper can be a good alternative metal for conductive inks because of its equivalent conductivity to silver (5.96 x 107 Ω-1 m-1), vast abundance, low price, and strong resistance to electrochemical migration. In the current work, we are developing inks based on silver and copper nanoparticles stabilized by polymers and synthesized by chemical, radiolytic, photochemical methods. The prepared inks have been deposited on the plasma-treated PET and glass substrates by the aerospray method. The inkjet printing method will be elaborated for printing electrical circuits after adjusting the viscosity, surface tension of inks using various additives. Sintering with thermal and photonic treatments was performed to increase the electrical conductivity through creation of percolation path. The 4 point-probe method was employed to measure the electrical conductivity after sintering. The obtained values of electrical conductivity (1.66 x 105 Ω-1 m-1) of our inks are comparable to commercial inks. This holds promise to apply our conductive inks in printed electronics such as flexible displays and sensors.

Keywords: conductive inks, flexible printed electronics, inkjet printing, metal nanoparticles

Rencontres Jeunes du C'Nano Ile-de-France

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ELECTRICALLY INJECTED OPO: DESIGN AND TECHNOLOGY

Optical parametric oscillators (OPOs) are widely tunable coherent sources based on parametric amplification in a nonlinear medium and resonant feedback in an optical cavity. While optically injected macroscopic devices are commercially available and micrometric OPOs have already been fabricated, a monolithic device integrating nonlinear cavity and laser source is yet to be demonstrated. We present a design integrating in the same epitaxial structure both an electrically injected laser source and a nonlinear resonant cavity.

As schematically represented in Fig. 1A, the main constitutive elements are: a high-power DFB laser with a lateral N contact designed to emit 100 mW around λ = 975 nm which is based on an existing diode from the III-V Lab; a racetrack resonator designed for the parametric amplification from an higher-order pump mode at λ to the fundamental TE and TM modes at 2λ; a two-level vertical coupler transferring power from the laser mode to the pump mode; independent lateral heaters to provide wavelength tunability. The length of the racetrack coupling section is used to achieve critical coupling for the pump.

The OPO threshold power is shown in Fig. 1B as a function of the racetrack coupling length for different values of losses of the generated waves. Considering reasonable losses levels, the threshold is of the order of 10 mW and, therefore it's compatible with the available pump power.

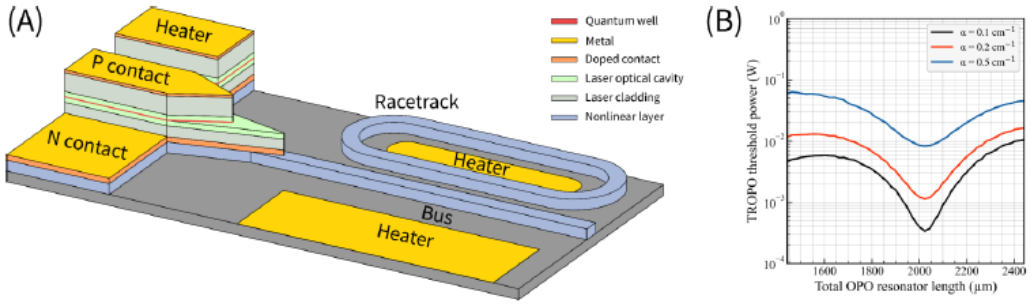

Fig. 1. (A) Out-of-scale sketch of the electrically injected OPO with a high-power DFB laser diode, a two-level vertical coupler transferring power to the pump mode of the nonlinear structure, a racetrack resonator coupled to a bus waveguide, and the heaters used to provide wavelength tunability. (B) The OPO threshold power as a function of the generated waves losses α and assuming pump losses αp = 1 cm^{-1}.

Keywords: nonlinear-optics, optical-parametric-oscillators, optoelectronics, guided-wave-optics

Rencontres Jeunes du C'Nano Ile-de-France

First Name, Family Name: Elyes DAHOUADI
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Employer, Laboratory: CNRS – LSPM
Thesis supervisor(s): M. ABDERRABBA & S. FARHAT
City: Villetaneuse

