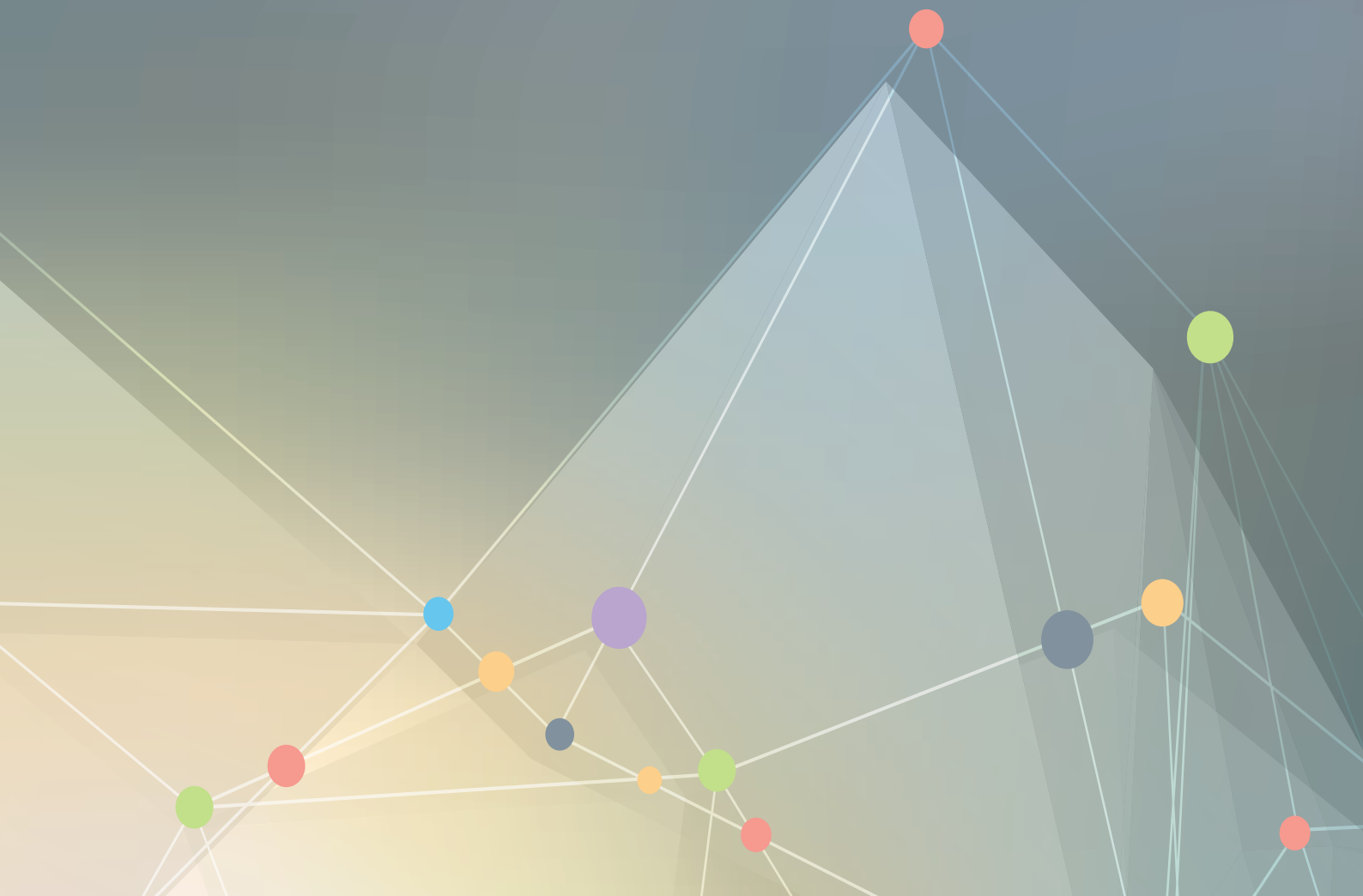
BOOK OF ABSTRACTS

Poster Presentations



POSTERS AREA 3

A3

Check the map at the end of the document

Thematic sessions

- Functional thin Films & Nanostructures: growth & properties
- 2D-Materials
- Nanoelectronics
- Nanomechanics: surface/ interface, composite nanomaterials, hybrid nanomaterials

List of Poster Presentations

AREA - 3

A3 - THIN FILMS I 2D MATERIALS I NANOELECTRONICS I NANOMECHANICS

A3-1	Detachment of SiC thin films by thermal stress and Hydrogen implantation.	Yamina BENNOUR • *Univ. of Tizi Ouzou - CEMHTI, France*
A3-2	Elaboration of multiscale nanostructured luminescent coatings by combining ZnO nanowires and Y3Al5O12:Ce3+ luminescent coatings	Audrey POTDEVIN • *Clermont Auvergne INP - ICCF, France*
A3-3	From Noble Metal Plasmonic to Organic Plasmonic	Pierre BLETEAU • *Univ. Paris Cité - ITODYS, France*
A3-4	Growth and NMR study of high quality ordered Mn5(Six Ge1-x)3 thin films on Ge(111) substrate	Sueyeong KANG • *Aix Marseille Univ. - CINaM, France*
A3-5	Hexagonal Ge on self-assisted GaAs Nanowires in MBE	Juliia DUDKO • *EC Lyon - INL, France*
A3-6	Laser direct writing photoluminescent patterns from ZnO nanocristals	Olivier SOPPERA • *CNRS - IS2M / C'Nano EST, France*
A3-7	Picosecond dynamics of multipulse femtosecond laser-induced transformations in Ag/TiO2 nanocomposites	Balint ELES • *Employer - Jean Monnet Univ. LabHC, France*
A3-8	Plasmonic properties and structure evolution of Ag-Fe nanoparticles produced by lazer vaporization under reactive atmospheres	Julien RAMADE • *Univ. Poitiers - P' Institute, France*
A3-9	Plasmonics as a tool to reveal metal/dielectric adhesion at the nanoscale: application to buffer effect of transition metals	Rémi LAZZARI • *CNRS - INSP, France*
A3-10	Structural disorder in SrTiO3 based Ruddlesden-Popper phases	Clarisse FURGEAUD • *CNRS - INL, France*
A3-11	Structure of spin-crossover molecules ultra-thin films on Cu(110)	Amandine BELLEC • *CNRS - MPQ, France*
A3-12	Surface and interface structures of Al-Fe thin films: from metastable to high temperature phases	Julian LEDIEU • *CNRS - IJL, France*
A3-13	Thermal treatments effect about Al position and environment inside AZO thin films	Olivier KERIVEL• *Sorbonne Univ.INSP*
A3-14	Atomistic growth mechanisms of Xenes epitaxial layers revealed by in-situ scanning tunneling microscopy	Laurita FLOREAN • *Sorbonne Univ. - INSP & LCPMR, France*
A3-15	Correlative imaging of single graphene oxide flake: sample selection and limitations	Lydia CHIBANE • *LNE, France*
A3-16	Determination of the potential of the 2D transition metal carbides (MXenes) for the heterogeneous catalysis. Application to the hydrogenation reactions in gas phase and liquid phase.	Zheming LI • *Univ. Poitiers - IC2MP, France*
A3-17	Optical and electrical properties of titanium and molybdenum carbide 2D layers thin films	Sophia TANGUI • *Univ. Poitiers - P' Institute, France*
A3-18	ELENA: a European project for electrical nanoscale metrology in industry	Brice GAUTIER • *INSA Lyon - INL / C'Nano AURA, France*
A3-19	Atomic Scale Simulations of Twins ,Äi Interfaces Interaction in a Nanolamellar Ag/Cu System	Sandrine BROCHARD • *Univ. of Poitiers - P' Institute, France*
A3-20	Improved nanometric control of ions and electrons via laser ionization and coincident detection	Clelia BASTELICA • *CNRS - LAC, France*
A3-21	Load versus displacement controlled nanomechanics¬†: insights from atomistic simulations	Hugo ITENEY • *CNRS - IM2NP, France*
A3-22	Strain ratio and thickness effects on plasticity and cracking of nickel thin films	Pierre GODARD • *Univ. Poitiers - P' Institute, France*
A3-23	Study of the mechanical properties of polymers reinforced with nanoparticles of adjustable size,shape and surface chemistry	Sakina MEFTAH • *UTC - ROBERVAL/MONARIS, France*
A3-24	Synthesis of molecularly imprinted polymer-based hybrid nanosensors by optical near-field photopolymerization	Amine KHITOUS • *Haute-Alsace Univ. - IS2M, France*
A3-25	Towards an electrically driven high Q, GHz mechanical resonator for quantum information applications	Marie JOLY • *Sorbonne Univ. - INSP, France*

C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Thematic Session: Functional thin films and nanostructures: growth and properties
Keywords: SiC, detachment, Hydrogen implantation, thermal stress.
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: reduction of crucial materials consumption.

