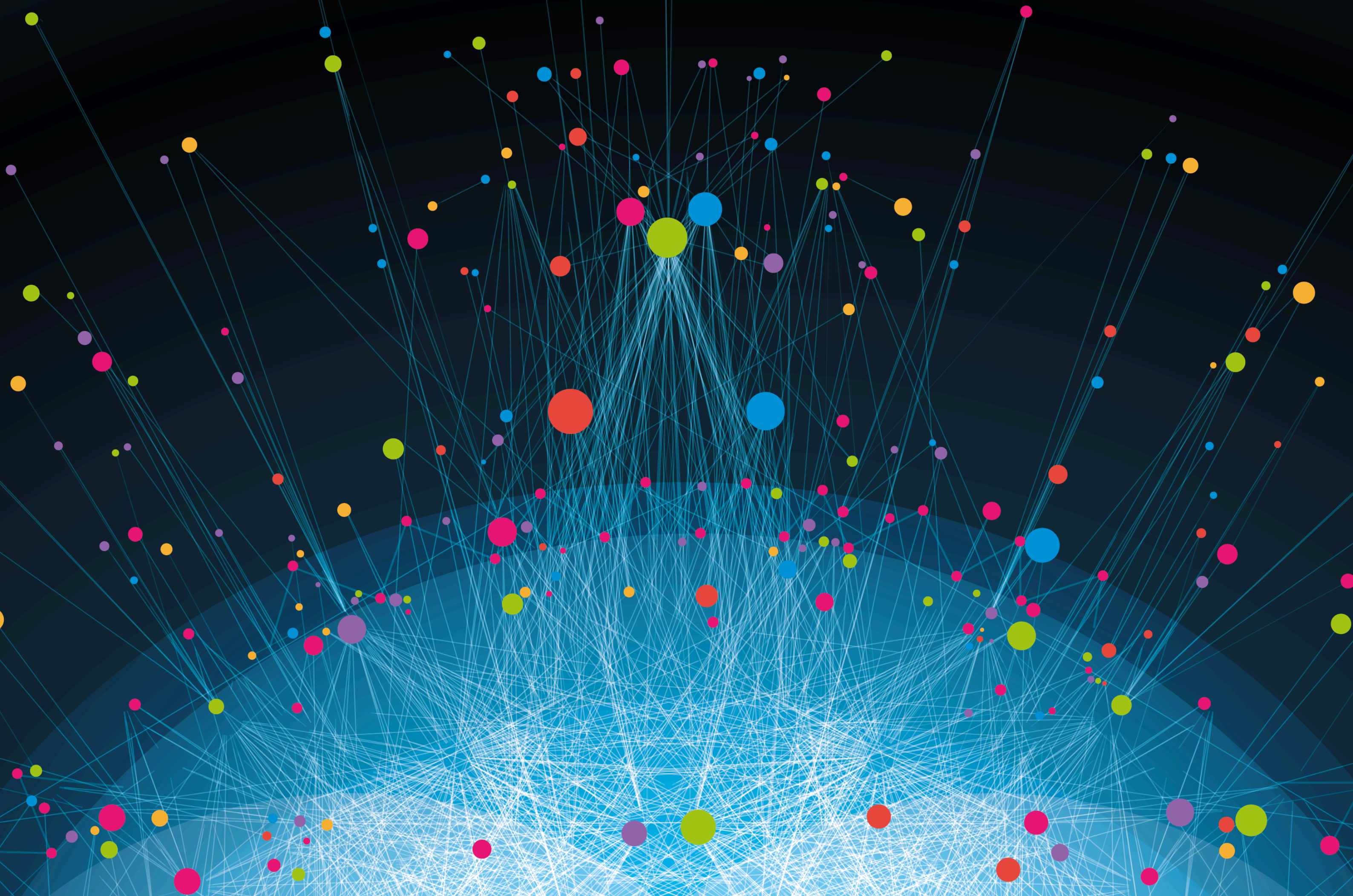
BOOK
OF
ABSTRACTS

Functional thin films, Nanostructures & 2D materials



Functional thin films, Nanostructures & 2D materials

Wednesday March 19th

10:30 A.M. - 12:30 A.M.

AMPHITHEATRE LOUIS ARMAND OUEST

Program of the session :

Chairs: David BABONNEAU & Rémi LAZZARI

HOUR	NAME	TITLE
10:30	**Emilie GAUDRY** **IJL - Univ. Nancy**	**Theoretical insights into ultrathin oxide films on metals and alloys: unraveling structures and stabilities**
11:00	Swayam SAHOO INL - ECL	Interface engineering for integration of VO2 on silicon for thermotronics
11:15	Jérémy BARBE IMN - Nantes Université	Sputtered La0.33NbO3 perovskite thin films for high-power Li-ions micro-batteries
11:30	Bertrand VILQUIN INL - Centrale lyon	Structural and electrical properties of ferroelectric HfZrO2-based nano-capacitors for non-volatile memories
11:45	Léa MEYNIER CINam - CNRS	Ferroelectric structure, crystallography and morphology of GeTe thin films grown on Si(111) : the key role of atomic steps
12:00	Qiang YU C2N - Université Paris-Saclay	Electric-field-assisted phase switching in GaAs nanowires
12:15	Chen WEI C2N - CNRS	In-Situ TEM Observation of III-V Nanowire Nucleation on Si

S1

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Short Biography

Émilie Gaudry, Prof at Université de Lorraine, is involved as a Scientific Director at Mines Nancy. She develops research activities at the Jean Lamour Institute, in the field of materials modeling with quantum chemistry and machine learning methods. Initially focused on metallic materials, quasicrystals and associated intermetallic compounds, the scope of her research activities has expanded more recently to metal/oxide interfaces and nano-materials. She is an associate researcher at the Soleil synchrotron where she develops approaches combining surface diffraction experiments and associated modeling. She is Director of the HPC computing center at the University (eXplor), a platform shared between staff from the University and associated EPSTs.

Title of Oral Presentation

Theoretical insights into ultrathin oxide films on metals and alloys: unraveling structures and stabilities

Keywords

ultrathin oxide films, density functional theory, oxide quasicrystals

Abstract of Oral Presentation

Thin perovskite films, made of a few-layer thick nano-sheets, have attracted considerable attention due to their extensive structural and electronic variability, linked to the huge number of conceivable unique chemical compositions. The combination of the low dimension with the structural flexibility of this class of crystals opened the door to a rich spectrum of applications in many fields, such as energy transition and catalysis, correlated materials and electronic devices.

Decreasing the thickness of two-dimensional (2D) perovskites down to the mono-layer limit is expected to deeply alter their structures and modify the physical and chemical properties. This has recently led to the emergence of novel structures with aperiodic ordering, i.e. dodecagonal oxide quasicrystal interfaces [1,2]. The driving force for these unique structural modifications, resulting from thickness reduction, are far from being fully unveiled [3]. Reduced bonding coordinations, possible strong surface polarizations, support effects and experimental conditions are supposed to play a role, but no clear picture has yet been drawn. In this talk I will show how two-dimensional complex oxide structures can be identified, while also questioning several descriptors that contribute to their stability. This work is a first step towards establishing structure-property relationships for this class of materials, which is crucial not only for advancing fundamental understanding of their unique characteristics but also for optimizing their performance in practical applications.

Acknowledgement

I would like to express my sincere gratitude to my collaborators in Japan and at IJL, especially Weiliang Ma. I also wish to acknowledge the computational resources (GENCI, TGCC, CINED, IDRIS, EXPLOR) and financial support (ANR NOUS) that made this work possible.

References

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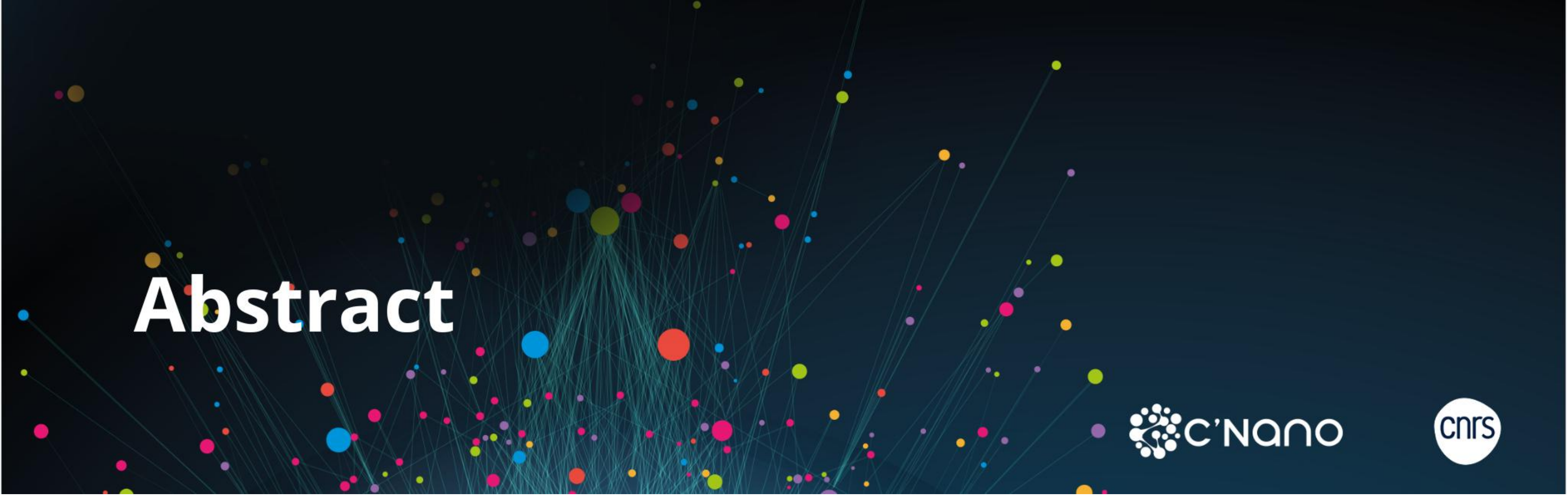
[3] T. Dorini et al., “Two-dimensional oxide quasicrystal approximants with tunable electronic and magnetic properties”, Nanoscale 13 (2021) 10771-10779



Thematic Session: Functional thin films, Nanostructures and 2D materials
Disciplinary fields involved: physics, electronics
Keywords: metal-insulator transition, oxide, sputtering, thermotronics

Interface engineering for integration of VO_2 on silicon for thermotronics

Swayam Prakash Sahoo[1,5], Matthieu Bugnet[2], Ingrid Cañero Infante[1], Victor Pierron[3], Laurence Méchin[3], Rebecca Cervasio[4], Pierre Hemme[4], Jean-Blaise Brubach[4], Pascale Roy[4], Luc Fréchette[5], Anne Lamirand[1], Bertrand Vilquin[1]

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Present day information processing is the result of the development of the microelectronics industry where information is processed via electrical currents and voltages. Unlike its electronic counterparts, thermal information processing (thermotronics) via radiative heat flow through thermal analogs of transistors remains a nascent technology. In order to achieve this, we use a phase change material, vanadium dioxide (VO_2), and exploit its non-linear change of optical properties as a function of its temperature. VO_2 undergoes a metal-insulator transition (MIT) at approximately 70°C, which induces large variations in its electrical and wavelength-dependent optical properties. These features make VO_2 a highly sought-after compound for optical, thermal, and neuromorphic applications[1]. To foster the development of VO_2-based devices for the microelectronic industry, it is also imperative to integrate VO_2 on silicon. However, high lattice mismatch and the formation of silicates at the interface between VO2 and Si degrade the quality and functionality of VO_2 films. Moreover, VO_2's polymorphic nature and stable V-O phases pose integration issues. To address these challenges, we investigate the MIT of VO_2 thin films integrated on Si with a $HfZrO_2$ (HZO) buffer layer. We demonstrate that VO_2 on HZO buffer layer exhibits an unusually low thermal hysteresis of ~4 °C[2]. These results unravel the influence of strain on M2 phase nucleation, which controls the hysteresis. Notably, the rate of phase transition is symmetric and does not change for the heating and cooling cycles, implying no incorporation of defects during cycling, and highlighting the potential HZO for VO_2 based devices reliable operation.

References:
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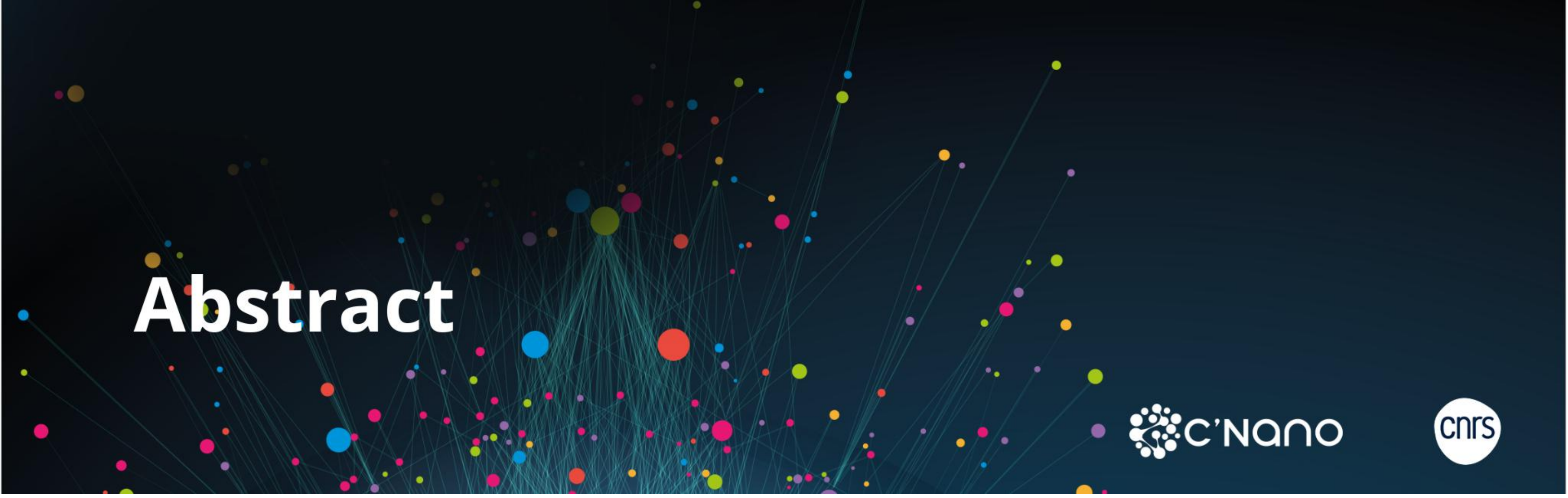
Acknowledgement:

This work was partly realized at the NanoLyon technology platform, the GREYC laboratory, and the AILES beamline of the Soleil Synchrotron. The authors thank their staff for the technical support. The STEM work was performed at the consortium Lyon-St-Etienne de microscopie. FIB experiments were supported by the French RENATECH network, the CPER Hauts de France project IMITECH and the Métropole Européenne de Lille. The authors also thank the Natural Sciences and Engineering Research Council of Canada (NSERC), Fonds de recherche du Québec (FRQNT), and Mitacs, for the financial support. LN2 is a joint International Research Laboratory (IRL 3463) funded and co-operated in Canada by Université de Sherbrooke (UdeS) and in France by CNRS as well as ECL, INSA Lyon, and Université Grenoble Alpes (UGA). It is also supported by the Fonds de Recherche du Québec Nature et Technologies (FRQNT).