HIGH-QUALITY MONOLAYER GRAPHENE BY INDUCTIVE HEATING

We report a route to high-quality mono layer graphene synthesis by chemical vapor deposition (CVD) using methane as precursor. The synthesis occurs on a centimeter-sized copper foil heated by electromagnetic induction in a controlled atmosphere. The rate of heating the metal foil is much faster than in traditional thermal CVD and typically steady-state temperature of ~ (1050±3) °C is reached after only ~2 min . The rapidity of the inductive heating process highlights the advantage of using this process to achieve graphene synthesis. In addition, electromagnetic heating only heats the metallic substrate allowing for improved process efficiency in terms of fast, localized, homogeneous and precise heating with energy saving. Due to these advantages, inductive heating has great potential for large scale and rapid manufacturing of graphene. In this presentation we will discuss the conceptual design of the reactor supported by modeling (Figure 1a-c). Then, the proof of concept will be illustrated through graphene growth on inductively heated copper with controllable domain size. As shown in Figure 1-d, little defective monolayer graphene is obtained in the Raman spectra with a very small percentage of multilayer graphene. Scanning electron microscopy confirmed the observation of nondefective graphene subdomains of average size of ~ 2 µm.

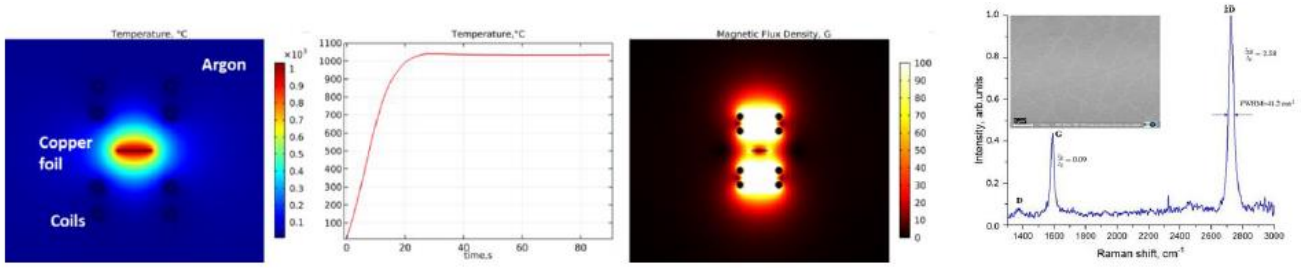

Fig. 1. (a) Temperature distribution in the induction heating system after applying a current of 243 A during 90 s. (b) Calculated copper foil surface temperature versus heating time. (c) Magnetic flux density (d) Raman spectra in confocal mode in air with the backscattering configuration using 473 nm laser excitation at room temperature of as-grown monolayer graphene on copper foil substrate, G peak at 1587 cm-1, 2D band at 2725 cm^{-1} (bandwidth ~41 cm^{-1}). Inset is SEM image showing graphene domains. Scale bar is 2 µm.

Keywords: graphene, inductive heating, copper, numerical simulation

Rencontres Jeunes du C'Nano Ile-de-France

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Employeur, Laboratoire : CNRS – UMPhy
Encadrant.e.s de thèse : Vincent CROS
Ville : Palaiseau

REDUCTION DU BRUIT DANS DES CAPTEURS A BASE DE VORTEX PAR LA DYNAMIQUE DE TRANSFERT DE SPIN

Les performances des capteurs magnétorésistifs sont principalement limitées par leur bruit 1/f basse fréquence [1]. Pour cette étude effectuée en collaboration avec A. Solignac, du SPEC/CEA, nous mesurons cette composante du bruit dans des capteurs à effet tunnel (TMR) à base de vortex. Nous avons comparé le niveau de bruit dans différentes configurations de magnétisation du dispositif, c'est-à-dire dans l'état vortex et dans l'état parallèle (P) ou antiparallèle (AP) uniformes. Un des résultats importants est que dans l'état vortex le capteur est au moins un ordre de grandeur plus bruyant que dans les états uniformes. Néanmoins, en exploitant la dynamique de la configuration vortex induite par le transfert de spin [2], nous observons une réduction du bruit 1/f, approchant des valeurs mesurées dans l'état AP, car le coeur du vortex a une probabilité plus faible de piégeage dans des sites défectueux. De plus, en entraînant la dynamique du coeur du vortex par un champ ou un courant rf non résonnant, nous démontrons que le bruit 1/f peut être encore réduit [3]. La capacité de réduire le bruit 1/f basse fréquence dans les dispositifs à base de vortex en tirant parti de leur dynamique de transfert de spin améliore donc leur applicabilité dans le champ des capteurs magnétiques [4].
Ce travail est soutenu par le projet français ANR "SPINNET" ANR-18-CE24-0012.