Detachment of SiC thin films by thermal stress and Hydrogen implantation

Yamina BENNOUR[1], Jacques BOTSOA[1], Esidor NTSOENZOK[1]

[1] *CEMTHI—CNRS, Site Cyclotron, 3A rue de la Férollerie, 45071 Orléans, France.*

SiC is a wide band gap semiconductor with a high potential for power electronic devices. However, issues mainly linked to the production costs of bulk SiC wafers have limited the expansion of SiC based electronics devices. Any low cost production approach is then welcome. This work deals with the production of thin films from a SiC wafer. Two techniques were used for that goal. The first method is based on stress induced spalling of bulk SiC wafers which has already been successfully applied on Si wafers [1]. Our Pioneer study on SiC using steel as stressor leads for the first time to the detachment of 62µm-thick SiC layer. The second method consists in ion cut of bulk SiC. For this work, SiC wafers were implanted with 2MeV hydrogen at high fluence. Implantation was followed by thermal annealing at 1300°C. We were able to detach a 32µm thick layer of SiC. This fits with Hydrogen range (R_P) as simulated by SRIM. Moreover, in order to gain insight on structural changes at different stages of the detachment method, different characterization techniques such as Raman, UV-Visible spectroscopy and Photoluminescence were used and their results will be presented.

Reference:

[1] Najoua Zayyoun *et al* 2019 *Surf. Topogr.: Metrol. Prop.* **7** 015005

C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Thematic Session: Functional thin films and nanostructures: growth and properties
Keywords: nanowires, sol-gel, luminescence, LED
Disciplinary fields involved: Chemistry, Physics
Sustainable Development Goals* eventually involved in your research: Affordable and clean energy (Goal 7)

Elaboration of multiscale nanostructured luminescent coatings by combining ZnO nanowires and $Y_3Al_5O_{12}:Ce^{3+}$ luminescent coatings

Aubry Martin[1,2], Audrey Potdevin[1], François Réveret[1], David Riassetto[2], Michel Langlet[2], Geneviève Chadeyron[1]

[1] *Université Clermont Auvergne, Clermont Auvergne INP, CNRS, Institut de Chimie de Clermont-Ferrand (ICCF), Clermont-Ferrand, France;*

[2] *Univ. Grenoble Alpes, CNRS, LMGP, Grenoble, France;*

In this work, we have taken advantage of the specificities of zinc oxide (ZnO) nanowires (NWs) gratings (porosity, specific surface…) for developing efficient luminescent coatings for LED lighting. The nanowires were obtained by hydrothermal growth on a sol-gel deposited photo-sensitive seed-layer and the selective growth came from the UV photo-engraving of the seed-layer directly deposited on the sol-gel derived Ce^{3+}-doped yttrium aluminum garnet ($Y_3Al_5O_{12}$:Ce or YAG :Ce) coatings. NW gratings of different heights, periods and widths were developed. The addition of NWs gratings on the top of YAG:Ce coatings was expected to influence their optical properties. SEM, AFM and angle-dependent photoluminescence measurements have been carried out to study the morphological and optical properties of the obtained functional heterostructures. In particular, the optical study shows that this original design leads to a different angular distribution of light together with an increase in emission efficiency of YAG:Ce coating upon blue excitation compared to the flat coating. This enhancement is very promising since a higher efficiency is obtained without using a superior amount of rare-earth ions, which are a critical resource. Emission features have revealed to depend on the gratings parameters. Results will be discussed in reliance on multiscattering and resonance events for photons within the structure, allowing them to escape from the phosphor layer by taking optical paths different from those of the flat coating.

Acknowledgment:
The authors acknowledge the French Agence Nationale de la Recherche for its financial support in the frame of the ANR SMARtLEDs project (ANR-19-CE08-0001).

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic session: Functional thin films and nanostructures: growth and properties
Keywords: plasmonics, conductive polymer, e-beam lithography, electrochemistry Chemistry
Sustainable Development Goals: Clean water and sanitation (Goal 6)

From Noble Metal Plasmonic to Organic Plasmonic

Pierre Bléteau[1], Sarra Gam-Derouich[1], Jean-Christophe Lacroix[1]
1.ITODYS laboratory, Université Paris Cité, Paris, France

Localized surface plasmon resonance has been extensively studied with metallic nanoparticles. The most used metals are gold, silver or platinum. However, the scarcity, the price and the pollution caused by the extraction of these metals push the scientific community to look for new materials.

Conductive polymers are an alternative that has been very little studied despite the great advantages they can bring. Conductive polymers not only avoid the use of rare and precious metals but also offer new functionalities. Thus, Magnus Jonsson's group in 2020 in *Nature*, shows that the nanostructuring of poly(3,4-ethylenedioxythiophene) (PEDOT) causes the appearance of a maximum in the infrared band around 1500-2000nm [1], [2]. With the support of theoretical calculations, the group demonstrates that the maximum of this band can be predicted by assuming that PEDOT nanoparticles are plasmonic.

We have explored by electron lithography approaches the formation of surfaces of PEDOT nanoparticles or different conducting polymers. The nanoparticle synthesis we explored allows to build any type of nanoparticles, sphere arrays, dimer arrays, nanosticks and show similar properties to Jonsson's results (**Figure 1**). We then characterized these surfaces by extinction spectroscopy, SEM, AFM and RAMAN spectroscopy in an attempt to reveal localized surface plasmon resonance.

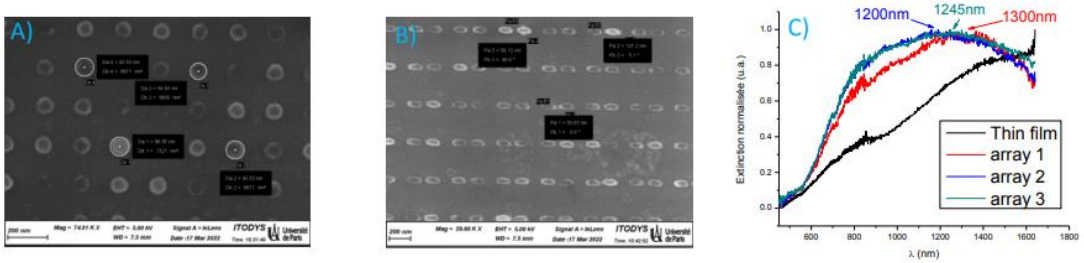


Figure 1: A) Array of 90nm diameter PEDOT spheres. B) Array of nanostick dimers, 120nm*50nm. C) Comparison of normalized extinction spectra between PEDOT nanoparticles and a PEDOT thin film.

References:

[1] S. Chen et al., "Conductive polymer nanoantennas for dynamic organic plasmonics," Nat. Nanotechnol., vol. 15, no. 1, pp. 35–40, 2020, doi: 10.1038/s41565-019-0583-y.
[2] A. Karki et al., "Electrical Tuning of Plasmonic Conducting Polymer Nanoantennas," Adv. Mater., vol. 34, no. 13, 2022

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Functional thin Films & Nanostructures: growth & properties
Keywords: Molecular beam epitaxy (MBE), Nuclear magnetic resonance (NMR), thin film, ferromagnetism, anti-ferromagnetism.
Disciplinary field involved: Physics

Growth and NMR study of high quality ordered $Mn_5(Si_x\ Ge_{1-x})_3$ thin films on Ge(111) substrate

Sueyeong Kang[1], Matthieu Petit[1], Roger Kalvig[2], Ewa Jedryka[2], Marek Wojcik[2], Vasile Heresanu[1], Lisa Michez[1]

1. *Aix Marseille Univ, CNRS, CINaM, AMUtech, Marseille, France*
2. *Institute of Physics, Polish Academy of Sciences, Aleja Lotników 32/46, PL–02668 Warsaw, Poland*

This poster will present the controlled and epitaxial growth of $Mn_5(Si_xGe_{1-x})_3$ thin films on Ge(111) substrate by Molecular beam epitaxy methods (co-deposition), as well as characterizations of their structural and magnetic properties by X-ray diffraction (XRD), Atomic force microscopy (AFM), Transmission electron microscopy (TEM), and Nuclear magnetic resonance (NMR).