Thematic Session: Couches minces fonctionnelles, Nanostructures & Matériaux 2D
Disciplinary fields involved (eg. Chemistry, Physics, Biology …)**:** Physics
Keywords (max. 4-5)**:** Sputtering, perovskite oxides, Li-ions batteries

Sputtered $La_{0.33}NbO_3$ perovskite thin films for high-power Li-ions micro-batteries

Oumar Toure[1], Marie-Paule Besland[1], Thierry Brousse[1,2], Jérémy Barbé[1,2]

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2. *Réseau sur le Stockage Electrochimique de l'Energie (RS2E), CNRS FR 3459, 33 rue Saint Leu, 80039 Amiens Cedex, France*

Abstract:

Considering the exponential growth of miniaturized electronic devices such as sensors for the internet of things (IOT), it appears mandatory to develop new micro devices for electrical energy storage and delivery, such as micro-power batteries. Although substantial advances have been made in lithium-ion batteries (LIBs) anodes, it is still necessary to go beyond the popular graphite and $Li_4Ti_5O_{12}$ anodes, which suffer from severe drawbacks.

Perovskite oxides have recently emerged as promising anode materials [1]. Here, we demonstrate the sputtering of $La_{0.33}NbO_3$ perovskite material with partial substitution of lanthanum in the A-site by vacancies, as negative electrode material for Li-ions batteries. The creation of vacancies channels in the perovskite film aims to allow rapid lithium insertion [2, 3].

La_xNbO_3 thin films were deposited by magnetron reactive co-sputtering of La and Nb targets. $La_{0.33}NbO_3$ with orthorhombic phase (Pmmm) is obtained after adjusting the power supplied to each target followed by *ex-situ* annealing in air at high temperature (T = 1000°C). X-ray diffraction (XRD) and scanning electron microscopy images (SEM) results are discussed for a series of thin films with varying La/Nb ratios and annealing parameters. Then, the electrochemical performance of the films are characterized by cyclic voltammetry measurements. A high capacity of 190 mAh/g is achieved at a low scan rate of 0.1 mV/s. At a faster scan rate of 2 mV/s, a capacity of 150 mAh/g was retained, indicating excellent rate performance suitable for high-power applications. These results highlight the potential of $La_{0.33}NbO_3$ thin films for use in high-power, high-capacity micro-battery systems.

References:

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[2] A. Khan *et al.*, « Lithium storage behaviour of AgNbO3 perovskite: Understanding electrochemical activation and charge storage mechanisms », *Energy Storage Mater.*, p. 103431, avr. 2024, doi: 10.1016/j.ensm.2024.103431.

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Thematic Session: Functional thin films, Nanostructures and 2D materials
Disciplinary fields involved: physics, electronics
Keywords: ferroelectricity, oxide, simulation, PVD, non-volatile memory

Structural and electrical properties of ferroelectric $HfZrO_2$-based nano-capacitors for non-volatile memories

Rebecca Cervasio[1], Marine Verseils[1], Pierre Hemme[1], Jean-Blaise Brubach[1], Alessandro Coati[1], Alina Vlad[1], Andrea Resta[1], Yves Garreau[1], Claudia Decorse[3], Emilie Amzallag[3], Jerome Creuze[3], Pascale Roy[1], Ingrid Canero Infante[2], Greta Segantini[2], Pedro Rojo Romeo[2], Grégoire Magagnin[2], Jordan Bouaziz[2], Bertrand Vilquin[2]

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In the quest for thinner and more efficient ferroelectric devices, $HfZrO_2$ (HZO) has emerged as a potential ultra-thin and lead-free ferroelectric material. Indeed, when deposited on a TiN electrode, 1-25 nm thick HZO exhibits excellent ferroelectricity capability allowing the prospective miniaturization of capacitors and transistor devices. To investigate the origin of ferroelectricity in HZO thin films, we optimized the deposition of ferroelectric HZO thin films by magnetron sputtering by playing on the deposition pressure and plasma gas composition [1-2]. We then conducted a far-infrared (FIR) spectroscopic study on five HZO films with thicknesses ranging from 10 to 52 nm, both within and out of the ferroelectric thickness range where ferroelectric properties are observed. Based on X-ray diffraction, these HZO films are estimated to contain various proportions of monoclinic (m-), tetragonal (t-) and polar orthorhombic (polar o-) phases, while only the 11, 17 and 21 nm thick are expected to include higher amount of polar o-phase. We coupled the HZO infrared measurements with DFT simulations for these m-, t- and polar o- crystallographic structures. The approach used was based on the supercell method, which combines all possible Hf/Zr mixed atomic sites in the solid solution. The excellent agreement between measured and simulated spectra allows assigning most bands and provides infrared signatures for the various HZO structures including the polar orthorhombic form [3].

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Acknowledgement:

This work was carried out on the NanoLyon technology platform and Synchrotron Soleil and implemented inside 3eFERRO and NanOx4EStor projects.

Thematic Session: functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Physics
Keywords (max. 4-5)**: Ferroelectrics, growth, atomic steps, stress**

Ferroelectric structure, crystallography and morphology of GeTe thin films grown on Si(111) : the key role of atomic steps

Léa Meynier[1], Boris Croes[1], Guillaume Ayala[1], Fabio Verducci[1], Stefano Curiotto[1], Pierre Müller[1], Fabien Cheynis[1], F. Leroy[1]

1. *Aix Marseille Université, CNRS, CINAM, AMUTECH, Marseille, France*

Ferroelectric Rashba semiconductors are a novel class of materials with strong potential for spintronic applications [1]. For GeTe thin films it has been shown that the ferroelectric polarization can be reversed with an electric field [2], and the spin chirality of the band structure is consistently changed [3].

In this presentation I will address the structure and morphology of GeTe thin films during the early stages of growth by molecular beam epitaxy (MBE) [4]. Using scanning tunneling microscopy (STM) we show that GeTe thin films grow initially via a homogeneous and crystalline buffer layer. Then atomically flat 2D islands of GeTe nucleate and grow preferentially at Si step edges. This process is rapidly dominated by a step-flow growth mode of GeTe layers. Despite a high surface morphology quality, a significant amount of twin domains is evidenced by low energy electron diffraction (LEED) and dark-field low energy electron microscopy (LEEM).

Considering the key role of atomic steps in the growth process, we show that using miscut substrates it is possible to suppress interfacial defects. In addition, since ferroelectricity and ferroelasticity are intimately related properties in GeTe, the stress relaxation mechanisms at GeTe/Si interface via atomic steps can favor one type of ferroelectric domain. We also show that the size decay of ferroelectric domains during annealing can be attributed to a thermo-mechanical stress arising from the significant difference of linear thermal expansion coefficients of Si and GeTe [5].

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Acknowledgement:

The project leading to this publication has received funding from Excellence Initiative of Aix-Marseille University A*MIDEX, a french "Investissements d'Avenir" programme through the AMUtech Institute. This work has also been supported by the ANR grants FETh (ANR-22-CE08-0023). We are grateful to Martiane Cabié (CP2M, Marseille) for lamella preparation of GeTe thin films by Focused Ion Beam.

Abstract

Thematic Session (Functional thin films, Nanostructures & 2D materials)**:**
Disciplinary fields involved (Material chemistry, Physics,)**:**
Keywords (nanowires, insitu TEM, crystal growth, polytypism)**:**

Electric-field-assisted phase switching in GaAs nanowires

Qiang Yu[1], Khalil Hassebi[1], Hakim Saidov[2], Ivan Erofeev[2] Charles Renard[1], Laetitia Vincent[1], Frank Glas[1], Utkur Mirsaidov[2], Federico Panciera[1]

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Abstract: The formation of crystal phase quantum dots (CPQDs), i.e. insertion of segments of one phase within a nanowire of a different phase, is of great interest to nanowire community, since they possess unique optical and electronic properties. In this work, we control the formation of CPQDs by introducing an external parameter: electric field (E-field). Compared with most comment methods like flux and temperature modulation, our method is able to achieve quasi-instantaneous crystal phase switch, therefore creating heterostructures with monolayer precision. The switching process is monitored in real-time using in-situ transmission electron microscopy (TEM). Thanks to our micro-fabricated Si substrate and custom-made holder, GaAs nanowires are grown epitaxially on Si(111) by chemical vapor deposition inside in-situ TEM. The substrate is shaped as a micro capacitor which allows us to apply an E-filed up to several V/nm in the direction parallel to the nanowire growth, and this strong E-field allows to achieve phase switching faster than monolayer formation. We will present high resolution videos showing the controlled phase switching induced by the E-field in GaAs nanowires, the formation of single and multiple CPQDs. Finally, we will discuss the E-field-induced phase switching mechanisms and propose a model to explain the experimental results based on theoretical calculations and finite element simulations.

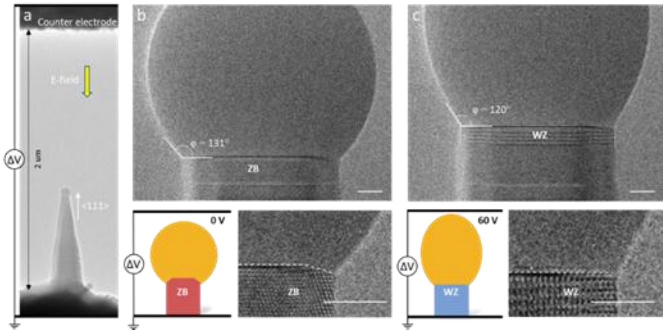

Fig.1 Crystal phase switching by electric field

Acknowledgement:

The authors thanks French National Research Agency ANR and Chinese Scholarship Council CSC for their funding.

Thematic Session: Nanostructures & 2D materials/ Nanoscale characterization
Disciplinary fields involved: Physics
Keywords: Semiconductor nanowire, Epitaxy, Nucleation & Growth mechanism, In-situ TEM

In-Situ TEM Observation of III-V Nanowire Nucleation on Si

Chen Wei[1], Laurent Travers[1], Julien Chaste[1], Cléophanie Brochard[1], Andrea Cattoni[1], Nathalie Bardou[1], David Bouville[1], Etienne Herth[1], Jean-Christophe Harmand[1], Federico Panciera[1]

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Monolithic integration of heterostructures, such as semiconductor nanowires (NWs) on silicon substrate, enables defect-free interfaces with promising applications in advanced electronic and photonic devices. To fully leverage the unique physical properties of NWs, precise control over their geometry, crystal structure, and doping is substantial, which requires a comprehensive understanding of their growth mechanisms, especially during the vital initial steps.

The early stages of nanowire growth remain the least understood, primarily due to the exclusive reliance on ex-situ characterization technique. In this work, we present in-situ, real-time observations of the nucleation and growth of self-catalyzed GaAs and GaP nanowires using a transmission electron microscope (TEM) integrated with molecular-beam-epitaxy (MBE) sources. Custom MEMS (micro-electromechanical system) chips, consisting of electron-transparent <111>-oriented Si membranes served as substrates, allowing nanowires to be grown directly on the membrane via the vapor-liquid-solid mechanism. The growth process is monitored simultaneously with high spatial and temporal resolution.

Building on these observations, we further optimized the experimental setup by incorporating advanced MEMS chips featuring patterned silica masks for selective area growth of nanowire arrays. This refinement enabled precise control over nanowire positioning while maintaining compatibility with in-situ TEM technique. Critical growth processes, including Ga droplet formation, crystal nucleation in mask opening, and axial growth afterwards, were directly visualized and analyzed.

Our study provides new insights into the dynamic processes governing nanowire formation, offering a pathway to refine growth techniques and achieve controlled nanowire synthesis for heterostructure-based applications.

References:

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Wednesday March 19th

4:30 P.M. - 6:30 P.M.

AMPHITHEATRE LOUIS ARMAND OUEST

Program of the session :

Chairs: Guillaume COLAS

HOUR	NAME	TITLE
16:30	**Aimeric OUVRARD** **ISMO - CNRS**	**Charge transfer and atomic interdiffusion in ordered plasmonic nanoparticles in interaction with molecules.**
17:00	Abeer FAHES ICMN - CNRS	Polymer-Integrated AgPt Bimetallic Nanoparticles for Durable Plasmonics
17:15	Christina VILLENEUVE-FAURE Laplace - Univ. Toulouse	A nanoscale investigation of plasma deposited AgNPs-based nanocomposites electrical properties for nanoelectronic applications
17:30	Lionel PATRONE IM2NP - CNRS	Self-assembled monolayer of push-pull chromophores towards the polarization modulation for controlled detection of biomolecules
17:45	Federico ZIZZI CEISAM/IMN - Nantes Univ.	Coupling of Nanomechanics and Photochromism in Azo Soft Materials: From Thin Films to Nanoparticles
18:00	Julien CASTETS ICMCB - Univ. Bordeaux	Fabrication of correlated disordered structures in thin films to tune the visual appearance of surfaces
18:15	Simon DELACROIX LPMC - Ecole Polytechnique	Synthesis of colored glasses by an original sol-gel/laser coupled approach

S2

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Short Biography

Dr. Aimeric Ouvrard is a physicist experimentalist in surface science and non-linear optics and molecular physics at the Institut des Sciences Moléculaires d'Orsay (Univ. Paris Saclay). After a PhD in semiconductor laser physics and molecular spectroscopy for atmospheric physics obtained at University of Montpellier (Fr) in 2005, he did a postdoctorate at Dublin City University for 2 years in the applied field of molecular spectroscopy for pharmaceutical and bioindustrial applications. In 2007, he changed his scientific direction during a second postdoc at Laboratoire de PhotoPhysique Moléculaire (Univ Paris Sud) in non-linear vibrational spectroscopy of supported metal catalysts. In 2009 he enters CNRS at ISMO, to conduct research in non-linear ultrafast spectroscopy of assemblies of molecules and plasmonic nanoparticles. After defending his HDR "Photo-physics of assemblies of nanoparticles and molecules" in 2021, he is now leader of the group "Femtophysics at interfaces" specialized in the development and study of various nanostrutured surfaces of interest for energy harvesting, nanooptics, molecular electronics and heterogeneous catalysis.

Title of Oral Presentation

Charge transfer and atomic interdiffusion in ordered plasmonic nanoparticles in interaction with molecules.

Keywords

nanoparticles, surface plasmon resonance, molecules, charge transfer, non-linear optics

Abstract of Oral Presentation

Understanding the interaction of molecules with nanoparticles is the key to control charge transfers for molecular electronics or energy production. The main difficulty lies in the need to probe at the scale of the individual molecule, otherwise having a system that is poorly dispersed in size to reduce the inhomogeneous broadening of the observables. In this context, we carry out ordered hybrid nano-assemblies where organic molecules functionalize metallic or plasmonic nanoparticles epitaxied on an alumina bilayer on Ni3Al(111). We combine non-linear/linear spectroscopy and microscopy, to reveal structural, chemical and plasmonic properties as well as the impact of charge transfer in those hybrid assemblies [1-5].