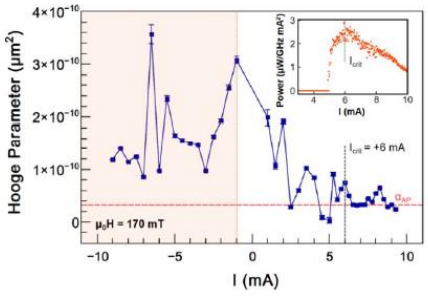

Fig.1- Evolution du niveau de bruit, mesuré par le paramètre de Hooge, en fonction du courant dc appliqué. Le détail montre la puissance d'oscillation de l'émission rf due à la dynamique du vortex émergent.

Références :
[1] D. Mazumdar *et al.*, Appl. Phys. Lett. **91**, 033507 (2007) ;
[2] A. Dussaux *et al.*, *Nat. Comms.* **1**, 8 (2010) ;
[3] M. Jotta Garcia *et al.*, Appl. Phys. Lett. **118**, 122401 (2021) ;
[4] Brevet déposé « SYSTEME ET PROCEDE DE SUPPRESSION DU BRUIT MAGNETIQUE BASSE FREQUENCE DE CAPTEURS MAGNETO-RESISTIFS » (2020).

Mots-clefs : capteurs magnétiques, Bruit basse fréquence, Transfert de spin, Dynamique de vortex

Rencontres Jeunes du C'Nano Ile-de-France

Abstract de Nicola CARLON ZAMBON

Centre de Nanosciences et de Nanotechnologies
(C2N, CNRS Université Paris-Saclay)

Lauréat Prix de thèse C'Nano Ile-de-France 2020

Rencontres Jeunes du C'Nano Ile-de-France

First Name, Family Name: Nicola CARLON ZAMBON
Title (PhD student 1st, 2nd, 3rd year/ Post-doc): Post-doc
Employer, Laboratory: Université Paris-Saclay – C2N
Thesis supervisor(s): Jacqueline BLOCH
City: Palaiseau

CHIRALITY AND NONLINEAR DYNAMICS IN POLARITON MICRORESONATORS

In semiconductor microresonators, optical and electronic excitations can be tightly confined, thereby allowing light and matter to interact so rapidly that the system excitations are effectively described as hybrid light-matter quasiparticles, called exciton-polaritons. The excitonic component endows polaritons with a large Kerr nonlinearity and provides optical gain, while etching of the cavity at the micron scale enables tailoring of the photonic component. Leveraging the versatility of this non-linear photonic platform, this PhD work focussed on two research axes:

- 1-We realized a novel integrated microlaser, emitting light with a finite orbital angular momentum and which helicity could be optically controlled. The original concept is based on the engineering of an analogue spin-orbit coupling and on the ability to optically break time-reversal symmetry by spin-polarizing the gain medium. This proof of concept, readily applicable to different photonic platforms, is relevant for optical processing of quantum and classical information.
- 2-We monitored single trajectories of single micropillar cavities, switching in a stochastic way between two metastable states because of vacuum fluctuations. Drawing a parallel between this system and the stochastic thermodynamics of a two-level classical bit, we defined and measured the entropy production at a single trajectory level and tested the validity of non-equilibrium fluctuation dissipation theorem. These metastable micropillars could be coupled within lattices and enable exploring the stochastic thermodynamics of mesoscopic systems. While this work focuses on the most fundamental aspects of the physics of photonic resonators, it also introduces novel concepts for optical devices, with potential room-temperature applications

Keywords: Polaritons, Spin-Orbit interactions, Structured light, Stochastic thermodynamics

Rencontres Jeunes du C'Nano Ile-de-France

Abstract de Simona MURA

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Rencontres Jeunes du C'Nano Ile-de-France

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Employer, Laboratory: Paris-Saclay University, Galien Paris-Saclay Institute (IGPS)
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NANOMEDICINES: TRACKING THEIR FATE FROM SITE OF ADMINISTRATION TO SITE OF ACTION