Mn_5Ge_3 and Mn_5Si_3 are two compounds exhibiting hexagonal $D8_8$ structure (space group $P6_3/mcm$) and they can be grown epitaxially on Ge(111) substrates[1]. However, they exhibit very different magnetic behavior. Mn_5Ge_3 is a metallic ferromagnet that presents a high spin polarization of the conduction electrons at the Fermi level, a Curie temperature of 296K and a strong uniaxial magnetocrystalline anisotropy along the hexagonal c axis[2]. On the other hand, Mn_5Si_3 is an antiferromagnetic alloy exhibiting a (meta)magnetic phase transition: antiferromagnetic with a chiral spin structure below 65K and collinear above[3].

In earlier time, the electrical and magnetic properties of the bulk $Mn_5(Si_x\ Ge_{1-x})_3$ materials have only been studied in the bulk phase by few research groups[4,5], however, no studies were carried out on the thin films. Our work, studying on high quality ordered thin films, expands the structural and magnetic knowledge on these complex materials through various and complementary characterizations. ^{55}Mn NMR spectrum reveals the changes of local magnetic properties over Si concentrations. XRD shows the correlation between Si concentration and lattice structural parameter deformation and crystallinity. Through comprehensive analysis, we bring further insights on the transition between the ferromagnetic behaviors of the $Mn_5(Si_0\ Ge_1)_3$ films and the anti-ferromagnetic $Mn_5(Si_1\ Ge_0)_3$ films.

References:

1. Zeng, C.; Erwin, S. C.; Feldman, L. C.; Li, A. P.; Jin, R.; Song, Y.; Thompson, J. R.; Weitering, H. H. Epitaxial Ferro magnetic Mn5Ge3 on Ge(111). *Appl. Phys. Lett.* **2003** , 83 (24), 5002 - 5004.

2. L Michez, A Spiesser, M Petit, S Bertaina, J-F Jacquot, D Dufeu, C Coudreau, M Jamet and V Le Thanh, Magnetic reversal in Mn5Ge3 thin films: an extensive study, J. Phys.: Condens. Matter 27 **2015** 266001

3. Sür gers, C.; Wolf, T.; Adelmann, P.; Kittler, W.; Fischer, G.; Löhneysen, H. Switching of a Large Anomalous Hall Effect between Metamagnetic Phases of a Non Collinear Antiferromagnet. *Nat. Publ. Gr.* **2017**, 1 - 7.

4. Panissod, P.; Qachaou, A.; Kappel, G. Inhomogeneous Transition from the Ferromagnetic State to the Antiferromagnetic State in Mn5(Ge1-xSix)3 Alloys: an NMR Study. *J. Phys. C Solid State Phys.* **1984** , 17 (32), 5799 - 5810.

5. Zhao, F. Q.; Dagula, W.; Tegus, O.; Buschow, K. H. J. Magnetic Entropy Change in Mn5Ge3-xSix Alloys. *J. Alloys Compd.* **2006** , 416 (1 2), 43 - 45.

Acknowledgment:

S K thanks the COST-OPERA Short-Term Scientific Mission program.

The authors thank C Coudreau for the technical assistance on the MBE cluster.

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Nanomaterials

Keywords: Nanowires, hexagonal Ge, nanostructures

Disciplinary field involved: Material Science

Sustainable Development Goals* eventually involved in your research: Industry, Innovation, and Infrastructure (Goal 9)

Hexagonal Ge on self-assisted GaAs Nanowires in MBE

Iuliia Dudko[1,2], Thomas Dursap[1], Anne D. Lamirand[1], Claude Botella[1], Philippe Regreny[1], Alexandre Danescu[1], Solène Brottet[1], Matthieu Bugnet[3], Sumeet Walia[2], Nicolas Chauvin[1], Jose Penuelas[1]

1. *Univ Lyon, Ecole Centrale de Lyon, CNRS, INSA Lyon, Université Claude Bernard Lyon 1, CPE Lyon, INL, UMR 5270, 69130 Ecully, France*
2. *School of Engineering, RMIT University, Melbourne 3001, Victoria, Australia*
3. *Univ Lyon, CNRS, INSA Lyon, UCBL, MATEIS, UMR 5510, 69621 Villeurbanne, France*

Hexagonal Ge is predicted to have novel electronic and optoelectronic properties therefore attracting great interest in the field of optoelectronics [1]. So far, hexagonal (Si)Ge with direct bandgap and wavelength tunability have been fabricated using nanowires with gold as a catalyst [2]. However, it is not compatible with the current CMOS technology [3].

In our work, hexagonal Ge has been grown on the facets of self-assisted GaAs nanowires by MBE using VLS mechanism [4]. An extended pure wurtzite segment was maintained by tuning the V/III ratio to appropriate values [5]. Following the growth of the GaAs core, a Ge shell has been grown with a long hexagonal segment. The crystal structure of the nanowires has been characterized with high-resolution scanning transmission electron microscopy (STEM) and dark field transmission electron microscope (TEM). The Ge surface chemistry was studied by X-ray photoelectron spectroscopy (XPS), and photoluminescence spectroscopy (PL) was performed to investigate the optical properties of the hexagonal Ge phase. The results have shown that the growth mechanism induce a strong As doping in hexagonal Ge, which can be controlled in a certain extent. Furthermore, the quantum confinement can be achieved in hexagonal Ge, leading to a blueshift of the emission.

References:

[1] Barth, S. (2021). Metastable Group IV Allotropes and Solid Solutions: Nanoparticles and Nanowires. Chemistry of Materials, 32, 2703.
[2] Fadaly, E.M.T. (2020). Direct-bandgap emission from hexagonal Ge and SiGe alloys. Nature, 580, 205.
[3] Hannon, J.B. (2006). The influence of the surface migration of gold on the growth of silicon nanowires. Nature, 440, 7080.
[4] Dudko, I. (2022). Hexagonal Ge Grown by Molecular Beam Epitaxy on Self-Assisted GaAs Nanowires. Crystal Growth & Design, 22, 32-36.
[5] Dursap, T. (2021). Wurtzite phase control for self-assisted GaAs nanowires grown by molecular beam epitaxy. Nanotechnology, 32, 155602.

Acknowledgment: This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 801512.

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session : Functional thin Films & Nanostructures: growth & properties
Keywords: ZnO, nanocrystals, photolithography, photoluminescence, optical coatings
Disciplinary fields involved : Material chemistry, photochemistry
Sustainable Development Goals* eventually involved in your research: Affordable & clean energy (Goal7) ,Industry, Innovation & Infrastructure (Goal 9)

Laser direct writing photoluminescent patterns from ZnO nanocristals

Quentin Kirscher[1,2], Samar Hajjar-Garreau[1,2], Fabien Grasset[3,4], Dominique Berling[1,2] and Olivier Soppera[1,2]

1. *Institut de Science des Matériaux de Mulhouse (IS2M) UMR 7361 CNRS-UHA, Université de Haute Alsace, Mulhouse, France*
2. *Université de Strasbourg, Strasbourg, France*
3. *CNRS-Saint Gobain-NIMS, IRL 3629, Laboratory for Innovative Key Materials and Structures (LINK), National Institute for Materials Science (NIMS), Tsukuba 305-0044, Japan*
4. *Univ. Rennes, CNRS, ISCR UMR 6226, ScanMAT UAR 2025, F-35000 Rennes, France*

Micro- and nanopatterning of metal oxide materials is an important process to develop electronic or optoelectronic devices. ZnO is a material of choice for its semiconducting and photoluminescence properties. In the frame of the nanoarchitectonics concept, we have developed and investigated a new process that relies on direct write laser patterning in the DUV range to prepare photoluminescent microstructures of ZnO at room temperature, under air. This process is based on a synthesis of colloidal ZnO nanocrystals (NCs) with a careful choice of the ligands on the surface to obtain an optimal (i) stability of the colloids, (ii) redissolution of the non-insolated parts and (iii) cross-linking of the DUV-insolated parts. The mechanisms of photocrosslinking are studied by different spectroscopic methods. This room temperature process preserves the photoluminescence properties of the NCs and the wavelength used in DUV allows to reach a sub-micrometer resolution, which opens new perspectives for the integration of microstructures on flexible substrates for opto-electronic applications. We also show that this concept can be extended to other metal oxide nanoparticles.