The mechanical stress in the bilayer induced by the substrate periodically modulates the surface reactivity, which ensures the ordered growth of Pd metal clusters [1]. The correlation of geometry to the reactivity of long-range, narrow size distributed Pd NPs containing from few atoms to several hundred are revealed using CO molecule as a probe of the surface structure [2]. This nanostructured surface allows producing ordered assemblies of NP weakly coupled with organic molecules (perylene) [4]. By evaporating gold or silver on the Pd core, plasmonic properties arise above two atomic layer thick shell, giving an additional control of photophysical properties. Pd/Ag core/shell NPs show a better long-range ordering and a reduced atomic interdiffusion at the core-shell interface compared to Pd/Au NPs [3] leading to a stronger plasmonic response [5]. When fullerene is evaporated on NPs, we follow in real-time the strong change of optical, vibronic and plasmonic properties. Charge transfer from NP to C60 affects the optical response and the vibronic structure and reduces the plasmonic response. This work paves the way for future assemblies, where charge transfer can be induced and followed in real-time at sub-ps timescale using ultrafast laser.

Acknowledgement

We thank the ANR for funding this work (LEMON Project ANR-15-CE09-0007), CNRS physique (CNRStremplin) for funding the spectrometer and EDOM doctoral school for the PhD grant of Xingtong Li in 2024.

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Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Physical Chemistry, Materials Chemistry, Nanoscience
Keywords: nanoplasmonics, atomic vapor deposition, photochemical process, polymer, long-term

Polymer-Integrated AgPt Bimetallic Nanoparticles for Durable Plasmonics

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Abstract

Multifunctional metal/polymer nanocomposite coatings, incorporating Ag and Pt nanoparticles dispersed within a poly(dipropylene glycol diacrylate) polymer matrix, have been developed to enhance desired properties and functionalities, particularly extending the detection spectrum into the near UV regions. This development addresses the growing demand for plasmonic applications at higher energies, beyond the conventional near-infrared to visible range [1].

Atomic vapor deposition (AVD) is notable for its capability to deliver a continuous flux of atoms during growth, ensuring moderate kinetic energy, low polydispersity in nanoparticle assemblies, and high throughput. This method also provides significant potential for improving nanocomposite performance by enabling precise control over the structural properties of thin films. To date, this technique has been primarily employed to synthesize monometallic (Ag, Pt) and bimetallic nanoparticles (e.g., AgAl [2], AgIn [2], AgPt [3], CoAg [4], CoPt [5]) dispersed within silica matrices. However, the development of long-term stable nanocomposites with durable structural and optical properties remains a key challenge.

Polymers serve effectively as matrices, facilitating nanoparticle ordering and orientation on surfaces while controlling their size, morphology, and separation distances. In our preliminary work, an organic component—a partially polymerized monomer—was deposited on Si/SiO_2 surfaces via a photochemical process. This was followed by the application of a thin AgPt layer using AVD, yielding a hybrid material with unique optical, structural, and physicochemical properties. This dual-method synthesis approach presents a novel perspective for nanocomposite fabrication. Our primary objectives are to minimize polydispersity in nanoparticle size distribution and to achieve effective embedding within the polymer matrix.

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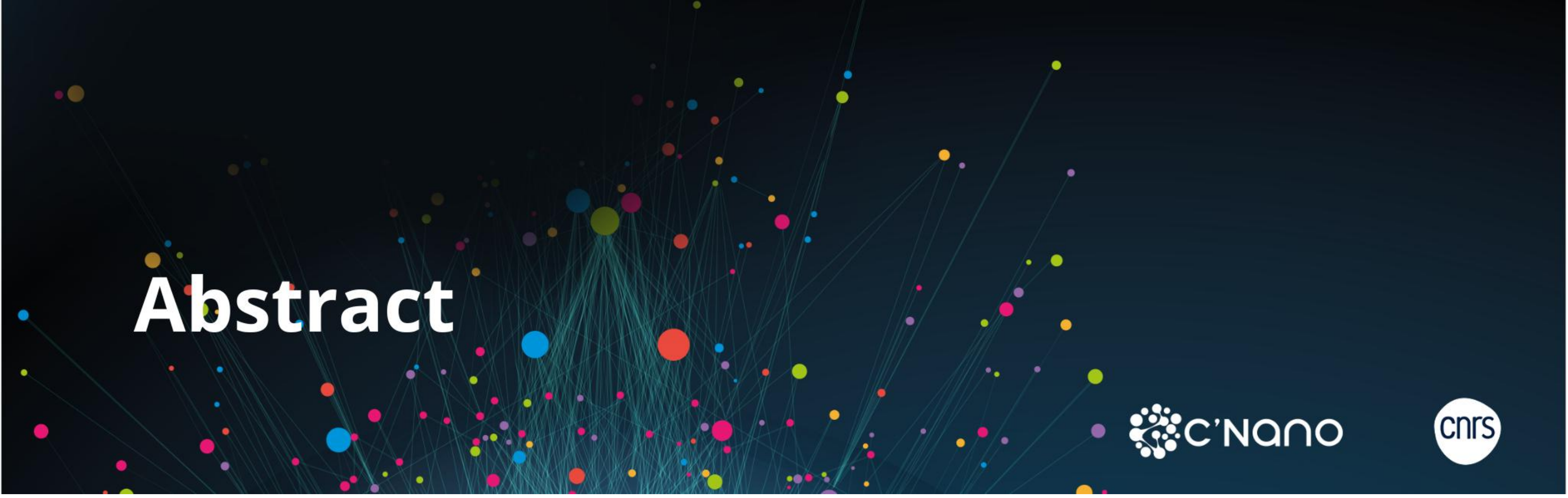
Acknowledgement:

We extend our gratitude to Prof. Lavinia Balan and Prof. Didier Zanghi at CEMHTI for their ongoing collaboration with our department and their valuable technical assistance in some experimental work.



Thematic Session: Functional Thin Films, Nanomaterials
Disciplinary fields involved (eg. Chemistry, Physics, Biology …)**: Materials**
Keywords (max. 4-5)**:** inorganic nanocomposites, thin films, plasma process, electrical properties, Atomic Force Microscopy

A nanoscale investigation of plasma deposited AgNPs-based nanocomposites electrical properties for nanoelectronic applications

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1. *LAPLACE (Laboratoire Plasma et Conversion d'Energie); Université de Toulouse; CNRS, UPS, INPT, Toulouse*

Abstract

The main challenge for efficient neuromorphic computing with non-volatile memory cells is to control the electrical properties at device scale, in terms of charges trapping and transport, current flow or dielectric permittivity [1]. To improve device performance, inorganic nanocomposite dielectric films, and particularly materials based on silver nanoparticles (AgNPs) embedded in silica (SiO_2) appear attractive due to their multifunctional properties [2]. Besides, to address their electrical properties at local scale, electrical modes derived from Atomic Force Microscopy are suitable: Conductive AFM (C-AFM) for current measurements, Kelvin Probe Force Microscopy (KPFM) for charge injection and transport or Electrostatic Force Microscopy (EFM) for dielectric permittivity.

This work investigates the electrical properties of dielectric nanocomposites comprising a single plane of AgNPs inserted in SiO_2 at a well-controlled distance from the surface [2]. The impact of AgNPs size (from 5nm to 20nm) on charge accumulation and dielectric permittivity is investigated by KPFM and EFM respectively. Results demonstrate that the inclusion of AgNPs succeeds in controlling the electrical properties. Indeed, AgNPs induce a modulation of the dielectric permittivity at nanoscale (lowering it above and increasing it between the AgNPs) inducing a modification of the apparent permittivity at macroscale. This phenomenon is more pronounced for smaller AgNPs (size lower than 15nm). Moreover, the presence of small AgNPs increases the amount of injected charge without modification of the charge transport processes compared to silica only. These results suggest that proper selection of the AgNPs allows a fine control of the electrical properties of the nanocomposite.

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Acknowledgement: *This work was supported by l'Agence Nationale de la Recherche in France, project ANR BENDIS (ANR-21-CE09-0008).*

Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Physics, chemistry
Keywords :

Push-pull chromophore ; ferrocene ; oligopeptide ; oligo(ethylene glycol) ; self ; assembled monolayer

Self-assembled monolayer of push-pull chromophores towards the polarization modulation for controlled detection of biomolecules

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Aix-Marseille Université - AMU, CNRS, ISEN, Universiité de Toulon
2 : Institut Matériaux Microélectronique Nanosciences de Provence UMR 7334 / ISEN-Méditerranée
Aix-Marseille Université - AMU, CNRS, ISEN, , Université de Toulon
3 : CINaM UMR 7325, Aix-Marseille Université - AMU, CNRS
4 : Institut Matériaux Microélectronique Nanosciences de Provence (IM2NP) UMR 7334, ISEN Yncréa Méditerranée
CNRS : UMR7334, Aix-Marseille Université - AMU, Université du Sud Toulon-Var

Within the specific detection of antibodies using antibody/antigen binding interactions [1-3], a promising functional ON/OFF-system has been proposed based on the reversible modification of the conformation of a charged oligopeptide by the application of an electrical potential on the surface [4]. So far, this system can only respond to a single electrical stimulus, thus limiting its use to a single antibody/antigen pair and preventing the detection of the binding interaction of several antibody/antigen pairs within a single platform. For this purpose, we are considering an original approach based on the use of "push-pull" chromophores to control the potential allowing the conformation of the oligopeptide to be switched between the OFF-state (antibody-antigen interaction not allowed) and the ON-state (interaction permitted). This structure of the push-pull chromophores forms an electrical dipole depending on the nature of the donor and attractor groups, and the π-conjugated bridge. The idea is to add push-pull chromophores presenting different electrical dipole moments -each one being associated to a specific electrical potential value- between the surface and the oligopeptide supporting a given antigen, and to insert these systems within an inert matrix of molecular compound of oligoethylene glycol(OEG). Therefore in this work we have synthesized original non-charged push-pull chromophores bearing a thiol anchroring group, and studied their self-assembled monolayers (SAMs) on gold surfaces. After having analysed the influence of the various parameters (solvent, concentration,...) on the quality of homogeneous push-pull films, we have devoted our work to the preparation of SAMs made of isolated push-pull chromophores inside the OEG inert matrix testing various approaches and parameters.

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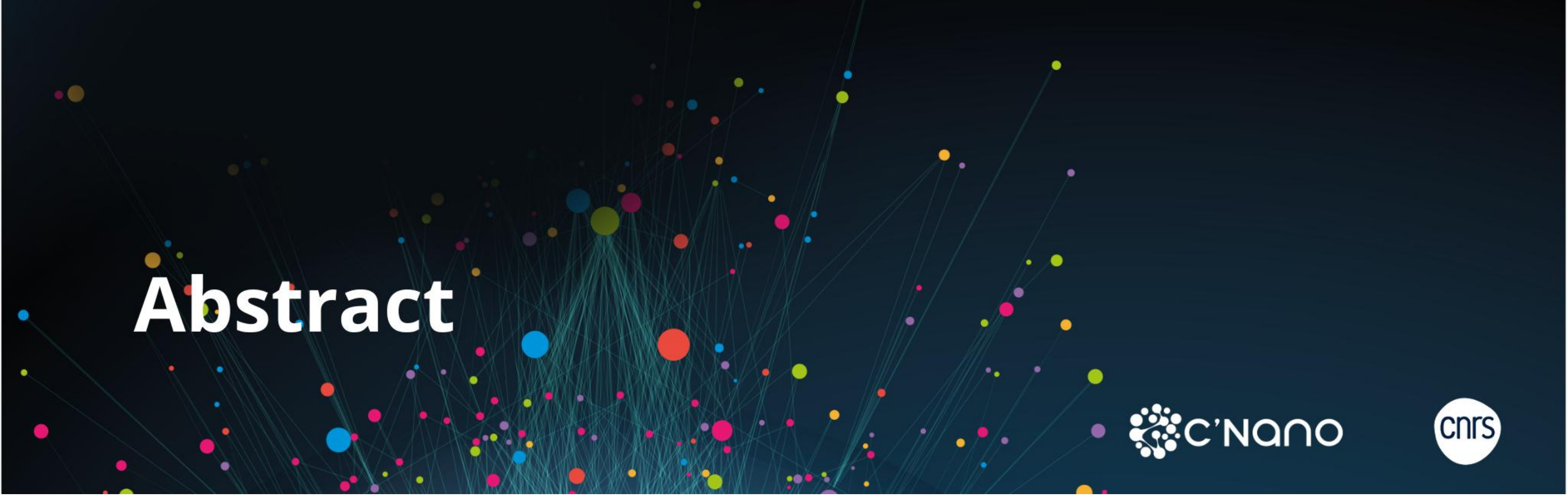
Acknowledgement:

This work was supported by the Centre National de la Recherche Scientifique (CNRS), the ministère de l'Enseignement Supérieur et de la Recherche (MESR), and AMUTech institute. J.W. acknowledges the MESR for his PhD fellowship.



Abstract

Thematic Session: Nanophotonics & Nanooptics-Functional thin films, Nanostructures & 2D materials

Disciplinary fields involved Chemistry, Photophysics, Physics

Keywords (max. 4-5)**: Photochromism, Atomic Force Microscopy, Nanoparticles, Azo Materials**

Coupling of Nanomechanics and Photochromism in Azo Soft Materials: From Thin Films to Nanoparticles

Federico Zizzi[1,2], Stéphane Cuénot[2], Eléna Ishow[1]

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2. *Nantes Université, CNRS, Institut des Matériaux de Nantes Jean Rouxel, IMN, UMR 6502 F-44000 Nantes, France.*

Size reduction from bulk to nanoscale materials is accompanied by well-known effects, such as strong spatial and quantum confinements and a significant increase in the surface-to-volume ratio.[1] While the resulting changes in optical, magnetic, and chemical properties of nanomaterials have largely been studied, the impact of downsizing on mechanical properties remains a relatively new area of investigation. In this field, especially at the nanoscale, Atomic Force Microscopy (AFM) has become the preferred method for quantifying mechanical properties.[2] However, most studies focus on hard nanoparticles, while evaluation of mechanical properties of soft organic nanoparticles, widely used in pharmaceuticals, present additional challenges due to their flexible molecular structure, making traditional models and algorithms less applicable. Azo materials, amenable to undergo reversible E → Z isomerization, offer new opportunities for probing the mechanical properties of soft nanoparticles, thanks to their ability to transduce optical excitation into mechanical motion.[3] The studies presented here explore the use of photochromic azo materials, combined with nanoscale mechanical measurements, to better understand the mechanical evolution of soft materials when going from thin films to nanoparticles. For this purpose, photocrosslinkable azo compounds, comprising crosslinkers with distinct flexibility, have been synthesized and processed as thin films and nanoparticles..[4] Photoisomerization studies reveal smaller E→→Z photoconversion after photopolymerization, for both thin films and NPs, accompanied by an increase in the material stiffness.

Combined photochromic and AFM investigations display clear relationships between the photoactuation ability and mechanical properties, especially the elastic modulus, of the azo materials, as a function of the flexibility of the crosslinkers. Of particular note are the significantly higher elastic modulus values determined for azo NPs compared to those of the thin film counterparts. As a prospect, the generation of cooperative systems is expected to induce extensive azo motion and mechanical deformation thereof, finding applications in the manufacturing of light-activated nanorobots or drug-release nanocontainers. .