Nanoscale systems for drug delivery have the potential to overcome the limitations of conventional treatments, thus providing a solution to unmet medical needs. The benefits of this approach have led to the commercialization of about fifty nanomedicines such as doxorubicin-loaded liposomes (Doxil®), paclitaxel-albumin nanoparticles (Abraxane®), and more recently, lipid carriers for the delivery of siRNA (ONPATTRO®) or mRNA (BioNTech/Pfizer and Moderna COVID-19 vaccines). These results provide clear evidence of the potential of nanomedicines for the efficient delivery of chemotherapeutics but there is still a substantial gap between the favorable preclinical results and the real clinical performances.
Nanomedicine introduction in the clinic has been partly hampered by the lack of effective delivery to the target in vivo. Among the multiplicity of imputable factors, a major role can be attributed to: (i) the modifications undergone by nanomedicines after interaction with molecules/proteins in the bloodstream that endow them with a specific molecular signature and (ii) the numerous biological barriers that these nanomedicines must cross (e.g., the vascular endothelium, the tumor extracellular matrix, etc…).
Hence, it is necessary to have a clearer comprehension of their fate after administration. Our group is focusing on this topic, and we are developing different tools to investigate the fate of nanomedicines both in the circulation after intravenous administration and, after extravasation, in the complex tumor microenvironment. During this talk, the most significant results we have obtained will be presented.

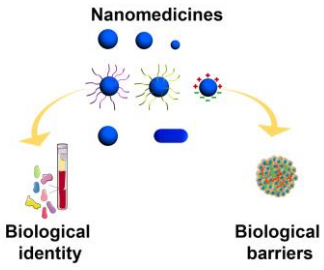

Figure 1. Schematic representation of the set of studies required for a relevant and predictive investigation of nanomedicines.

References: Anselmo AC, Mitragotri S, Nanoparticles in the clinic: An update. *Bioeng Transl Med.* **2019**, 4:e10143; Pautu V *et al.*, When drug nanocarriers miss their target: extracellular diffusion and cell uptake are not enough to be effective. *Biomater. Sci.* **2021**, 9, 5407; Lazzari G *et al.*, Multicellular spheroid based on a triple co-culture: A novel 3D model to mimic pancreatic tumor complexity. *Acta Biomater.* **2018**, 78, 296; Sobot D et *al.*, Conjugation of squalene to gemcitabine as unique approach exploiting endogenous lipoproteins for drug delivery. *Nat Commun.* **2017**, 8, 15678.

Keywords: nanomedicine, biological identity, 3D culture models

Rencontres Jeunes du C'Nano Ile-de-France

Abstracts des jeunes doctorant.e.s & post-doctorant.e.s de la région Ile-de-France

Rencontres Jeunes du C'Nano Ile-de-France

Prénom, NOM : Simon DELACROIX
Statut (doctorant 1ere, 2ème, 3ème année/ Post-doc) : Postdoc
Employeur, Laboratoire : Ecole Polyetchnique – LPICM, LPMC, IMAP
Ville : Palaiseau - Paris

DEVELOPPEMENT D'UN CAPTEUR SERS POUR LA DETECTION DE COMPOSES ORGANIQUES VOLATILS

La détection de composés organiques volatils (COVs) est cruciale dans de nombreux domaines, que ce soit la santé, l'écologie ou la sécurité. En effet, ces composés organiques, possédant un point d'ébullition relativement bas, sont des marqueurs de la qualité de l'air mais peuvent aussi traduire dans certains cas la présence de composés explosifs. Développer des capteurs rapides, peu coûteux, sélectifs et suffisamment sensibles pour pouvoir détecter de faibles quantités de COVs dans l'air ambient est donc une nécessité. Pour ce faire, la spectroscopie Raman est une méthode d'analyse prometteuse mais souffre malheureusement d'un manque de sensibilité. Afin de pallier ce problème, deux approches sont envisagées. La première est d'utiliser la spectroscopie Raman exaltée de surface (SERS), consistant à augmenter le signal émis par une molécule au voisinage d'une surface possédant des propriétés plasmoniques1. La seconde est l'augmentation locale, au voisinage du capteur, de la concentration en COVs en les piégeant au sein d'un matériau poreux. Les matériaux poreux envisagés dans cette étude sont des Metal-Organic-Frameworks (MOFs), réseaux de coordination généralement tridimensionnels2. Ces deux approches sont compatibles et la synthèse de matériaux composites mêlant ces deux propriétés permettrait de développer des capteurs de COVs extrêmement efficace (Figure 1). Les premiers résultats de synthèse de matériaux, composites et nanoparticules coeur-coquilles Au@MOFs, seront présentés ainsi que leur perforamnce pour la détection SERS d'un composé modèle.