Figure : Photographs of the ZnO colloidal solution (left) and patterns on Si obtained by laser direct write Deep-UV photolithography (right) under UV-light illumination

References:

[1] Yeh, C. C.; Zan, H. W.; Soppera, O., Solution-Based Micro- and Nanoscale Metal Oxide Structures Formed by Direct Patterning for Electro-Optical Applications. *Advanced Materials* **2018,** *30* (50). doi: 10.1002/adma.201800923

[2] Kirscher, Q.; Hajjar-Garreau, S.; Grasset, F.; Berling, D.; Soppera, O., Deep-UV laser direct writing of photoluminescent ZnO submicron patterns: an example of nanoarchitectonics concept. *Science and Technology of Advanced Materials* **2022,** *23* (1), 535-546. doi: 10.1080/14686996.2022.2116294

[3] Proust, V.; Kirscher, Q.; Nguyen, T. K. N.; Obringer, L.; Ishii, K.; Rault, L.; Demange, V.; Berthebaud, D.; Ohashi, N.; Uchikoshi, T.; Berling, D.; Soppera, O.; Grasset, F., Hafnium Oxide Nanostructured Thin Films: Electrophoretic Deposition Process and DUV Photolithography Patterning. *Nanomaterials* **2022,** *12* (14). doi: 10.3390/nano12142334

Acknowledgments: This work was carried out as part of the France–Japan international collaboration and the "DUVNANO" project ANR-18-CE08-0022. The authors thank Loïc Vidal for XPS and HRTEM analysis.

C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Thematic Session: Functional thin films & Nanostructures: growth & properties
Keywords: Nanoparticle reshaping, Self-organized Nanostructure, Pump-probe Microscopy, Ultrafast Dynamics, Plasmonic Nanocomposites
Disciplinary fieldsinvolved: Physics
Sustainable Development Goals eventually involved in your research: Quality Education (Goal 4), Re-duced Inequalities (Reduces Inequalities)

Picosecond dynamics of multipulse femtosecond laser-induced transformations in Ag/TiO_2 nanocomposites

Balint Eles[1], Julien Lumeau[2], Antonin Moreau[2], Nathalie Destouches[1]

1. *Laboratory Hubert Curien, CNRS UMR 5516, Institut d'Optique Graduate School, Univ Lyon, Saint-Etienne, France*
2. *Univ Aix Marseille, CNRS, Centrale Marseille, Institut Fresnel, Marseille, France*

Exploring ultrashort laser-induced phenomena in plasmonic nanocomposites is of great relevance due to the large number of applications of such materials[1,2] and the numerous fundamental mechanisms that interplay on multiple timescales. The detailed literature of universal ultrafast and fast phenomena is provided by pump-probe experiments in weak excitations,[3] but the number of contributions conducted in strong excitation conditions triggering irreversible material response is considerably more limited. Despite some remarkable contributions investigating such phenomena,[4,5] several aspects on the energy relaxation above sample transformation threshold need to be explored. Our work aims to reveal additional mecha-nisms involved in the plasmonic nanocomposite transformation induced by ultrafast laser light. The mul-tipulse sub-picosecond to nanosecond dynamics in Ag nanoisland ensemble encapsulated between two ultrathin TiO_2 layers is investigated using two-color pump-probe microscopy experiment. The sample re-sponse exhibits strong pulse number-dependent features, both on the ultrafast and hundreds of ps time-scales. The time-resolved results are supported by *ex situ* transmission electron microscopy characteriza-tions that reveal the morphological evolution of the sample. The chronology of the laser-excited system on the ultrashort and short timescales is proposed based on the combination of experimental techniques. In addition, the dynamics in the spallation regime revealed the features of film deformation on hundreds of ps timescale. The presented results extend the literature of mechanisms triggered in ultrashort laser-excited plasmonic systems in strong excitation conditions.

References:

(1) Sharma, N.; Destouches, N.; Florian, C.; Serna, R.; Siegel, J. Tailoring Metal-Dielectric Nanocomposite Materials with Ultrashort Laser Pulses for Dichroic Color Control. *Nanoscale* 2019, 11 (40), 18779–1878911 (40), 18779–18789.

(2) Destouches, N.; Sharma, N.; Vangheluwe, M.; Dalloz, N.; Vocanson, F.; Bugnet, M.; Hébert, M.; Siegel, J. Laser-Empowered Random Metasurfaces for White Light Printed Image Multiplexing. Adv. Funct. Mater. 2021, 31 (18), 2010430.

(3) Hartland, G. V. Optical Studies of Dynamics in Noble Metal Nanostructures. Chem. Rev. 2011, 111 (6), 3858–3887.

(4) Warth, A.; Lange, J.; Graener, H.; Seifert, G. Ultrafast Dynamics of Femtosecond Laser-Induced Shape Transformation of Silver Nanoparticles Embedded in Glass. J. Phys. Chem. C 2011, 115 (47), 23329–23337.

(5) Werner, D.; Furube, A.; Okamoto, T.; Hashimoto, S. Femtosecond Laser-Induced Size Reduction of Aqueous Gold Nanoparticles: In Situ and Pump−probe Spectroscopy Investigations Revealing Coulomb Explosion. J. Phys. Chem. C 2011, 115 (17), 8503–8512.

Acknowledgment: This research was funded by Agence Nationale de la Recherche française, project MIXUP (ANR-18-CE39-0010).

C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Thematic Session Functional thin films and nanostructures : growth and properties
Keywords Plasmonics, nanoalloys, electron microscopy, lazer vaporization, *in situ* characterization
Disciplinary fields involved Physics, materials

Plasmonic properties and structure evolution of Ag-Fe nanoparticles produced by laser vaporization under reactive atmospheres

J.Ramade[1], E.Cottancin[2], M-A Lebeault[2], C. Langlois[3], L.Piccolo[4], M.Broyer[2], M.Hillenkamp[2], J.Lerme[2], F.Calvo[5], M.Pellarin[2] *Affiliation 1* (*calibri 10, black)*

1. *Institut PPRIME, PMM Department, PPNa Team, Université de Poitiers, Poitiers, France*
2. *ILM, AGNANO Team, Université de Lyon, Lyon, France*
3. *MATEIS, SNMS Team, INSALYON, Lyon, France*
4. *IRCELYON, CATREN Team, Université de Lyon LYON, France*
5. *Univ. Grenoble Alpes, CNRS, LiPhy, Grenoble, France*

Multimetallic nanoparticles offer the possibility to mix elements to achieve novel systems combining their respective properties, or even generate new ones. In this context, mixing a plasmonic metal such as silver with a reactive one allows to use the optical properties, especially the localized surface plasmon resonance (LSPR) as a probe to unravel the chemical structure, as its evolution under reactive atmospheres. It is thus important to develop optical setups allowing the *in situ* monitoring of chemical processes involved in such atmospheres. Here, we show the development of an *in situ* optical spectroscopy setup (figure 1.a) used to monitor the oxidation and the reduction of Silver-Iron AgFe [1,2] nanoalloys synthesized according to the Low Cluster Beam Deposition (LECBD) Technique[3]. The optical characterization of a large assembly were combined with the investigation of single NPs by Environmental Transmission Electron Microscopy [4] and Monte Carlo simulations of the structural stability at specific temperatures. Studies were performed for two compositions ($Ag_{80}Fe_{20}$ and $Ag_{50}Fe_{50}$). We show that these metals, according to their phase diagram, initially segregate with a silver-enriched surface and that iron spontaneously oxidizes when exposed to air, leading to its diffusion and the formation of iron oxide at the surface. *In situ* optical spectroscopy alternatively performed under reducing and oxidizing conditions reveals that the oxidation and reduction of iron is a reversible process, directly observable on the optical spectra (figure 1.b) and in accordance with the optical simulations. Based on these results, a scenario depicting the restructuring mechanisms under oxidation and reduction is proposed.