Abstract

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Thematic Session: Functional thin films, Nanostructures & 2D materials.
Disciplinary fields involved: Chemistry.
Keywords: Thin films, sol-gel chemistry, bottom-up synthesis, surface structuration.

Fabrication of correlated disordered structures in thin films to tune the visual appearance of surfaces

Julien Castets[1], Lucien Roach[1], Estelle Morvan[2], David Montero[3], Glenna L. Drisko[1].

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2. *Institut Européen de Chimie et Biologie*, UAR3033 CNRS, Univ. Bordeaux, INSERM US01, Pessac 33600, France
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The macroscopic appearance of a surface can be tuned through the structuration at the nano/microscale. Correlated disordered lies between the two extremes of periodic and random spatial structural configurations[1,2]. Such nanostructuration can be achieved through control over the spatial arrangement of the structures which acts to scatter light, unlocking novel optical properties such as angle-dependent diffusion[1].

We explore the synthesis of partially disordered perforated silica layers on large surfaces (~ 10 cm^2) by a combination of dip-coating deposition[2] and sol-gel chemistry. Perforations, submicrometric in scale, are produced from water droplet adsorption from a humid atmosphere, driven by the salinity of the film. By adjusting the solution conditions (e.g. salt concentration, nature of ionic species) and the deposition process (relative humidity, withdrawal speed, drying temperature), the diameter, surface coverage, and surface density of the perforations are varied, leading to tunable structures. Specifically, the perforation morphology can be tuned using chloride and bromide counterions in the solution, resulting in an increase in the degree of perforation organization[3]. A surface presenting short-range structural correlation between perforations was achieved, displaying angle-dependent diffusion. Furthermore, the fabrication process was successfully transferred from flat to curved surfaces.

In the future, the perforated silica layers can be used as structurally correlated surfaces to trap optically resonant particles, while silica nanoparticles were already successfully trapped in the perforated thin films. The appearance of these surfaces on 3D objects will be characterized using a goniometric set-up.

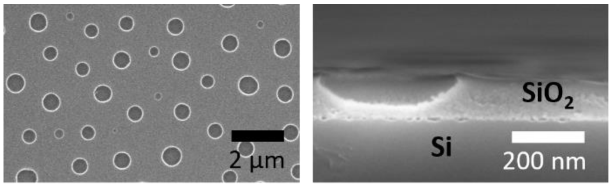

Figure 1. SEM images of a perforated silica thin film from (left) top-down view and (right) cross-sectionnal view.

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Thematic Session: Functional thin Film & Nanostructures
Disciplinary fields involved: Chemistry
Keywords: sol-gel, laser synthesis, composites, nanopigments

Synthesis of colored glasses by an original sol-gel/laser coupled approach

Ms. Julia Castelo Pedrotti[1], Dr. Iryna Gozhyk[2], Dr. Medina Elise[2], Dr. Jeremie Tesseire[2], Prof. Thierry Gacoin[1], Dr. Simon Delacroix[1]

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2. Groupe Revêtements fonctionnels par voie liquide, Département Couches Minces, Saint-Gobain Recherche, 93300 Aubervilliers, France

The synthesis of transparent thin films of various colors with good mechanical properties and capable to resist to high temperature treatments is still a synthetic challenge. The use of inorganic nanoparticles as pigments is of a major interest due to their thermal stability but some issues as to be address. In addition to security problems during the manipulations of nanopowders, the control of the nanoparticles size during the colloidal synthesis and the dispersion of particles inside a glass matrix are not easy to overcome. To face these limitations, we propose an original pathway of *in situ* nucleation of nanoparticles inside a glass matrix thanks to a laser treatment. The laser annealing has indeed many advantages such as a local heating with fast temperature ramps allowing the reduction of the nanoparticles growth ensuring a homogeneous coloration.

In this project, a synthetic pathway based only on liquid soluble precursors of glass and inorganic pigments is developed (Figure 1). First, metal and silica precursors will be deposed by spin or spray-coating on a substrate. Sol-gel chemistry will then assure the formation of a glass matrix and last, pigments will be formed thanks to the laser irradiation. The influence of the different parameters (composition, fluence…) will be presented and the different composite materials will be characterized with various analytical methods (XRD, SEM, EDX, UV-Vis, Raman…).

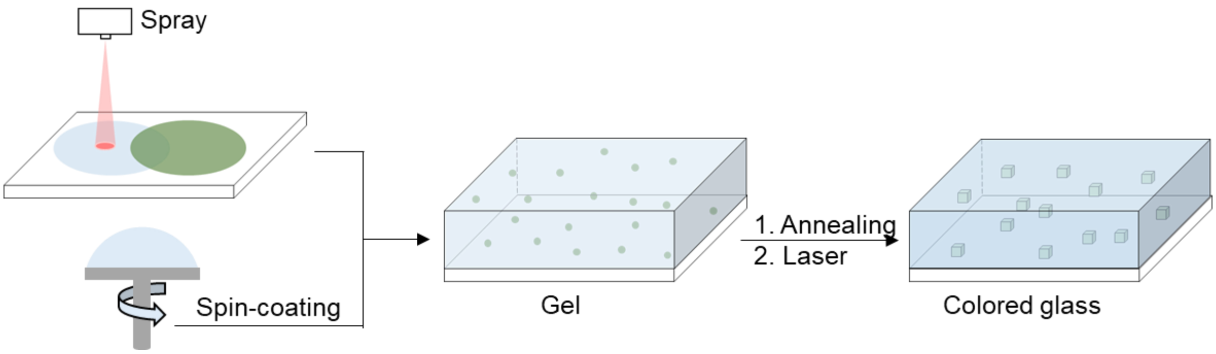

Figure 1. Synthetic pathway of a colored glass: deposit of precursors by spin or spray-coating follow by an annealing to obtain a gel. A laser treatment will induce the crystallization of colored nanoparticles inside the glass matrix.

Thursday March 20th

2:00 P.M. - 4:30 P.M.

AMPHITHEATRE GASTON BERGER

Program of the session :

Chairs: Anthony SZYMCZYK

HOUR	NAME	TITLE
14:00	**Matteo GHIDELLI** **LSPM - CNRS**	**Boosting mechanical properties of metallic thin films through advanced nanoengineered design strategies**
14:30	Catherine DE VILLENEUVE PMC - CNRS	Fe-based MOF layers on silicon surfaces
14:45	Kenza JOYEN ICGM - Univ. Montpellier	Molecular sieving membrane for selective hydrogen sensing
15:00	Vincent JOURDAIN LCC - Univ. Montpellier	In situ optical microscopy studies of the catalytic growth and shrinkage of individual carbon nanotubes
15:15	Aude SIMON LCPQ - CNRS	Growth of large carbon molecules and mixed metal-carbon nanoparticles driven by organometallic clusters: interdisciplinary studies
15:30	Alexia BISTINTZANOS INSP - Sorbonne Univ.	pH influence on the structure of metal-organic thin films at the air/water interface
15:45	Ana Karen PIÑON-VASQUEZ MIM2 - Chimie ParisTech	Design and Synthesis of Bioactive Materials Using Two-Photon Polymerization and Thiol-Ene Click Chemistry
16:00	Guillaume COLAS Institut FEMTO-ST - CNRS	Lubrication by self-assembled multilayer enabled through tribochemical transformation into nanometric thick C-based solid material
16:15	Rémi LAZZARI INSP - CNRS	Interface and grain boundary contributions to electron transport in thin films: an application to silver based low e-coatings

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Short Biography

Dr. Matteo Ghidelli is CNRS researcher at LSPM-CNRS heading the group Mechanics of Functional Thin Films composed by 7 faculty and >15 temporary researchers. Dr. Ghidelli completed a joint PhD in 2015 at the Uni. Grenoble Alpes (France) and the Uni. catholique de Louvain (Belgium). After postdoctoral positions at the Uni. Rome Tre and Politecnico di Milano (Italy), he served as Group Leader at Max Planck Institute for Sustainable Materials (Germany), heading the group of “Thin films & Nanostructured Materials” and in 2020, he joined the LSPM. Here, he established a new research activity focused on the synthesis of nanostructured thin films and micro-scale mechanical characterization, especially using in situ SEM techniques. His work emphasizes innovative nanoengineering strategies - such as the synthesis of nanocomposites, nanogranular films, and interface dominated materials - designed to enhance and precisely control mechanical properties and deformation behavior. Dr. Ghidelli is author of 44 papers and he secured >1.5 M€ as third parts funding. In 2022, he obtained the “Habilitation à diriger des recherches (HDR)” and, at the present, he supervises 4 PhD students and 1 postdoc.

Title of Oral Presentation

Boosting mechanical properties of metallic thin films through advanced nanoengineered design strategies

Keywords

Metallic thin films; Mechanical properties; Nanoengineering thin film strategies; In situ SEM micromechanics

Abstract of Oral Presentation

The current trend toward miniaturization in devices components in key technologies such as microelectronics, energy production, sensors and wear protection requires the development of high-performance thin films with superior mechanical properties combining mutually excluding mechanical properties such as high yield strength and ductility.

Achieving such performance, relies on leveraging microstructure-induced mechanical properties, requiring the precise control of film's microstructure, atomic composition, grain size and thickness based on nanoengineering design concepts. Here, I will present recent results for several class of advanced thin film materials including nanostructured metallic glasses (ZrCu, ZrCuAl)[1, 2] high entropy alloys (CoCuCrFeNi) and nanolaminates (fully amorphous, amorphous/crystalline)[3, 4], highlighting how the control of the microstructure affect the and micro-scale mechanical behavior and enable ultimate mechanical properties. Among the main results, I will show the fabrication of fully amorphous Zr24Cu76/Zr61Cu39 nanolaminates by magnetron sputtering with controlled nanoscale periodicity (Λ, down to 5 nm), local chemistry and glass-glass interfaces [3]. I will show how the shear band instability can be mitigated when $\Lambda \leq 50$ nm, reaching remarkably large elastic/plastic deformation (16%) and yield strength (~2GPa) by micro-pillar compression [3]. Then, I will present the potential of Pulsed Laser Deposition (PLD) as a novel technique to synthetize nanostructured cluster-assembled ZrCu and CoCuCrFeNi films, reaching ultimate yield strength (>3 GPa) and ductility (>6 %) for ZrCu. Finally, I will focus on the synthesis of crystal/glass ultrafine nanolaminates by PLD[4] in which 4 nm Al (crystalline) separate 6 and 9 nm-thick Zr50Cu50 metallic glass nanolayers, showing high yield strength (3.4 GPa) in combination with enhanced elastoplastic deformation (>6%, in compression), while managing to effectively block the percolation of shear bands even at >15% deformation[4]. Overall, I will show how fine microstructural control in metallic thin films is an effective strategy to tailor their deformation behavior and boosting their mechanical properties with potential for industrial applications.

Acknowledgement

Special acknowledgments to Andrea Brognara, Francesco Bignoli, and Davide Vacirca for their experimental work as well as to Philippe Djemia, Damien Faurie, James Best and Gerhard Dehm. This work is supported by the ANR-DFG PRCI "Nanostructured Thin Film Metallic GLASSes with superior mechanical/Electrical properties" (EGLASS, ANR-22-CE92-0026-01) and the ANR JCJC project "MICRO-scale mechanical characterization of thin film High Entropy Alloys" (MICRO-HEAs, ANR-21-CE08-0003-01).

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Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Surface chemistry
Keywords (max. 4-5)**:** MOF, Metal Organic Framework, thin layers, silicon

Fe-based MOF layers on silicon surfaces

W. Fu, N. Soulmi, M. Rosso and C. Henry de Villeneuve

Laboratoire PMC CNRS, Ecole Polytechnique, Institut Polytechnique de Paris, Palaiseau, Franc

MOFs (Metal Organic Frameworks) are crystalline porous materials having a strong potential for numerous applications (fluid storage, catalysis, sensors, electronic devices, etc.).[1, 2] Most often synthesized as (nano) microcristalline powders, the fabrication of MOF layers, which is a prerequisite for some applications, remains very often a challenge.[1, 2] Within this context, we are interested in the fabrication of MOF layers by direct growth onto functionalized silicon surfaces with tunable surface chemistry and that are compatible with a large range of MOF synthesis conditions (chemical and thermal stability). The systems under investigation are Fe-based MOFs obtained from Fe^{3+} and 1,4-benzene dicarboxylic acid (BDC) precursors. Our studies show the (co)nucleation and growth of different Fe-BDC structural phases on the surfaces as well as different layer morphologies (oriented growth of 3D individual crystallites or dense polycrystalline layers of variable thickness (few nms (**Fig.1a**) up to 1µm), depending on the synthesis conditions. An interesting result is the evidence of the formation of textured ultrathin 2D layers exhibiting extended monocrystalline domains, whose crystalline structure (cubic Fe-MIL 101) could be determined by AFM (**Fig.1b**).[3]

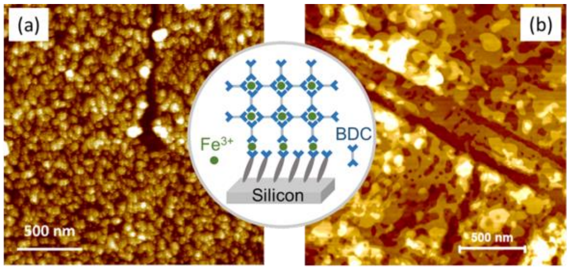

Figure 1: Examples of Fe-BDC polycrystalline **(a)** and 2D textured **(b)** thin layers obtained on -COOH functionalized silicon surfaces. The layer thickness is ~10 nm **(a)** and ~ 35 nm **(b)**. For the sample **(b)** the AFM image shows a characteristic structure with flat terraces separated by regular steps (5 nm height) that enabled to determine identify the type of structural phase (Fe-MIL101 with (111) texture).