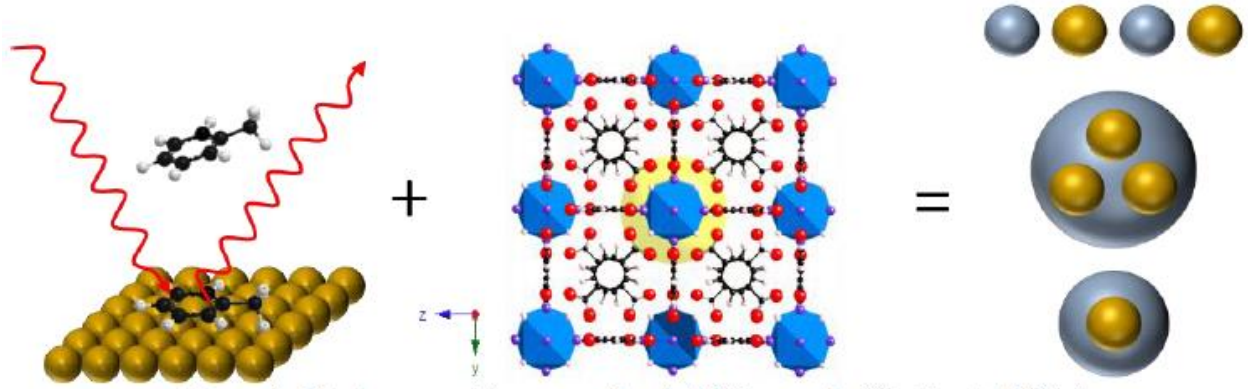

Figure 1. Développement de composites Au/MOFs pour la détection de COVs/

Références :
1. Langer, J. *et al*. Present and future of surface-enhanced Raman scattering. *ACS Nano* **14**, 28–117 (2020).
2. Yuan, S. *et al*. Stable Metal–Organic Frameworks: Design, Synthesis, and Applications. *Adv. Mater*. **30**, 1–35 (2018).

Mots-clefs : nanoparticules d'or, SERS, MOF, core-shell, COV

Rencontres Jeunes du C'Nano Ile-de-France

First Name, Family Name: Davide ROMANIN
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Employer, Laboratory: CNRS – INSP
Supervisor(s): Alex CHIN
City: Paris

THE LANDAU-PEIERLS DISTORTION IN THE LINEAR ACETYLENIC CARBON CHAIN: AN AB-INITIO STUDY OF THE INTERPLAY BETWEEN ELECTRONIC CORRELATIONS AND ANHARMONIC LATTICE DYNAMICS

The linear acetylenic carbon chain (or carbyne) is the simplest example of a 1D carbon system and the prototype of a charge-density wave (CDW). As a matter of fact, at the harmonic level, it undergoes a Landau-Peierls phase transition from an orderered metallic phase (cumulene) to a distorted insulating phase (polyyne) due to an unstable phonon mode with momentum $2k_F$ (where k_F is the Fermi momentum). Its existence is still controversial: while both the Coleman and the Mermin-Wagner-Hohenberg theorems prevent polyyne from existing at any temperature, Landau and Peierls showed that the long-range nature of interatomic forces stabilizes the distorted system. In this work we re-investigate the Landau-Peierls distortion of carbyne from first principles, departing from the harmonic description of lattice dynamics and taking into account electronic correlations. Moreover, thanks to the stochastic self-consistent harmonic approximation (SSCHA), we also study the temperature dependent free energy landscape by including phonon-phonon anharmonic interactions in a nonperturbative way.

*D. R. acknowledges the support of the ANR project ACCEPT (Contract No. 195608.). This work was granted access to the HPC resources of TGCC under the allocation 2021-A0100912417 made by GENCI. Computational resources were also provided by the CINECA award "ISCRA B" HP10BB2RVB (2019).

Keywords: carbon, density functional theory, anharmonicity, phase transition, one-dimensional

Rencontres Jeunes du C'Nano Ile-de-France

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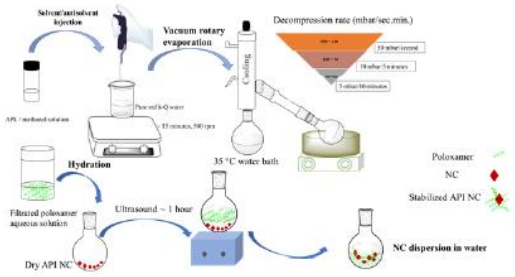
Employer, Laboratory: Université de Paris – UTCBS
Supervisor(s): Yohann CORVIS
City: Paris

BIOPHARMACEUTIC PROPERTIES ENHANCEMENT OF PREDNISOLONE BY PREPARING AND CHARACTERIZING NANOCRYSTAL AQUEOUS SUSPENSIONS OF THE ACTIVE INGREDIENT