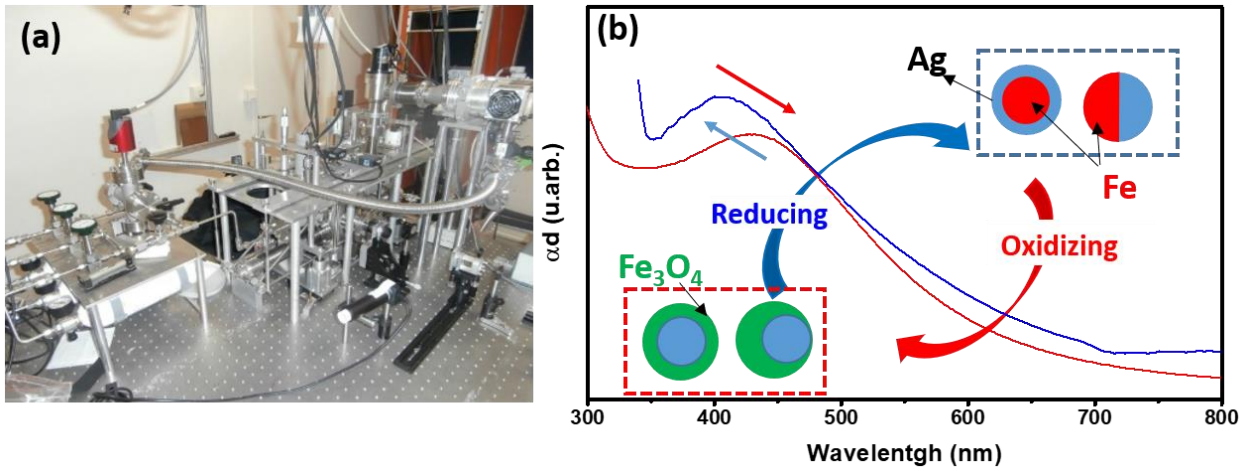


Figure 1 : (a) A picture of the environmental optical setup. (b) Optical spectra in situ acquired during after exposure of a reducing (blue) and oxidizing (red) atmosphere of $Ag_{50}Fe_{50}$ nanoparticles.

References:

[1] J.RAMADE et al., *J. Phys. Chem. C*, **123**, 15693−15706, (2019)
[2] J.RAMADE *et al. Nano Res.* **11**, 6074–6085 (2018).
[3] A. PEREZ et al., *Int. J. Nanotechnol*., **7**, 523−574, (2010).
[4] J.RAMADE et al., *Nanoscale*, **9**, 13563-13574, (2017).

Acknowledgments:

The authors would like to acknowledge support from GDR 3182 Nanoalliages, European COST Action MP1302 Nano-spectroscopy and the international research network -IRN "Nanoalloys" of CNRS. We also thank the regional computing center CALMIP for providing generous computational resources (project p1141). The authors also thank the Centre Lyonnais de Microscopie Electronique (CLYM) for access to FEI Titan ETEM and N. Blanchard and M. Aouine for technical support. The samples were elaborated at the PLYRA facility with the technical support of C. Albin, O. Boisron, C. Clavier, and A. Mosset. The initial structure for the MC simulations was transposed from earlier work on Fe−Au NPs and was generated by Dr. Magali Benoit (CEMES, Toulouse, France), whom we gratefully acknowledge.

C'Nano THE NANOSCIENCE MEETING Poitiers March, 15, 16 and 17 2023

Thematic Session: Functional thin Films & Nanostructures: growth & properties
Keywords: Plasmonics; metallic nanoparticle; growth; wetting
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: -

Plasmonics as a tool to reveal metal/dielectric adhesion at the nanoscale: application to buffer effect of transition metals

M. Messaykeh[1], R. Cavallotti[1,3], E. Chernysheva[1,2], S. Castilla[1], Q. Herault[1,2], E. Meriggio[1], S. Chenot[1], P. David[1], G. Cabailh[1], J. Jupille[1], A. Koltsov[3], I. Gozhyk[1,2], R. Lazzari[1]

1. *Institut des NanoSciences de Paris, CNRS/Sorbonne Université, 4 Place Jussieu, 75005 Paris*
2. *Surface du Verre et Interfaces, CNRS/Saint-Gobain, 39 Quai Lucien Lefranc, 93300 Aubervilliers*
3. *Arcelor Mittal Maizières Research, Voie Romaine, 57280 Maizières-lès-Metz*

The morphology and adhesion energy of nanosized metal particles supported on dielectrics escapes the rules established for large objects due the strong contribution of surface/interface in their energetics. The evolution of wetting during Volmer–Weber growth of nanoparticles is studied by *in situ* UV-vis surface differential reflectivity spectroscopy (SDRS). The integrated s-polarized SDR signal is shown to be proportional to the oscillator strength of the optically excited plasmon resonances parallel to the surface. Dielectric modelings showed that this quantity is a reliable reporter of the aspect ratio of the particles from which adhesion energy can be derived. Applied to noble (Ag, Au) or transition metals (Cr, Ni) and Zn on weakly interacting dielectric (Al_2O_3, SiO_2, KBr) and semiconducting (TiO_2, ZnO) substrates, this plasmonic approach evidences a universal "U"-shaped variation of the aspect ratio with film thickness and therefore size [1]. The first branch of the "U" is assigned to a size-dependent equilibrium shape related to surface/interface stress effects [2]. A significant decrease in adhesion energy parallels a rounding of the particles. The second branch partly stems from flattening due to incomplete coalescence. The potentialities offered by SDRS are also illustrated by the seed/adhesion effect of Cr buffer at the Zn/Al_2O_3 interface [3].

References:

[1] R. Lazzari, J. Jupille, R. Cavallotti, E. Chernysheva, S. Castilla, M. Messaykeh, Q. Herault, E. Meriggio. Plasmonics of supported nanoparticles reveals adhesion at the nanoscale: implications for metals on dielectrics. *ACS Appl. Nano Mater.*, 3:12157, 2020.
[2] R. Lazzari, J. Goniakowski, G. Cabailh, R. Cavallotti, N. Trcera, J. Jupille, P. Lagarde. Surface and epitaxial stress for supported metal clusters. *Nano Lett.*, 16:2574, 2016.
[3] M. Messaykeh, S. Chenot, P. David, G. Cabailh, J. Jupille, A. Koltsov, and R. Lazzari. An *in situ* and real-time plasmonic approach of seed/adhesion layers: chromium buffer effect at the zinc/alumina interface. *Crystal Growth & Design*, 21:3528, 2021.

Acknowledgment: This work was supported by French state funds managed by the ANR within the Investissements d'Avenir program under reference ANR- 11-IDEX-0004-02 and more specifically within the framework of the Cluster of Excellence MATISSE led by Sorbonne Universités

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Functional thin Films & Nanostructures: growth & properties
Keywords: Ruddlesden-Popper phases, MBE, HRSTEM, EELS, XRD
Disciplinary fields involved: Physics
Sustainable Development Goals* eventually involved in your research: not applicable

Structural disorder in $SrTiO_3$ based Ruddlesden-Popper phases

C. Furgeaud[1], A. Danescu[1], R. Bachelet[1], L. Largeau[2], M. Bouras[3] and G. Saint-Girons[1]

1. INL-UMR5270/CNRS, 36 avenue Guy de Collongue, 69134 Ecully cedex (France)
2. Centre de Nanosciences et de Nanotechnologies, Universite Paris-Saclay, CNRS, Palaiseau (France)
3. GEMaC, UVSQ, CNRS, Université Paris Saclay (France)

$(SrTiO_3)_n(SrO)$ Ruddlesden-Popper homologous series (RP phases) present outstanding physical properties such as high T_c superconductivity, colossal magneto-resistance, low loss dielectricity, ferroelectricity, low thermal conductivity for heat harvesting, engineerable optical properties, all of them being tuned by the RP order n [1-3]. This flexibility of properties engineering boosts active researches.
The elaboration of these compounds is a true challenge: whereas RP phases with order $n \leq 3$ can be synthetized by melt growth, there is no driving force for the spontaneous formation of RP phases with $n > 3$ [4]. The latter can be elaborated by epitaxial growth, and particularly by molecular beam epitaxy (MBE) allowing layer by layer deposition. However, the RP structural quality is highly sensitive to incident elemental flux drift, which typically cause the formation of vertical SrO stacking faults [5] causing structural disorder and affecting the RP functional properties.
In this contribution, we will present a detailed High Resolution Scanning Transmission Electron Microscopy and Electron Energy Loss Spectroscopy study of the structural disorder of $(SrTiO_3)_n(SrO)$ thin layers grown by molecular beam epitaxy on $SrTiO_3$ substrates. We will particularly focus on the different vertical SrO stacking fault configurations and their impact on the RP phase order. To have a multi-scaling approach, we will also compare and correlate HRTSTEM with X-ray Diffraction analysis for a better and detailed understanding of the structural disorder in $SrTiO_3$ based Ruddlesden-Popper phases.