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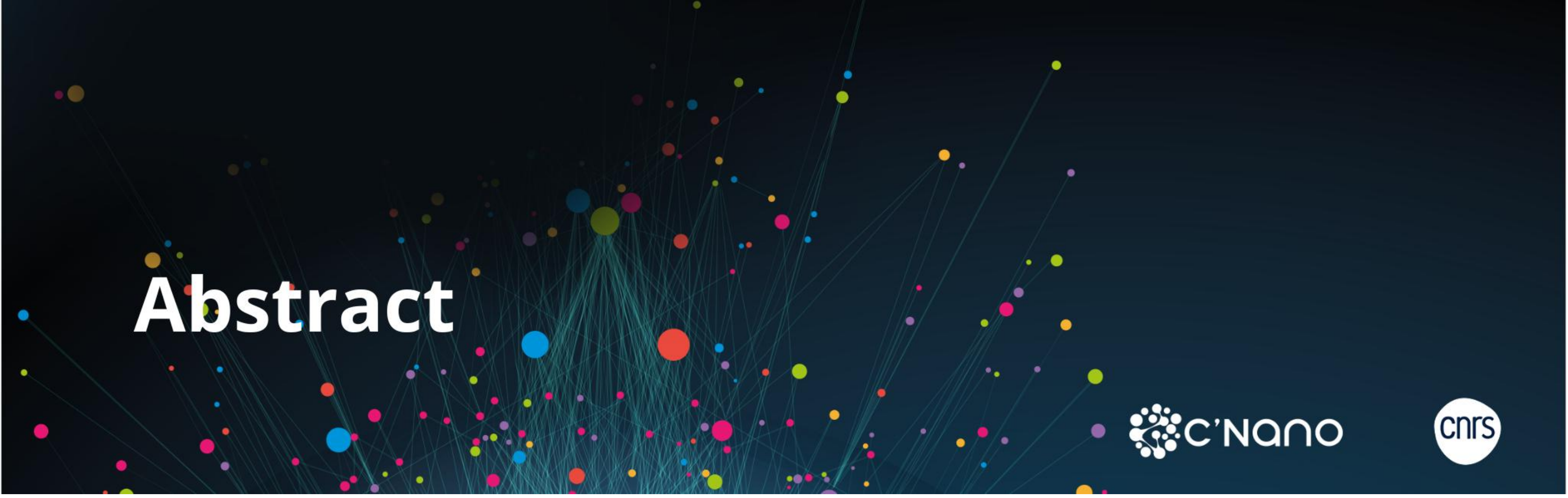

Abstract

Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Chemistry
Keywords: - MLD - Hydrogen selectivity – Alucone - Gas sensing

Molecular sieving membrane for selective hydrogen sensing

Kenza Joyen[1,2], Romain Platel[1], Frédéric Favier[1], Mikhael Bechelany[2]

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2. Institut Européen des Membranes (IEM) – UMR 5635, Université de Montpellier, ENSCM, CNRS, 34090 Montpellier, France

In the context of sustainable development and the use of renewable energy sources, dihydrogen is an attractive energy carrier. However, when its concentration in the air exceeds 4%, it becomes potentially explosive, posing significant safety concerns. Most hydrogen sensors are constructed using semiconductor metal oxides[1], but they exhibit limited sensitivity and selectivity when detecting hydrogen in the presence of other gases. Our objective is to develop a sensor capable of accurately measuring H_2 in various industrial gas[2] mixtures (such as CH_4, CO_2, H_2S, etc.). The sensor we aim to develop is equipped with a porous alumina membrane, serving as a molecular sieve to enhance sensitivity and selectivity in hydrogen detection. This membrane is deposited through molecular layer deposition (MLD) and subsequently subjected to heat treatment to achieve the desired porosity[3,4]. The initial step involves the deposition of a sensitive layer, which consists of palladium deposited via sputtering. In a second step, a layer of alucone is deposited through MLD to produce a porous alumina-based structure that is subjected to heat treatment at various temperatures (200 to 500°C) under different atmospheric conditions, including air and/or controlled atmospheres. For hydrogen detection, electrical measurements are performed. When hydrogen comes into contact with palladium, it forms a palladium hydride. This chemical reaction leads to a change in the sensor's resistivity, enabling us to measure response times (Figure 1). Ideally, we aim for the porous alumina membrane to exclusively permit hydrogen to pass through, ensuring that the sensor does not respond to the presence of other gases.

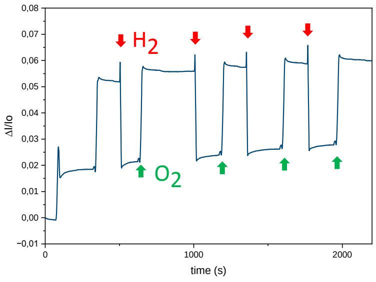

Figure 1 : Current response ΔI/Io = f(t) of a sensor based on a Palladium film and a porous alumina membrane of 50 cycles

Abstract

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Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Chemistry, Physics
Keywords: carbon nanotubes, catalytic growth, CVD, in situ, optics

In situ optical microscopy studies of the catalytic growth and shrinkage of individual carbon nanotubes

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Abstract

Understanding the kinetic selectivity of single-walled carbon nanotube (SWCNT) growth at the scale of individual nanotubes is essential for the development of growth methods with high chiral selectivity, a major bottleneck for their application in microelectronics. Here we report on the use of homodyne polarization microscopy [1,2] for high-throughput imaging of long individual nanotubes under real growth conditions (at ambient pressure, on a substrate), and with sub-second time resolution. Our *in situ* observations on hundreds of individual nanotubes [3] reveal that about half of them grow at a constant rate all along their lifetime while the other half exhibits stochastic changes in growth rates, and switches between growth, pause and shrinkage. Statistical analysis shows that the growth rate of a given nanotube essentially varies between two values, with similar average ratio (~1.7) regardless of whether the rate change is accompanied by a change in chirality. These switches indicate that the nanotube edge or the catalyst nanoparticle fluctuates between different configurations during growth [4]. In addition, we will show that nanotubes can switch from growth to shrinkage, either stochastically or by the introduction of a gas phase etchant like water. We will show that both processes are controlled by the nanotube/catalyst interface and that they are dependent on the nanotube chirality.

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Acknowledgement:

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Thematic Session: functional thin films, nanostructures and 2D material
Disciplinary fields involved: chemistry, physics
Keywords (max. 4-5)**: organometallics, gas phase, astrochemistry, quantum chemistry, plasma**

Growth of large carbon molecules and mixed metal-carbon nanoparticles driven by organometallic clusters: interdisciplinary studies

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The ANR project GROWNANO is motivated by the need to understand the formation of carbonaceous/organosilicon dust in the presence of metal atoms (Fe, Ag, Ti, Al, Mg) with expected impact in the field of astrophysics and that of new materials for nanoelectronics . Astrochemical models currently do not take into account the role of metals in the nucleation and growth of carbonaceous dust. GROWNANO investigates the role of organometallic complexes and nanoclusters in these processes (Figure 1). These studies also provide useful guidelines for a better control of nanoparticle synthesis.

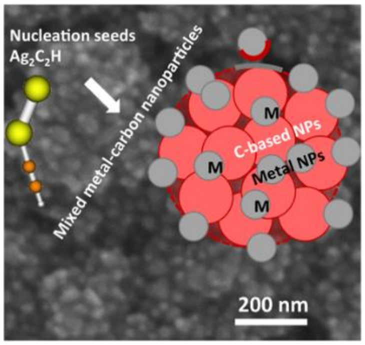

Figure 1. The different scales explored in the ANR GROWNANO

GROWNANO makes use of complementary reactors. The laser vaporization (LVAP) reactor on the PIRENEA 2 setup at IRAP allows us to investigate the first steps of nucleation and growth whereas the formation of the nanoparticles in the plasma gas phase is studied using the Plasma reactor at LAPLACE, which brings physical and chemical complexity with respect to LVAP. A variety of *in-situ* and *ex-situ* analytical methods are used to characterize the materials synthesized in the two reactors [1]. In addition, a computational reactor investigates reaction dynamics and makes the bridge between the two size scales by using DFT methods for small species and approximated DFTB methods for larger ones [2]. Current challenges and results of this collaborative interdisciplinary work will be presented.

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Acknowledgement:

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Thematic Session : Functional thin films, Nanostructures and 2D materials
Disciplinary fields involved : Chemistry, Physics and Materials science
Keywords : Silver nanoclusters, carboxylate coordination, Multilayer formation, Air/water interface, Hybrid thin films

pH influence on the structure of metal-organic thin films at the air/water interface

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Metal-organic thin films are pivotal in nanoscience due to their unique optoelectronic properties. This study explores the interactions between silver ions and fatty acid diacetylene (DA) films formed at the air/water interface. Using the Langmuir film procedure, crystalline DA films are prepared on a liquid subphase containing silver salts. Grazing incident X-ray diffraction (GIXD) and surface X-ray fluorescence (XRF) are used to assess the influence of the silver ions (Ag^+) on the structure and stability of the DA film. The metal-organic film is then transferred onto a solid substrate and characterized by atomic force microscopy (AFM).
We form a 10,12-heptacosadyinoic acid (HCDA) Langmuir film on a water subphase containing silver sulfate (Ag_2SO_4) at two different pH, basic (9/10) and acid (5/6), respectively.
At a basic pH, GIXD and XRF analyses reveal the formation of a crystalline metal-organic multilayer film, with a characteristic Ag-Ag distance of $\approx$ 0.33 nm. AFM measurements indicate a thickness of ≈6/7 nm, consistent with a trilayer structure. This behavior is attributed to Ag+'s high polarizability creating bidentate bridging coordination with the HCDA carboxylate groups.
At acidic pH, protonation of carboxyl groups prevents significant interaction with Ag^+, resulting in stable HCDA monolayers with a thickness of ≈2 nm. However, post-irradiation, X-ray-induced water radiolysis reduces the dielectric constant, enabling covalent interactions that drive HCDA silver-enriched multilayer structure (thickness≈6/7 nm) and the emergence of the XRF silver signal. These findings enhance the understanding of metal-organic hybrid film formation and their structural properties under varying conditions, with potential implications for optoelectronic applications.

Acknowledgment: We thank Synchrotron SOLEIL for the beamtime

Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved Chemistry
Keywords (max. 4-5)**: Two-photon polymerization (TPP), Thiol-ene reaction, Scaffold**

Design and Synthesis of Bioactive Materials Using Two-Photon Polymerization and Thiol-Ene Click Chemistry

Ana Karen Piñon-Vazquez[1,2], Xingming Ju[1,3], Elnaz Nematollahi [1,3],Raphaelle Renou [1,3], Ferdinando Tristán-López[2] , Sylvie Coscoy[3] , Vincent Semetey[1]

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The cellular microenvironment plays a crucial role in biology and serves as a key determinant of cell behavior and function in various biological processes. The extracellular matrix (ECM) within the cellular microenvironment provides not only structural support to cells but also a source of three-dimensional (3D) biochemical and biophysical cues that influence and regulate cellular behavior. Tissue engineering enables the design of scaffolds with precise control at the cellular scale. In particular, advanced technologies like two-photon polymerization (TPP) allow for sub-micron-scale microfabrication, with applications spanning medical bio-implants and fundamental cellular biology.

This work aims to leverage chemistry and TPP to fabricate 3D microstructures with precise control over local chemistries and scaffold properties, serving as a tool for cellular biology. We focused on a synthetic material, off-stoichiometry thiol-ene (OSTE) resins, widely used for 3D structure fabrication due to their excellent mechanical properties. TPP facilitates the straightforward fabrication of these 3D structures. By adjusting the ratio of two functional groups (thiols and alkenes), we can create surfaces with an excess of either thiol or alkene groups, offering significant opportunities for post-fabrication functionalization.

Also we explored the grafting of polyethylene glycol (PEG) onto OSTE surfaces via a thiol-ene reaction to impart anti-adhesive properties. These findings open the door to developing tailored 3D scaffolds for use in cell biology, allowing for the precise modulation of surface chemistries to influence cellular interactions and behavior.

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Ucla, P., Ju, X., Demircioglu, M., Baiz, S., Muller, L., Germain, S., ... & Coscoy, S. (2022). Dynamics of endothelial engagement and filopodia formation in complex 3D microscaffolds. International Journal of Molecular Sciences, 23(5), 2415.
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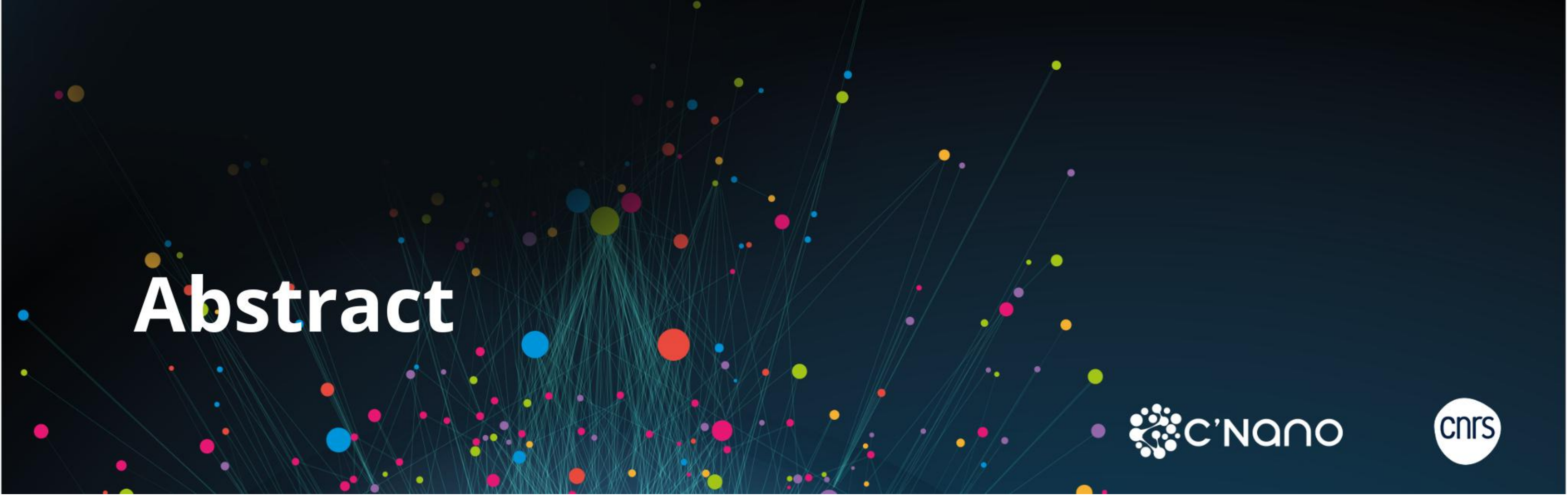

Abstract

Thematic Session : Couches minces fonctionnelles, Nanostructures & Matériaux 2D
Disciplinary fields involved : chemistry, mechanics, material science
Keywords : Tribology, tribochemistry, SAM, Atomic force microscopy,

Lubrication by self-assembled multilayer enabled through tribochemical transformation into nanometric thick C-based solid material

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4. *CNES, 31401 Toulouse, France*

Lubricating space mechanisms is a real challenge due to the stringent requirement imposed by such application. Indeed, lubrication must be sustained in dry and humid air, in vacuum, remain stable over long period of time, etc. Miniaturization and cost effectiveness impose the development of new lubricants.

In this study, lubrication based on self-assembled molecular layer made of alkylphosphonic acid (APA) deposited by spray has been evaluated as a new avenue to lubricate contact in air and vacuum. Tested on a macroscale contact, performances in vacuum have been extremely good (low friction from 0.03 to 0.06) and comparable to the best reference dry lubricants (MoS_2), while lubrication tends to fail early in air (as MoS_2 does…). To better understand the underlying mechanisms, in depth study of the material before and after friction has been conducted using SEM, Raman Spectroscopy, XPS, REELS and AFM in both high resolution peakforce tapping imaging and peakforce quantitative mechanical mapping modes. During friction in vacuum, mass spectrometry was used to monitor the chemical composition of the vacuum environment.

The results show that after spray, the molecules of APA agglomerate to form multilayered structures whose individual layers correspond to a stack of 3 molecular layers. As soon as mechanical shear is imposed during friction, a significant transformation occurs within the interface: the molecular layers turns into a solid bulk material demonstrating C-C bounding and C π-π^* bounding, without showing different overall elemental composition, as compared to APA. Such tribochemically formed bulk material degrades quickly under friction in air, but not in vacuum.

Acknowledgement:

We thank CNES for funding the study, the technology center MIMENTO (Femto-ST Institute, France) for the access to SEM/EDS facilities.

Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Physics
Keywords: thin film resistivity, low-e coating, microstructure, grain boundary and interfaces

Interface and grain boundary contributions to electron transport in thin films: an application to silver based low e-coatings

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The challenge of green-house gas reduction pushes towards a better thermal insulation of housing. In this context, glass industry strives to decrease the infra-red radiative transfer across windows while keeping transparency. In the so-called low-E or solar control glazings, the functionality is provided by a complex stack of layers deposited by magnetron sputtering in which the active component is a ~10 nm thick Ag film encapsulated between ZnO dielectric layers. Its infra-red reflective characteristics are intimately related to its electrical resistivity. Thus, understanding the main contributions to electron transport in thin metallic films is of paramount importance for product improvement.

In this study on model ZnO/Ag/ZnO stacks [1], low temperature resistivity measurements have been systematically coupled to structural characterizations (x-ray scattering and transmission electron microscopy) to disentangle the main electron scattering mechanisms, namely at interfaces, grain boundaries and point defects. By using different substrates (glass vs single crystals *i.e.* polycrystalline vs epitaxial films), by changing the nature of interfaces and by annealing, strong differences in terms of metal crystallinity could be achieved at constant thickness (12 nm). The analysis of transport data in the framework of the Mayadas-Shatzkes model [2] evidenced (i) beyond grain size, a strong role of film texture and (ii) beyond interface roughness, a contribution of interface barrier. Nevertheless, as resistivity intrinsically escapes the Matthiessen's rule at such thickness, all contributions to electron scattering are strongly correlated.

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Poster Session

FUNCTIONAL THIN FILMS, NANOSTRUCTURES & 2D MATERIALS/ NANOSCALE CHARACTERIZATION

N° POSTER	TITLE	NOM	Prénom
64	OVERCOMING SAMPLE PREPARATION CHALLENGES IN NANOPARTICLE CHARACTERIZATION BY SEM	AMBERT	Stéphane
65	THE HREELM Project – The High Resolution Electron Energy Loss Microscope is coming to probe the surface vibrations at the microscopic scale	AMIAUD	Lionel
66	Development of measuring protocols and data processing methods for reference samples designed to calibrate electrical measurements at nanoscale	CHRETIEN/PIQUEMAL/HOUZE/MORAN-MEZA/HAROURI	Pascal/François/Frédéric/josé/Abdelmounaim
67	AI-Machine Learning models for conductive electrical modes on AFM: maps prediction and material clustering	COQ GERMANICUS	Rosine
68	Unravelling complex mixtures at the nanoscale: the power of coupling field flow fractionation and electron microscopy (FFF-EM)	CROUZIER	Loic
69	Boron Phosphide Nanocrystals from the Viewpoint of Pair Distribution Function Analysis	DOISNEAU	Clara
70	Combined Study of Casimir-Polder Interactions and Patch Potentials on SiNx Nanogratings	FABRE	Nathalie
71	Nano-architecture of mixed organic layers on a silver surface	GUAN	Yimin
72	CARBON NANOTUBE MECHANICAL MASS SENSOR WITH SUB-YOCTOGRAM SENSITIVITY AT ROOM TEMPERATURE	HENN	François
73	Nanoscale characterization of ZnS:Cu Phosphor Powder	HERNANDEZ	Roberto
74	Fluorescence properties of mixed-dimension heterostructures	LE BALLE	Juliette
75	In-rich InGaN/GaN nanowires for red light emitting diodes	TCHOULAYEU POSSIE	Nidel Dilan
76	Design of efficient nanocatalysts for H2 release from boranes and silanes	THIBAULT	Maxime
77	THE HREELM Project – The High Resolution Electron Energy Loss Microscope is coming to probe the surface vibrations at the microscopic scale	AMIAUD	Lionel
78	Enhanced Light Absorption through Nanostructuring of Titanium Nitride (TiN)	BEN MOUSSA	Nizar
79	Study of physical properties of antiphase boundaries in III-V epitaxial layer on silicon with conductive tip atomic force microscopy (C-AFM) and with Kelvin Probe Force Microscopy (KPFM) techniques.	BERNARD	Rozenn
80	Interfacial self-assembly of polydiacetylene and graphene oxide for organic photovoltaics	BISTINTZANOS	Alexia
81	TMD Engineering of 2D-Magnetic Tunnel Junctions – From Barriers to Electrodes	DANIEL	Jane
82	Study and Characterization of TzDA Langmuir Films for Polydiacetylene-Based Sensors	KANDYLI	Maria
83	Charge transfer between plasmonic PdAg nanoparticles and C60 molecules	LI	Xingtong
84	Développement et caractérisation de cristaux magnoniques sur substrats flexibles pour la straintronique	MNASRI	Walid
85	Direct CVD graphene integration for Spintronics	PERRIN	Jérémy
86	Design and Synthesis of Bioactive Materials Using Two-Photon Polymerization and Thiol-Ene Click Chemistry	PINON VASQUEZ	Ana Karen
87	Engineering Spin Wave dispersion and Surface Acoustic Wave-driven FMR in Fe thin films by N-implantation	SHARMA	Anupam

Thematic Session: nanomaterials
Disciplinary fields involved: Physics
Keywords : Titanium Nitride (TiN), Nanostructuring, Light Absorption,Black TiN

Enhanced Light Absorption through Nanostructuring of Titanium Nitride (TiN)

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Abstract : Titanium nitride (TiN), an N-type semiconductor with a wide bandgap (3.4 eV), exhibits excellent optical transmission in the visible range. In this study, we show how the nanostructuring of TiN affects its light absorption properties and transforms it into “black TiN". Reflectance measurements show a significant reduction in light reflectance from 40% to 10% at 900 nm while increasing the etching time. Photoluminescence spectra are also given for a 400nm thickness sample with different etchant ratios of H_2O_2 and TBR19 (D1 non etched, D2 to D4 corresponding to 100:6, 100:10 and 100:3 ratios). The influence of the silicon (Si) substrate was accounted for and taken as background. Morphological SEM analysis reveals the evolution: nanopyramidal structures in TiN give way to a porous architecture in black TiN, drastically increasing the surface area and improving light absorption. These results underline the potential of black TiN for advanced photonic and optoelectronic applications, as the black TiN films offer good electronic and optical properties even with the presence of pores which enhances the non-radiative processes [3].

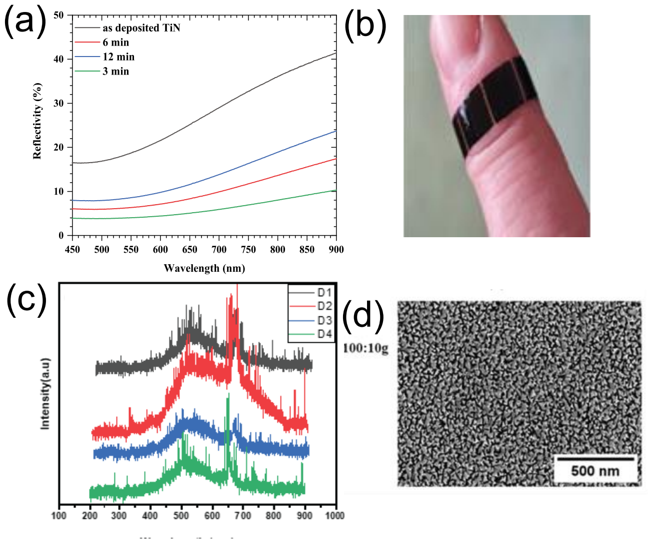

Figure 1: a) Reflectivity measurements of the coated substrate: as deposited, etched for 6 min, etched for 12 min, and etched for 3 min by chemical processing, b) black TiN on a flexible polymer film, c) Photoluminescence measurement with different etching ratio, and d) SEM of a 400nm black TiN sample.

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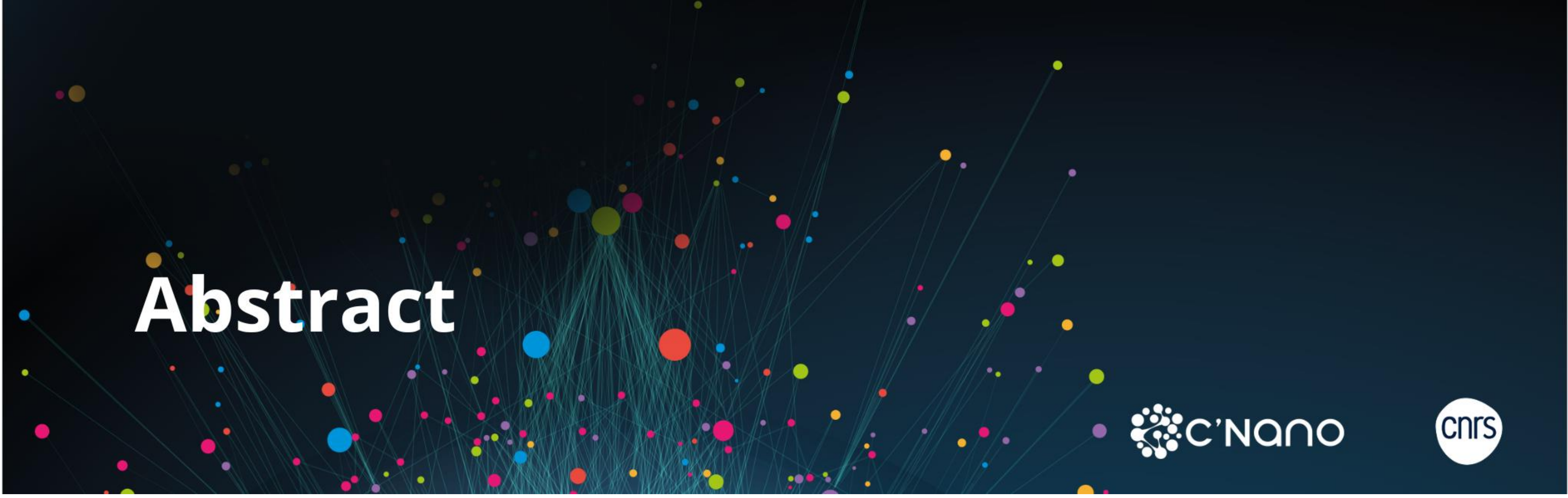
Patent: PCT/EP2022/070562



Abstract

Thematic Session (eg. Nanophotonics & nano-optics, nanomaterials, nanobioscience …)**:**
Couches minces fonctionnelles, Nanostructures & Matériaux 2D
Disciplinary fields involved (eg. Chemistry, Physics, Biology …)**: Physics**
Keywords (max. 4-5)**: antiphase boundaries, III-V on silicon, C-AFM, KPFM, monolithic integration**

Study of physical properties of antiphase boundaries in III-V epitaxial layer on silicon with conductive tip atomic force microscopy (C-AFM) and with Kelvin Probe Force Microscopy (KPFM) techniques.

Rozenn Bernard[1], Michel Ramonda[2], Audrey Gilbert[3], Tony Rohel[1], Julie Le Pouliquen[1], Karine Tavernier[1], Nicolas Bertru[1], Jean-Baptiste Rodriguez[3], Eric Tournié[3], Yoan Léger[1], Charles Cornet[1]

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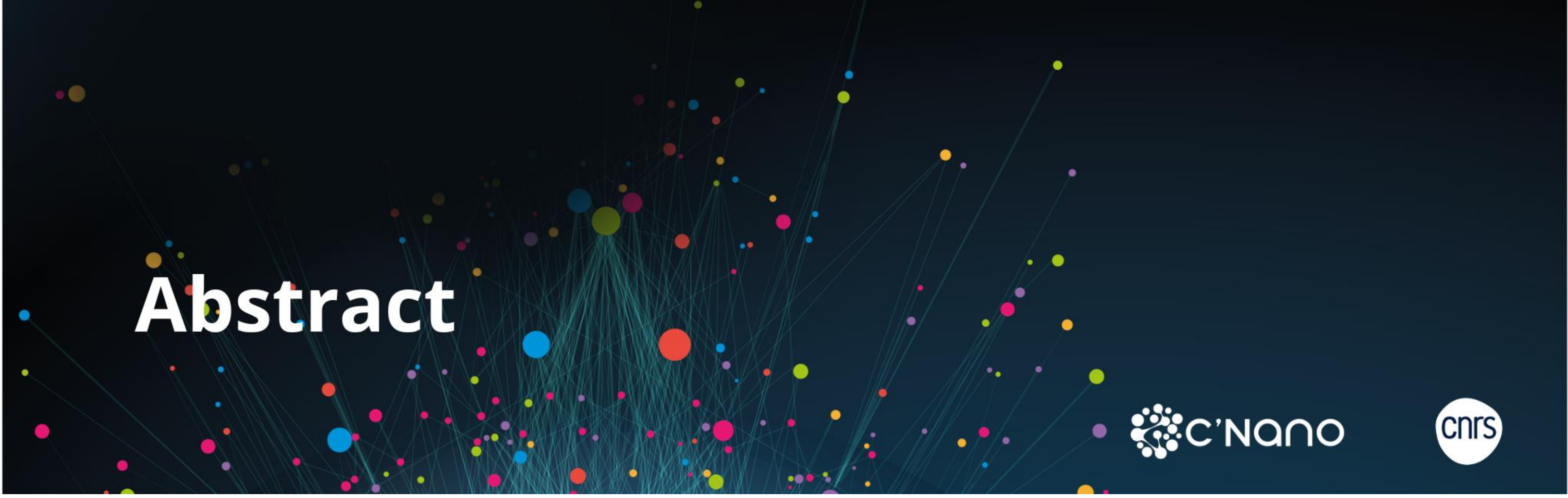
Intensive research in recent years has focused on the heteroepitaxy of III-V semiconductors on silicon, driven by its potential to enable high-quality, low-cost devices for photonic and energy applications. Recent studies aimed at deepening the understanding of the fundamental physical processes involved in III-V/Si heteroepitaxy [1-4] have shown that most crystal defects, which negatively impact device performance and are commonly observed in III-V epilayers grown on silicon, originate during the early stages of crystal growth. Among these, the influence of antiphase boundaries (APBs) on the optoelectronic properties of III-V/Si materials and devices has been widely examined. However, only a limited number of studies [5] have investigated the physical properties of APBs, particularly at the nanoscale, using techniques such as conductive atomic force microscopy (C-AFM) and Kelvin probe force microscopy (KPFM).

In this work, we explore the physical properties of APBs in GaP//Si and GaAs//Si samples using C-AFM and KPFM. We analyze the electrical properties and surface potential variations of III-V//Si samples, both in their as-grown state and after chemical mechanical polishing (CMP) to eliminate the effects of topography. Furthermore, we discuss the correlation between the conductive behavior of APBs and local variations in surface potential relative to the III-V matrix, according to III-V growth conditions and to silicon surface preparation.