Panpan Ma[1], René Laï-Kuen[2], Nathalie Mignet[1], Yohann Corvis[1]
[1] *Université de Paris, Faculté de Santé, CNRS, Inserm, UTCBS, 4 avenue de l'Observatoire, 75006 Paris, France.*
[2] *Université de Paris, Faculté de Santé, Cellular and Molecular Imaging Technology Platform, 75006 Paris, France.*

Up to 90% of the active ingredients (API) currently in development present low solubility (i.e. ~65% and ~15% belong to class II and class IV of the Biopharmaceutics Classification System, respectively).[1] Therefore, in order to develop new drugs towards clinical applications, improving API solubility is a major challenge for the pharmaceutical field.[2] Many approaches have been proposed to overcome the bioavailability issues during drug development. Among them, nanocrystals (NCs) consisting of pure API stabilized by the use of surfactants have been proposed to optimize the therapeutic efficiency of drugs with better safety, targeting and administration through various routes.[3] The UTCBS pioneered the bottom-up approach with minimal amount of stabilizer to engineer etoposide NCs.[4] This project reinforced the legitimacy of drug NCs as potent forthcoming delivery systems for nanomedicines through parenteral administration and presenting less side effects than the related conventional marketed product.[5] The present work consists of developing our expertise on therapeutic NCs with other API pharmaceutical class like prednisolone, a synthetic cortisol compound. By controlling several parameters and conditions, the proportions of API and stabilizing agent were adjusted to screen out the best formulation of nanocrystal with optimized yield, long-term stability, and sustained release properties.



References:
[1] I. Nikolakakis, I. Partheniadis. Pharmaceutics, 2015, 9, 50.
[2] B. Martin et al. ChemMedChem, 2019, 14, 8.
[3] J. Junghanns, R. Muller. Int. J. Nanomedicine, 2008, 3,295.
[4] B. Martin et al. Sci. Rep., 2020, 10, 18059.
[5] E. Lepeltier et al. Front. Chem., 2020, 8,626468.

Mots-clefs : low solubility, nanocrystals, bottom-up approach, drug bioavailability

Rencontres Jeunes du C'Nano Ile-de-France

Abstract de Kokoura MENSAH

Institut Cochin
(CNRS / INSERM / Université de Paris)

Lauréat Prix de thèse C'Nano Ile-de-France 2020

Rencontres Jeunes du C'Nano Ile-de-France

Prénom, NOM : Kokoura MENSAH
Statut (doctorant 1ere, 2ème, 3ème année/ Post-doc) : Postdoc
Employeur, Laboratoire : ESPCI – Institut Cochin
Ville : Paris

DÉTECTION D'ACIDES NUCLÉIQUES AVEC DES RÉSEAUX DE TRANSISTORS À BASE DE GRAPHÈNE

Les réseaux de transistors à effet de champ ont été fabriqués à partir de graphène (GFETs) obtenu par dépôt chimique en phase vapeur (CVD) et la détection électronique de l'hybridation d'ADN jusqu'à des concentrations femtomolaires a été réalisée. Un procédé original a été développé pour des feuilles de graphène de grande surface, qui comprend une fine couche d'alumine (ALD) , protégeant le graphène de la contamination pendant la structuration des motifs par photolithographie. Il permet la fabrication de réseaux de transistors de haute qualité, présentant des tensions de point de Dirac stables proches de zéro dans des conditions ambiantes. La passivation de la puce telle que fabriquée avec une couche composée de deux oxydes différents évite le contact électrochimique direct entre les solutions d'ADN et la couche de graphène pendant la détection d'hybridation. Les molécules d'ADN sondes sont immobilisées électrostatiquement via un revêtement de poly-L-lysine (PLL) de la surface de la puce. L'adsorption de ce polymère chargé positivement induit un décalage positif du point de Dirac et l'immobilisation ultérieure de sondes d'ADN chargées négativement induit un décalage négatif. Des phénomènes d'hybridation ont été réalisés sur le réseau surmonté d'un bassin protégeant les connexions électriques. Des mesures d'hybridation différentielles et en temps réel sont réalisées. Une limite de détection de 10 fM a été atteinte pour l'hybridation de cibles ADN de 20 nucléotides. Les signaux de tension typiques sont d'environ 100 mV et les dérives parasites inférieures à 1 mV par heure.

Mots-clefs : ADN, Hybridation, Graphène, Transistors, Réseau