References:

[1] G. A. Pan *et al.,* Nat. Mater. **21**, 160 (2022)
[2] Y. Moritomo, A. Asamitsu, H. Kuwahara, and Y. Tokura, Nature **380**, 141 (1996)
[3] N. M. Dawley *et al.,* Nat. Mater. **19**, 176 (2020)
[4] G. J. McCarthy, W. B. White, and R. Roy, J. Am. Ceram. Soc. **52**, 463 (1969)
[5] Y. F. Nie *et al.*, Nat. Commun. **5**, 4530 (2014)

C'Nano THE NANOSCIENCE MEETING Poitiers March, 15, 16 and 17 2023

Thematic Session: Functional thin Films & Nanostructures: growth & properties
Keywords (max. 4-5)**:** thin molecular layer, spin cross-over molecules, epitaxial strain
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: -

Structure of spin-crossover molecules ultra-thin films on Cu(110)

Amandine Bellec[1], Yves Garreau[1,2], Vincent Repain[1], Alessandro Coati[2]

1. *Université Paris Cité, CNRS, Laboratoire Matériaux et Phénomènes Quantiques, F-75013, Paris, France*
2. *Synchrotron SOLEIL, L'Orme des Merisiers, Saint-Aubin, 91192 Gif sur Yvette, France*

Spin crossover (SCO) molecules present two spin states that can be controlled by external stimuli such as light or temperature. Their ability to switch makes them promising for incorporation in molecular spintronic devices. In this purpose, it is mandatory to understand how the properties of spin crossover molecules are modified when in direct contact with metallic substrates and how the growth of molecular films is governed by the substrate. Additionally, the bistability, i.e. the ability to reversibly switch between two stable states in the hysteretic temperature range, is an important property that needs to be controlled at the nanoscale.
Grazing incidence x-ray diffraction measurements on monolayer of $Fe[HB(3,5\text{-}(CH_3)_2Pz)_3]_2$ (Pz=pyrazolyl) adsorbed on Au(111) and Cu(111) substrates enable us to evidence that an epitaxial relationship between the molecular layer and the substrates exists[1]. This has a direct consequence on the transition from one spin-state to the other either by using temperature[2,3] light[4] or electric field[5] as external stimuli. Here, we will discuss in detailed the molecular structure of $Fe[HB(3,5\text{-}Me_2Pz)_3]_2$ ultra-thin films adsorbed on Cu(110). For sub-monolayer coverage, the molecules arrange in a nearly hexagonal structure which is a reconstruction of the underlying Cu(110). For larger thicknesses, an additional molecular network appears which resemble the [100] plane of the bulk molecular crystal. By XAS measurements, we demonstrated that for a one-monolayer-high layer, the molecules are locked in the high spin state; while for a six-monolayer-high layer the molecules recovered their spin-crossover properties.

References:

1. C. Fourmental et al., J. Phys. Chem. Lett., 10, 4103 (2019)
2. K. Bairagi et al., Nat. Comm., 7, 12212 (2016)
3. M. Kelaï et al., J. Phys. Chem. Lett., 12, 6152-6158 (2021)
4. L. Zhang et al., Angew. Chem., 59, 13341-13346 (2020)
5. Y. Tong et al., J. Phys. Chem. Lett., 12, 11029-11034 (2021)

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Functional thin film & Nanostructure: growth & properties
Keywords: STM, TEM, DFT, complex intermetallics, surface alloy.
Disciplinary fields involved: Physical chemistry /Materials science
Sustainable Development Goals* eventually involved in your research: Responsible Consumption & Production (Goal 12)

Surface and interface structures of Al-Fe thin films: from metastable to high temperature phases

J. Ledieu1,4, D. Dubaux1,4, F. Brix1,4, É. Gaudry1,4, M.-C. de Weerd1,4, P. Gille2, S. Šturm3,4, M. Podlogar3,4, J. Ghanbaja1,4, S. Migot1,4, M. Sicot1,4 and V. Fournée1,4

1. *Université de Lorraine, CNRS, IJL, F-54000 Nancy, France*
2. *Department of Earth and Environmental Sciences, Crystallography Section, Ludwig Maximilians Universität München, Theresienstr. 41, D-80333 München, Germany*
3. *Jožef Stefan Institute, Department for Nanostructured Materials, Jamova Cesta 39, 1000 Ljubljana, Slovenia*
4. *International Associated Laboratory PACS$_2$, CNRS Université de Lorraine, Nancy, France and Jožef Stefan Institute, Ljubljana, Slovenia*

Low coefficients of friction, low adhesion or even enhanced oxidation resistance are among the surface properties that have motivated the production of several Al-based complex intermetallics as thin films. For specific deposition processes such as hot-dip aluminizing of steel or cast-iron parts, the formation of complex intermetallics can also occur fortuitously at the coating-substrate interface [1]. Here, the microstructure of the resulting coating generally consists of several layers of Al-Fe intermetallics with different interfaces which *in fine* will dictate the adhesion, the lifetime and the mechanical properties of the thin film.

To gain more insights into the formation of the Al-Fe intermetallics phases and the associated interfaces with the surrounding matrix, the adsorption of Fe on Al(100) and Al_9Co_2(001) surfaces has been investigated combining both experimental and theoretical methods. We will show how a structural similarity between Al(100) *fcc* planes and pure Al layers present in the metastable Al_9Fe_2 compound stabilised this binary phase [2]. The Al_9Fe_2(001) surface and Al_9Fe_2(001)/Al(100) interface structures will be described at the atomic scale along with the epitaxial relationship. In a second part, we will demonstrate how intermetallics of various structural complexities can be selectively grown on Al_9Co_2(001) for different Fe coverages and dosing temperatures. The successful epitaxial growth of the high temperature Al_8Fe_5, *B2* AlFe, and approximant $Al_{13}Fe_4$ phases will be presented. Finally, the Al_8Fe_5(100)/Al_9Co_2(001) interface modeled by *ab initio* calculations will be discussed [3].

References:

[1] R. Mola, T. Bucki and K. Wcislo, Arch. Foundry Eng. 14 (2014) 85.
[2] D. Dubaux, É. Gaudry, M.-C. de Weerd, S. Šturm, M. Podlogar, J. Ghanbaja, S. Migot, V. Fournée, M. Sicot, J. Ledieu, Appl. Surf. Sci. 533 (2020) 147492 1-8.
[3] D. Dubaux, F. Brix, É. Gaudry, P. Gille, M.-C. de Weerd, V. Fournée, M. Sicot, J. Ledieu, Appl. Surf. Sci. 591 (2022) 153100.

Acknowledgment: This work is supported by the European Integrated Center for the development of New Metallic Alloys and Compounds and the IRP PACS2 CNRS-Université de Lorraine.