Abstract

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Acknowledgement:

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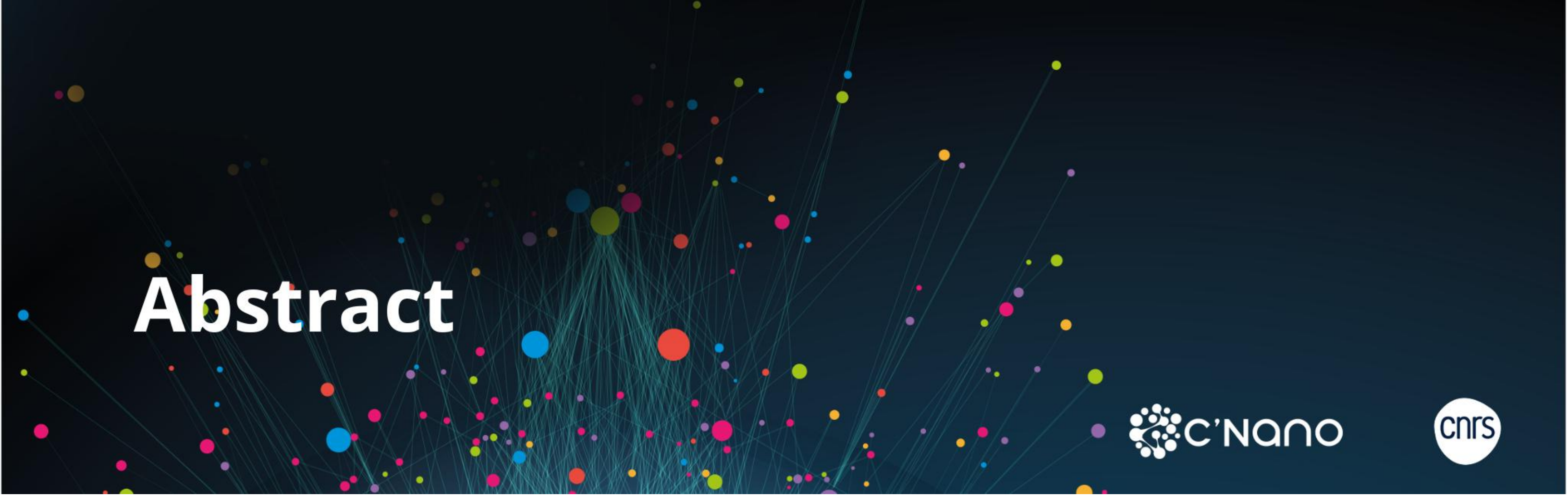

Abstract

Thematic Session : Functional thin films, Nanostructures and 2D materials
Disciplinary fields involved :Chemistry, Physics and Materials science
Keywords : GO, Polydiacetylene, Organic Photovoltaics, Nanointerfaces, Charge Transfer

Interfacial self-assembly of polydiacetylene and graphene oxide for organic photovoltaics

Alexia Bistintzanos[1], Sylvie Spagnoli[1], Hervé Cruguel[1], Philippe Fontaine[2], Arnaud Hemmerle[2], Francesco Carlà[4], Michel Goldmann[1,2,3]

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Engineering functional nanointerfaces is key to advancing organic photovoltaic (OPV) technologies. We report the fabrication of a graphene oxide (GO)/polydiacetylene (PDA) hybrid nanostructure using the Langmuir-Blodgett (LB) technique, enabling precise control over molecular organization at the nanoscale. PDA, a π-conjugated polymer, undergoes a stimuli-responsive chromatic transition (blue to red), making it a promising material for light-harvesting applications. When interfaced with GO—an amphiphilic nanomaterial with tunable electronic properties—its optical and electronic behavior is significantly modified.

Grazing Incidence X-ray Diffraction (GIXD) and X-ray Reflectivity (XRR) confirm that PDA forms a highly ordered monolayer on GO, stabilized by electrostatic interactions. Raman spectroscopy reveals that GO suppresses PDA's color transition, preserving PDA'S visible light absorption. Kelvin Probe Force Microscopy (KPFM) and Ultraviolet Photoelectron Spectroscopy (UPS) demonstrate that charge redistribution at the interface increases PDA's work function, improving charge injection—a crucial factor for OPV efficiency.

Our results highlight GO/PDA nanointerfaces as tunable electronic and optical platforms for next-generation photovoltaics and nano-optoelectronic devices.

Acknowledgement:
We thank Synchrotron SOLEIL and Diamond Light Source for the beamtime

Thematic Session: Nanomaterials
Disciplinary fields involved: Physics
Keywords: Spintronics, 2D Ferromagnets, 2D spin valves, Pulsed Laser Deposition (PLD)

TMD Engineering of 2D-Magnetic Tunnel Junctions – From Barriers to Electrodes

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Spintronics has revolutionized data storage, notably through the development of highly sensitive hard-drive read-heads based on Giant Magnetoresistance (GMR), and later Tunnel Magnetoresistance (TMR) technologies. These are at the core of Magnetic Tunnel Junctions (MTJs), nowadays composing the latest generation of ultra-fast and low power Magnetic Random Access Memories (MRAMs) and fueling post-CMOS unconventional electronics strategies (including spin logics, stochastic, neuromorphic and quantum computing). In this direction 2D materials [1] have unleashed a multitude of previously unexploited possibilities for spintronic devices. As such, graphene has already demonstrated impressive performance, achieving record spin polarization of up to -98% in a MTJ [2]. But more recently, a new class of materials, 2D ferromagnets, have emerged as particularly promising for spintronics, as they could pave the way to gate-controllable 2D magnetic tunnel junction (2D-MTJ) spin valve devices. However, a 2D ferromagnet efficiently working at room temperature remains a clear challenge. In this work, we focus on the development of room temperature 2D ferromagnets and their integration as electrode into 2D-MTJs. Specifically, we have engineered 2D ferromagnets based on Fe4GeTe2. To achieve this, we have recently developed novel in-situ processes based on large-scale pulsed laser deposition (PLD) techniques to allow the growth and heterostacking of different 2D materials [3]. We will discuss how to reach one step further with the large-scale integration of these materials into tailored 2D heterostructures.

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Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Physics

Keywords: Sum Frequency Generation, Nanoparticles, Surface Differential Reflectance Spectroscopy, Charge transfer

Charge transfer between plasmonic PdAg nanoparticles and C_{60} molecules

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Understanding the interaction of molecules with nanoparticles (NP) is crucial to control charge transfer in nanoscience. Using ordered assemblies is a way to efficiently control optical and electronic properties [1-3]. We have investigated assemblies of ordered plasmonic NP [4] in strong interaction with molecules to understand the role of NP surface plasmon resonance (SPR) on the photophysical properties of the molecule and the charge transfer dynamics. Pd/Ag core/shell plasmonic NPs made in vacuum are functionalized by $C_{60.}$ Their photophysical, plasmonic and vibrational properties are monitored by linear and nonlinear optical spectroscopy techniques and STM microscopy after the growth.

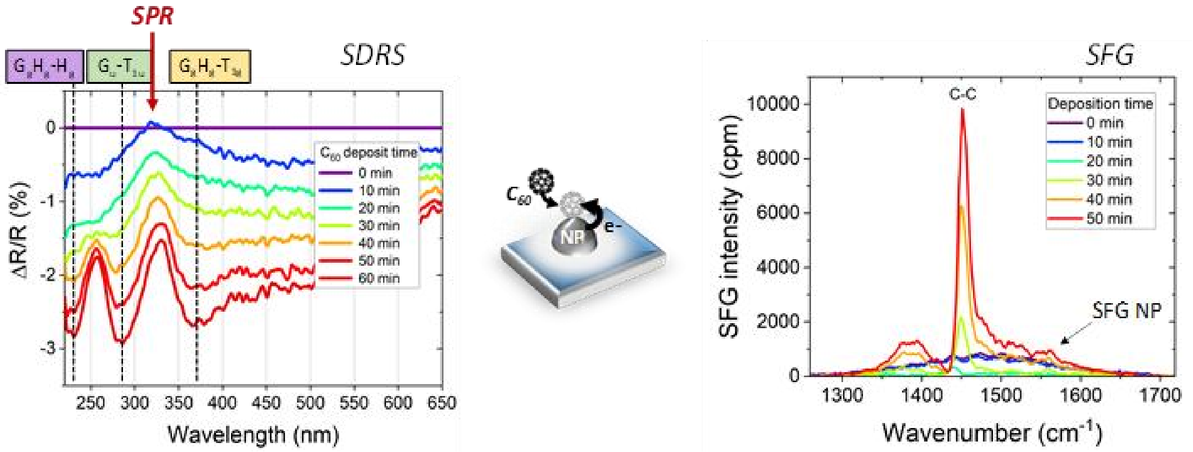

Fig.1. (left) SDRS spectra and (right) SFG spectrum as a function of C_{60} deposition time. (middle) Schematic diagram of C_{60} on NP and the consequent charge transfer.

By tracking UV/Vis absorption and vibrational response as a function of time, we observed that in the early stage of C_{60} growth, only the changes of SPR are observed. As the deposition time increased,

C_{60} vibronic bands appear. Concurrently, C-C vibration shows a quadratic growth over time. These observations indicates a strong interaction between the NP and C_{60}. By confronting experimental data to 3D E_{field} distribution simulation, we propose a growth mechanism scenario and how it impacts the C_{60}-NP coupling and their optical properties. It opens the way to control charge and energy transfer processes more effectively by driving the position of the molecule in the vicinity of the nanoparticle. Such control is crucial for molecular electronics, photocatalysis, solar cells, and sensors.

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Acknowledgement:

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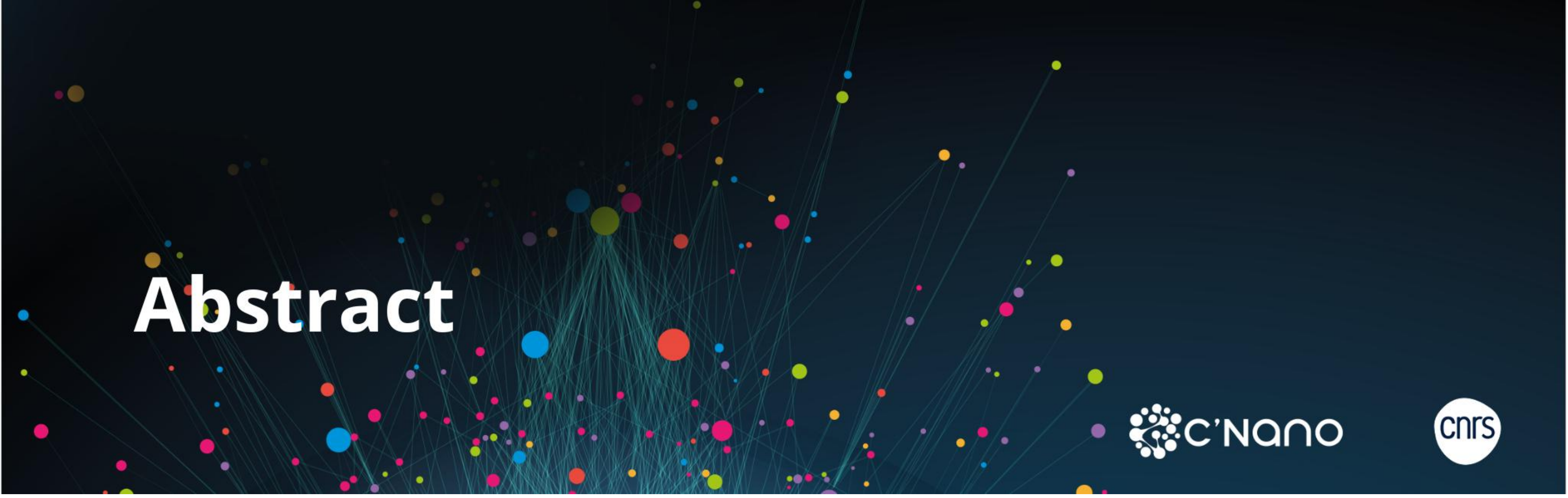

Abstract

Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved: Physics, Chemistry, Materials Science
Keywords: Polydiacetylenes, Langmuir films, thin sensors

Study and Characterization of TzDA Langmuir Films for Polydiacetylene-Based Sensors

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Diacetylenes polymerize under irradiation to form blue polydiacetylenes (PDAs), known for their chromogenic and fluorogenic transitions.[1] The blue-to-red PDA transition occurs under various stimuli, but the red form's low fluorescence limits sensitivity. To address this, we propose TzDA, a di-alkyl backbone molecule modified with a tetrazine fluorophore to enhance fluorescence recovery.[2] Our goal is to develop ultra-thin, sensitive sensors using homogeneous, polymerizable TzDA Langmuir films.
The Langmuir technique enables the creation of monomolecular films by spreading amphiphilic molecules in a volatile solvent on a water/air interface. After solvent evaporation, the film is compressed, and surface pressure (Π) vs. Area per molecule (Apm) is measured, revealing 2D phase behavior.
Initial experiments on unpolymerized TzDA films revealed unusual Π-Apm isotherms: as temperature decreased from 20°C to 5°C, the lift-off point shifted to higher areas with no detectable 2D phase transitions. Brewster Angle Microscopy (BAM) confirmed a condensed phase, while Atomic Force Microscopy (AFM) showed monolayer and multilayer domains with tilted molecular conformations. Grazing Incidence X-ray Diffraction (GIXD) detected no signal from monolayer domains but revealed a well-ordered, tilted (45°) structure in multilayer regions. X-Ray Reflectivity (XRR) confirmed an average film thickness consistent with mixed mono- and multilayer structures.
UV-Vis spectroscopy of irradiated films indicated reduced multilayer formation at lower temperatures, likely due to enhanced molecular spreading. These findings suggest TzDA forms multilayered films at low surface pressures, with polymerization occurring only in well-ordered domains.

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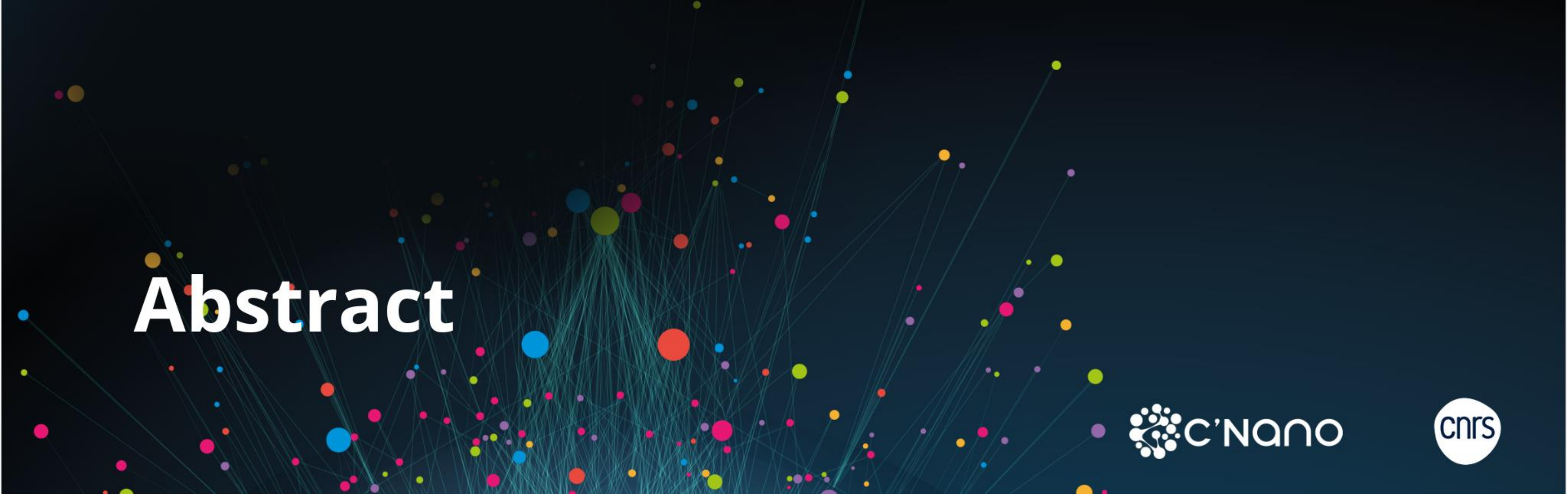

Abstract

Session thématique: Nanomagnetisme & Spintronique
Domaines disciplinaires concernés: Physique
Mots-clés: Lithographie interférentielle, nanostructure, nanomagnétisme, spintronique

Développement et caractérisation de cristaux magnoniques sur substrats flexibles pour la straintronique.