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Functional thin Films & Nanostructures: growth & properties **Keywords:** Al doped ZnO, thin film, thermal treatment, AR-XPS, XAS
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: -

Thermal treatments effect about Al position and environment inside AZO thin films

O. Kerivel[1], R. Lazzari[1], H. Montigaud[2], S. Guilet[1]

1. *Institut des NanoSciences de Paris, CNRS/Sorbonne Université (UMR 7588), Paris, 75005, France*
2. *Surface du Verre et Interfaces, CNRS-Saint-Gobain Recherche (UMR 125), Aubervilliers, 93300, France*

Al doped zinc oxide (AZO) thin films have already proved their efficiency as transparent conductive oxide (TCO) in various fields, such as solar cells or low emissivity coating, for several decades.[1] However, despite extensive literature about synthesis conditions and the optimization of conductivity features, some misunderstandings persist. The effect of thermal treatment and more precisely the possibility of formation and segregation of the second phase is still an obstacle to the control of AZO films properties.[2] In our work, AZO films were synthesized by direct current magnetron sputtering deposition. Several parameters, such as substrate deposition (ZnO or Si monocrystal), the atmosphere during sputtering (with or without oxygen), type of target (metallic or ceramic), and doping rate (1, 2, or 3 wt%) have been modified to have a large panel of samples. Afterward, each of them was submitted to high-temperature annealing (under a normal or vacuum atmosphere) to understand the influence of all these parameters. In agreement with the literature, atomic force microscopy (AFM) and X-ray diffraction (XRD) revealed an improvement in crystalline quality and an increase in grain size after annealing.[3] Angle-resolved x-ray photoelectron spectroscopy (AR-XPS) highlights aluminum surface enrichment after annealing. X-ray absorption spectroscopy (XAS) spectrums indicate $ZnAl_2O_4$(spinel) phase apparition after 800°C annealing under a normal atmosphere for all samples supported on silicon. All that results are a new step toward the understanding of phase formation inside AZO thin film and how to avoid it to conserve a low resistivity.

References:

[1] K. Ellmer et al. Berlin: Springer, 2008.
[2] M. Vinnichenko et al. Appl. Phys. Lett., vol. 96, n° 14, p. 141907, avr. 2010, doi: 10.1063/1.3385024.
[3] K. Ellmer et al. J. Phys. D: Appl. Phys., vol. 49, n° 41, p. 413002, oct. 2016, doi: 10.1088/0022-3727/49/41/413002.

Acknowledgment: A particular thanks for Nicolas TRCERA from LUCIA beamline (SOLEIL) and Yunlin from INSP for their precious help in measurement and interpretation.

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: 2D materials
Keywords: Silicene, Germanene, Scanning Tunneling Microscopy, Growth
Disciplinary field involved: Physics

Atomistic growth mechanisms of Xenes epitaxial layers revealed by in-situ STM

L. Florean,[1] K. Zhang,[1] A. Curcella,[1] R. Bernard,[1] Y. Borensztein,[1] H. Cruguel,[1] G. Prévot[1]

1. Institut des NanoSciences de Paris, Sorbonne Université, Paris, France

2D-Xenes (where X = Si, Ge ...) are a class of two-dimensional materials from the group IVA that possess electronic properties different from those of the corresponding 3D bulk. For example, silicene (germanene), that corresponds to a buckled hexagonal plane of Si (Ge), has an electronic structure similar to the one of graphene. However, they cannot be obtained by exfoliation and must be synthesized on a substrate. The successful growth of silicene and germanene has been claimed on various metal substrate, such as Ag, Au, Pt, Al, but many of the results found are controversial since the involvement of the substrate during growth is unknown.

We have developed a series of tools to follow by Scanning Tunneling Microscopy (STM) the epitaxial growth of Xenes monolayers. For all systems studied (Si/Ag, Si/Al, Si/Au, Ge/Ag, Ge/Al), we have observed that the IVA atoms interact strongly with the substrate, in contradiction with the corresponding bulk phase diagrams showing for all cases a negligible mutual solubility in the temperature range studied [1-5]. Depending on the couple IVA /substrate, we observed either growth of Xene domains inserted in the substrate terraces, surface alloy formation or bulk alloy formation. The analysis of atomic motion and of the density of domains allows us to extract the kinetic barriers associated to the mechanisms of exchange between substrate and IVA atoms, and to the diffusion by jumps on the substrate.

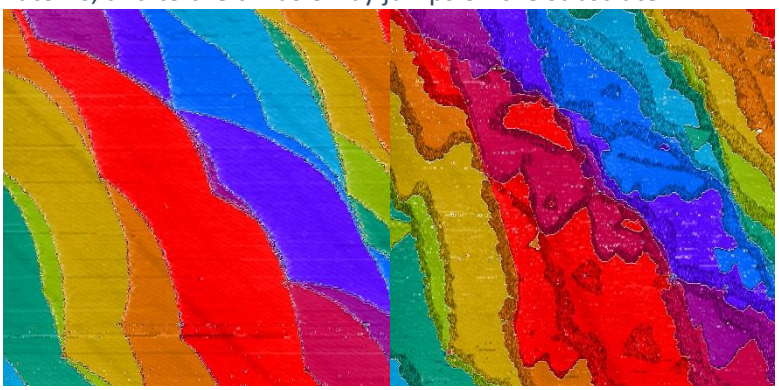


Figure. Evolution of the Ag(111) surface before and after depo-sition of 0.42 ML Si at 506 K. The exact same area (600 x 600 nm^2) is shown on both images.

References:

[1] G. Prévot et al., *Appl. Phys. Lett.* **105** (2014) 213106 [2] R. Bernard et al., *Phys. Rev. B* **92** (2015) 045415 [3] G. Prévot et al., *Phys. Rev. Lett*. **117** (2016) 276102 [4] A. Curcella et al., *Nanoscale* **10** (2018) 2291 [5] K. Zhang, R. Bernard, Y. Borensztein, H. Cruguel, G. Prévot, *Phys. Rev. B* **102** (2020) 125418

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: 2D Materials
Keywords: Graphene oxide, Raman measurements, SPM measurements, Correlative approach
Disciplinary fields involved: Chemistry, Physics, 2D Materials

Correlative imaging of single graphene oxide flake: sample selection and limitations

Lydia Chibane[1], Alexandra Delvallée[1], Khaled Kaja[1], Nolwenn Fleurence[1], Emmanuel Flahaut[2], Nicolas Feltin[1]

[1]Laboratoire National de métrologie et d'Essais (LNE), 29 avenue Roger Hennequin, 78197 Trappes.
[2]Centre Inter-universitaire de Recherche et d'Ingénierie des Matériaux - UMR CNRS 5085, 118 Route de Narbonne, 31062 Toulouse.
lydia.chibane@lne.fr , alexandra.delvallee@lne.fr

Graphene is of major interest for a large number of applications currently under development. However, its production remains complex in large quantities. Graphene oxide (GO) is much easier to synthesize and is therefore often used as a precursor for the preparation of reduced graphene oxide (rGO), whose morphology and physicochemical properties tend more towards graphene as the reduction is more advanced. However, rGO contains a number of structural defects that influence its physicoch emical properties, such as its electrical and thermal conductivity, etc. To control this reduction, it is interesting to follow the evolution of these physico-chemical properties during the GO reduction process, starting with a good characterization of the properties of the initial GO. Based on our expertise in hybrid metrology specifically developed for measuring single nano-object [1], we have chosen to characterize the GO through the correlation of various microscopy technique on single GO flake: Raman spectroscopy/microscopy, Scanning Electron Microscopy (SEM), Atomic Force Microscopy and derivate techniques (AFM, SThM, SMM, KPFM). This correlative imaging approach implies that each limitation of each technique have to be considered to select the ideal sample and substrate. Moreover, strategy must be put in place so that when correlative microscopy is performed the location of the flakes is easy and the least invasive techniques are used before the most invasive ones. We show in the poster the limitation induced by the various techniques of microscopy.

Reference:

[1] L. Crouzier, et al. 2019. "Development of a New Hybrid Approach Combining AFM and SEM for the Nanoparticle Dimensional Metrology." Beilstein Journal of Nanotechnology 10, page 1523-1536

C'Nano THE NANOSCIENCE MEETING Poitiers March, 15, 16 and 17 2023

Thematic Session: 2D Materials

Keywords: MXenes, 2D materials, Heterogeneous catalysis, Hydrogenation, CO_2

Disciplinary fields involved: Chemistry, Material Science

Sustainable Development Goals* eventually involved in your research: Climate Action (Goal 13)

Determination of the potential of the 2D transition metal carbides (MXenes) for the heterogeneous catalysis. Application to the hydrogenation reactions in gas phase and liquid phase.