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Les matériaux nanostructurés suscitent un intérêt croissant en magnétisme en raison de leurs propriétés uniques, différentes de celles des matériaux massifs. Leur intégration sur des substrats flexibles ou extensibles ouvre la voie à de nouvelles applications, comme la spintronique flexible et les capteurs conformables, et bien d'autres encore [1,2]. Dans cette étude, nous présentons tout d'abord la fabrication d'un masque en résine par lithographie interférentielle, une méthode innovante et rapide pour créer des motifs nanométriques avec une grande précision, sans masques physiques. Cette technique est idéale pour la production de cristaux magnoniques, offrant des avantages en coût, efficacité et flexibilité, compatibles avec une large gamme de substrats. Grâce à cette approche, nous avons fabriqué des cristaux magnoniques CoFeB sur différents types de substrat (Kapton® et silicium), avec des périodicités allant de 0,5 µm à 1 µm. Les propriétés magnétiques statiques et dynamiques de ces cristaux ont été étudiées par MOKE, FMR et BLS. FMR et BLS ont permis d'identifier des modes localisés dépendant de la taille et de la géométrie des cristaux. Les cycles d'hystérésis étaient particulièrement sensibles à la géométrie, tandis que les modes dynamiques ont été identifiés grâce à des simulations micromagnétiques. Pour les cristaux sur substrats flexibles, des contraintes mécaniques contrôlées ont permis de moduler ces modes [3]. Ces résultats seront détaillés lors de cette présentation.

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Thematic Session : Nanoelectronics, nanomagnetism & Spintronique
Disciplinary fields involved : Physics
Keywords : MTJs, Graphene, 2D materials, interfaces

Direct CVD graphene integration for Spintronics

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Spin-based electronics, recently highlighted as a leading candidate for highly efficient and ultrafast embedded memories (such as MRAMs) and post-CMOS unconventional electronics strategies (including spin logics, stochastic, neuromorphic and quantum computing), has experienced considerable growth. Beyond the intrinsic spin transport properties of graphene, 2D materials have unlocked a wealth of previously unexplored opportunities for spintronic devices.
We will present results concerning the integration of graphene in vertical Magnetic Tunnel Junctions. We will show that a thin graphene passivation layer, directly integrated by low temperature catalyzed chemical vapor deposition (CVD) [1,2], allows to preserve a highly surface sensitive spin current polarizer/analyzer behavior and adds new enhanced spin filtering properties. Here, the graphene layer prevents the oxidation of the ferromagnet enabling the use of novel processes for spintronics devices. [3].
Comprehensive characterizations of complete spin valves making use of graphene grown by CVD will be presented. First, we will illustrate the protection property of graphene by demonstrating the use of ozone-based ALD processes for fabricating efficient spin valves protected with graphene. Following this, we will discuss the experimental spin signals in the context of highly efficient bulk band structure spin filtering effect (reminding MgO symmetry filtering). Additionally, we will also highlight the critical role of interfacial hybridization for spin selection (a.k.a spinterface) for spin selection. Notably, we will reveal spin polarizations exceeding 98% in Magnetic Tunnel Junctions (MTJ), with ab-initio calculations in support. [4, 5] We will further discuss potential toward scaling of 2D materials based spin devices, and integration into applications.

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Thematic Session: Functional thin films, Nanostructures & 2D materials
Disciplinary fields involved Chemistry
Keywords (max. 4-5)**: Two-photon polymerization (TPP), Thiol-ene reaction, Scaffold**

Design and Synthesis of Bioactive Materials Using Two-Photon Polymerization and Thiol-Ene Click Chemistry

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The cellular microenvironment plays a crucial role in biology and serves as a key determinant of cell behavior and function in various biological processes. The extracellular matrix (ECM) within the cellular microenvironment provides not only structural support to cells but also a source of three-dimensional (3D) biochemical and biophysical cues that influence and regulate cellular behavior. Tissue engineering enables the design of scaffolds with precise control at the cellular scale. In particular, advanced technologies like two-photon polymerization (TPP) allow for sub-micron-scale microfabrication, with applications spanning medical bio-implants and fundamental cellular biology.

This work aims to leverage chemistry and TPP to fabricate 3D microstructures with precise control over local chemistries and scaffold properties, serving as a tool for cellular biology. We focused on a synthetic material, off-stoichiometry thiol-ene (OSTE) resins, widely used for 3D structure fabrication due to their excellent mechanical properties. TPP facilitates the straightforward fabrication of these 3D structures. By adjusting the ratio of two functional groups (thiols and alkenes), we can create surfaces with an excess of either thiol or alkene groups, offering significant opportunities for post-fabrication functionalization.

Also we explored the grafting of polyethylene glycol (PEG) onto OSTE surfaces via a thiol-ene reaction to impart anti-adhesive properties. These findings open the door to developing tailored 3D scaffolds for use in cell biology, allowing for the precise modulation of surface chemistries to influence cellular interactions and behavior.

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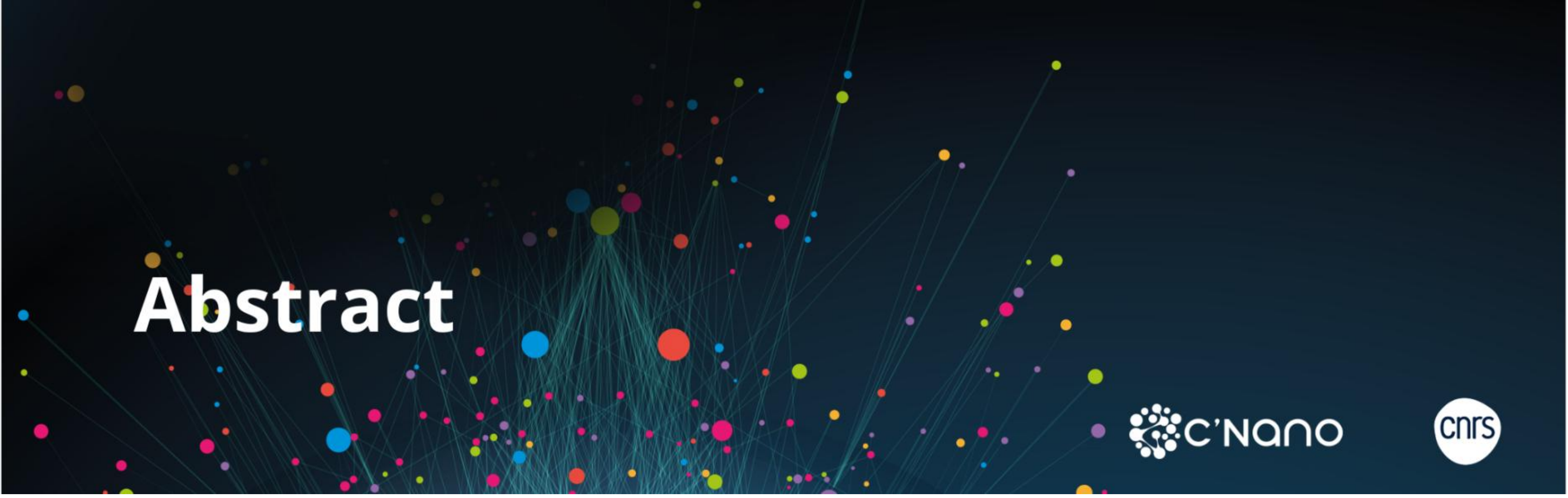

Abstract

Thematic Session (Nanoelectronics, nanomagnetism & spintronics)**:**
Disciplinary fields involved (Physics, Material Science)**:**
Keywords (Surface Acoustic Waves, SAW-FMR, Ion Implantation)**:**

Engineering Spin Wave dispersion and Surface Acoustic Wave-driven FMR in Fe thin films by N-implantation

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In the quest for future magnonic devices, the engineering of spin wave (SW) spectra is deemed to be crucial to manipulate local propagation modes, enabling the control of SW propagation. One of the promising techniques to modify the local spin wave propagation is through ion implantation in magnetic films which is the subject of our study.

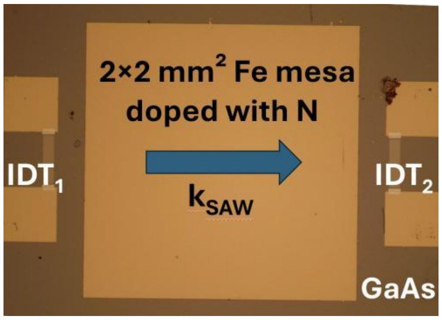


Figure 1: Sample under study. Surface acoustic waves are excited electrically by the input IDT$_1$ and detected by the receiving IDT$_2$.

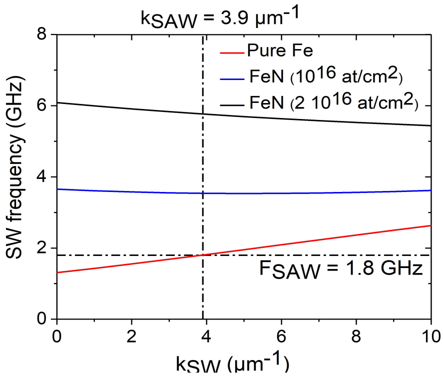
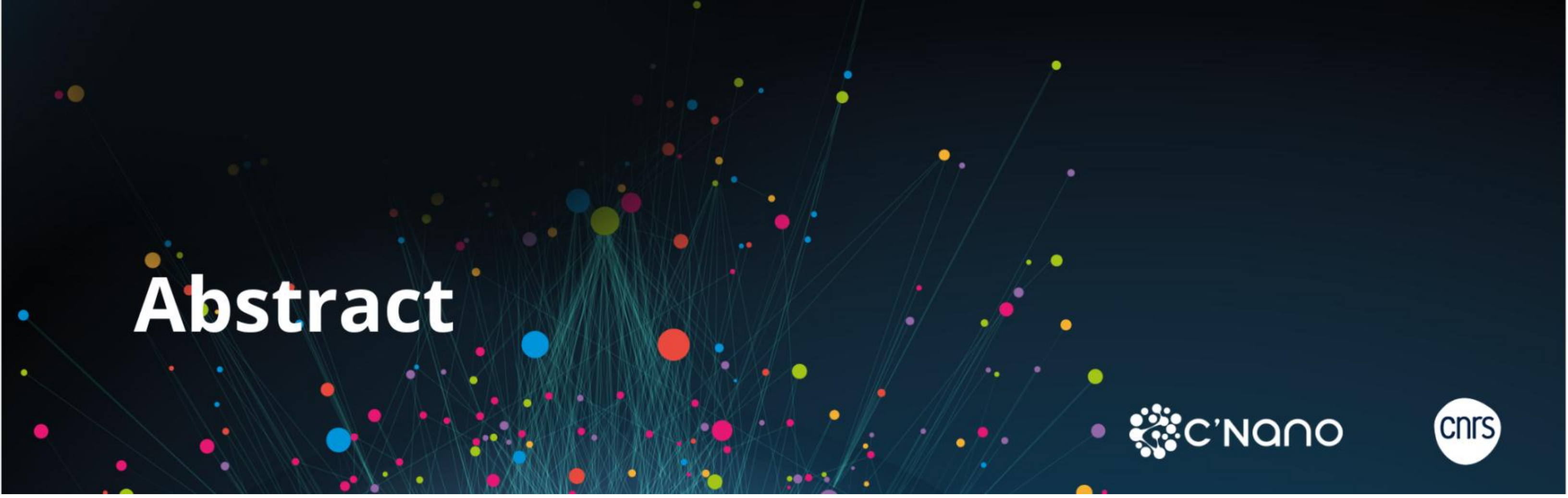


Figure 2: SW dispersions for pure and doped Fe films plotted at B_{ext} =58.4 mT, the resonant field for pure Fe. A horizontal line at the SAW frequency of 1.8 GHz intersects the SW dispersion curve of pure Fe, indicating resonance between the SAW and SW precession frequencies. No such resonance occurs for doped Fe films at this field.



Abstract

Surface acoustic waves (SAWs) are of extreme importance for their ability to interact with magnons, and to induce magnetization dynamics, making them ideal for scalable magnonic devices [1]. Our study deals with SAW propagation on a piezoelectric GaAs (001) substrate, with an Fe thin film deposited on it via molecular beam epitaxy (MBE) and etched into a 2×2 mm^2 mesa (Figure 1). The Fe mesa has been doped using an accelerator with N atoms at low dosage in order to preserve the epitaxy conditions and the low SW damping of pure Fe films [2]. This ion implantation slightly modifies the magnetocrystalline anisotropies, resulting in controlled varিration of the SW dispersion (Figure 2).

We have observed that the resonant magnetic field, where the SW frequency matches the SAW frequency for SAW-FMR, shifts to lower fields with increasing N-doping levels in Fe (Figure 3 (top)). This shift corresponds to changes in SAW attenuation (Figure 3 (bottom), confirming the effectiveness of ion implantation in engineering SAW-SW interaction. Furthermore, we anticipate to control this interaction locally using a Focussed Ion Beam (FIB) technique.

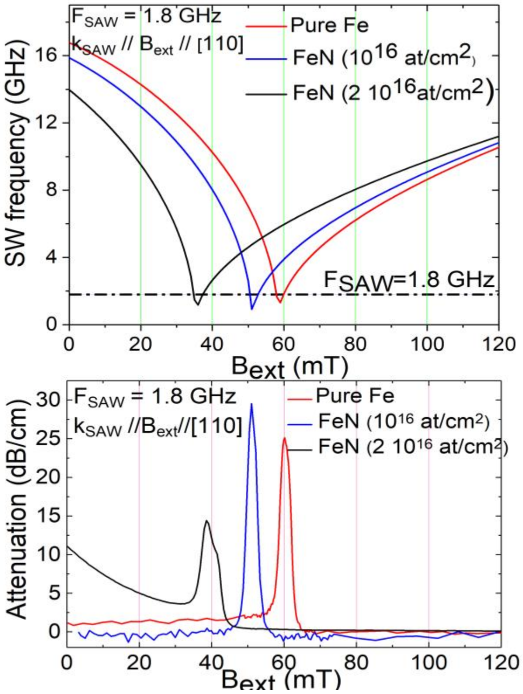


Figure 3: The SW frequencies as a function of B_{ext}, aligned parallel to kSAW along the [110] hard axis of Fe, calculated for k_{SW} = k_{SAW} = 3.9 μm^{-1} (top figure). The equations for this calculation are extracted from [3]. Experimental SAW attenuation curves as a function of B_{ext} (bottom figure).

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