Zheming Li[1], Lola Loupias[1], Gwendoline Lafaye[1], Anthony Le Valent[1], and Stéphane Célérier[1].

1. *IC2MP, SAMCat (From the Active Site to the Catalytic Material), University of Poitiers, Poitiers, Franc*

Nowadays, the research about two-dimensional (2D) transition-metal carbides, nitrides and carbonitrides (MXenes) is growing and gaining more and more attention in many different fields, such as catalysis, electromagnetic interference shielding, energy storage, medicine and many others [1]. This is due to the high chemical richness of MXene family with more than 40 successfully synthesized configurations and more than 100 predicted stoichiometric compositions. [2] The MXenes with the general formula of $M_{n+1}X_nT_x$, where M is a group 3-6 early transition metal, X is carbon (C) and/or nitrogen (N), T_x are the surface termination groups (for example,-OH, -O-,–F etc.) and n, the layer number (1 to 4) are obtained by removal of the A element of their corresponding 3D precursors, the MAX phases, with $M_{n+1}AX_n$ formula, where A is an element mainly from column 13-14 of the periodic table.

Recently, MXenes were explored in the domain of heterogeneous catalysis showing promising potential. [3] Besides their physical and chemical properties, MXenes, with a high surface/volume ratio, characteristic of 2D material, can offer the potential active sites for different heterogenous catalytic processes. For example, Mo_2CT_x MXene was already successfully used as active support of copper for CO_2 hydrogenation. [4]

At IC2MP, molybdenum and titanium based MXenes are synthesized, characterized and studied as a catalyst and/or support for two reactions: (i) in the liquid phase for the selective hydrogenation of aldehydes (biomass valorization) and (ii) in the gas phase for the CO_2 hydrogenation to methanol.

References:

[1] Lim, K.R.G., Shekhirev, M., Wyatt, B.C. et al. Fundamentals of MXene synthesis. Nat. Synth 1, 601–614 (2022). https://doi.org/10.1038/s44160-022-00104-6

[2] Wei, Y., Zhang, P., Soomro, R. A., Zhu, Q., Xu, B., Advances in the Synthesis of 2D MXenes. Adv. Mater. 2021, 33, 2103148. https://doi.org/10.1002/adma.202103148

[3] ***J. Mater. Chem. A***, 2021,9, 19589-19612 https://doi.org/10.1039/D1TA04097A

[4] Zhou, H., Chen, Z., López, A.V. et al. Engineering the Cu/Mo2CTx (MXene) interface to drive CO2 hydrogenation to methanol. Nat Catal 4, 860–871 (2021). https://doi.org/10.1038/s41929-021-00684-0

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: 2D Materials
Keywords: MXene**,** 2D transition metal carbides, electrical properties, optical properties, spectroscopic ellipsometry
Disciplinary fields involved: Physics, Chemistry

Optical and electrical properties of titanium and molybdenum carbide 2D layers thin films

S. Tangui[1], S. Hurand[1], L. Loupias[2], S. Célérier[2], A. Benmoumen[1,3], P. Moreau,[3] M.-L. David[1] and V. Mauchamp[1]

1. *Université de Poitiers, ISAE-ENSMA, CNRS, PPRIME, Poitiers France.*
2. *Université de Poitiers, CNRS, IC2MP, Poitiers, France*
3. *Nantes Université, CNRS, IMN, Nantes, France*

MXenes are a family of 2D transition metal carbides and nitrides obtained from the exfoliation of nanolaminated ceramics named MAX phases. [1] Their chemical formula is $M_{n+1}X_nT_x$, where M is a transition metal, X is C and/or N, T_x are surface terminations (e.g. -O, -OH, -F) inherited from the chemical exfoliation process and n = 1, 2 or 3. Generally speaking, MXenes are hydrophilic and have a metallic electrical behavior, making these materials promising for numerous applications, including transparent conductive thin films.[2] However, calculations based on Density Functional Theory predict some Mo-based phases to have a semiconductor like behavior [3] which would significantly increase the application range of MXenes, including e.g. thermoelectric generators.[4] In this work, we investigate experimentally the role of the Ti to Mo substitution on the electronic properties of MXene by focusing on the optical and electrical properties of $Ti_3C_2T_x$ and $Mo_2Ti_2C_3T_x$ spin coated thin films (figure 1). The films are a collection of MXene flakes and their electrical transport properties comprise two contributions, namely: intra and inter flake transport. [5] Optical measurements by spectroscopic ellipsometry in infrared range allows one to probe the intra-flake transport only. By coupling optical and electrical measurements, we are thus able to better understand the electrical properties of the films and evidence the differences in terms of transport mechanisms (i.e., charge carrier densities, intra/inter flake electron mobilities) for these two compositions.

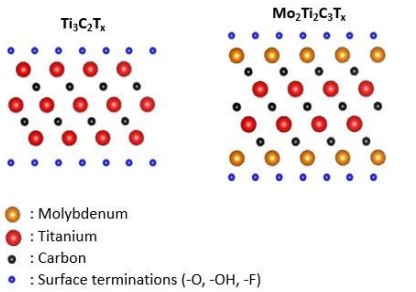


Figure 1: schematic representation of Ti3C2Tx and Mo2Ti2C3Tx crystal

References:

[1] M. Naguib et al., « Two-dimensional nanocrystals produced by exfoliation of Ti3 AlC2 », Adv Mater, vol. 23, no 37, p. 4248-4253, oct. 2011, doi: 10.1002/adma.201102306.
[2] A. D. Dillon et al., « Highly Conductive Optical Quality Solution-Processed Films of 2D Titanium Carbide », Advanced Functional Materials, vol. 26, no 23, p. 4162-4168, 2016, doi: 10.1002/adfm.201600357.
[3] B. Anasori et al., « Control of electronic properties of 2D carbides (MXenes) by manipulating their transition metal layers », Nanoscale Horiz., vol. 1, no 3, p. 227-234, avr. 2016, doi: 10.1039/C5NH00125K.
[4] S. Park et E. W. K. Young, « E-FLOAT: Extractable Floating Liquid Gel-Based Organ-on-a-Chip for Airway Tissue Modeling under Airflow », Advanced Materials Technologies, vol. 6, no 12, p. 2100828, 2021, doi: 10.1002/admt.202100828.
[5] J. Halim, E. J. Moon, P. Eklund, J. Rosen, M. W. Barsoum, et T. Ouisse, « Variable range hopping and thermally activated transport in molybdenum-based MXenes », Phys. Rev. B, vol. 98, no 10, p. 104202, sept. 2018, doi: 10.1103/PhysRevB.98.104202.

Acknowledgment:
This work was supported by the French government program "Investissements d'Avenir" (EUR INTREE, reference ANR-18-EURE-0010)

C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Thematic Session: Nanomechanics: surface/interface, composite nanomaterials, hybrid nanomaterials
Keywords: Twinning, Molecular Dynamics, Nanolamellar Ag/Cu, Interfaces
Disciplinary field involved: Physics

Atomic Scale Simulations of Twins – Interfaces Interaction in a Nanolamellar Ag/Cu System

Sandrine BROCHARD[1], Julien DURINCK[1], Loïc VAN HOORDE[1]

1. *Pprime Institute, Department of Physics and Mechanics of Materials, University of Poitiers, ISAE-ENSMA, CNRS Poitiers, France*

For a decade, modern synthesis methods, such as severe plastic deformation, were developed and applied to metallic lamellar composites in order to reduce their layer width to less than 100 nm. Nowadays, these new nanostructured materials offer outstanding mechanical properties which are partly attributed to the role increasingly played by interfaces in their plastic behavior. This role is crucial in the nanolamellar Ag/Cu composite. Indeed, silver is known to twin easily under mechanical stresses whereas copper needs more specific conditions to do so. In the Ag/Cu composite, experimental studies by transmission electron microscopy showed that the deformation twins coming from silver layers may readily cross some interfaces and spread in copper layers. In that respect, it extends the spectrum of the mechanical conditions for twinning in copper. Although these observations were then completed by atomistic simulation studies, several questions for a better understanding of elementary mechanisms remain unanswered. Atomistic simulations, and mainly molecular dynamics, fit particularly well to the nanometric scale and to the study of elementary mechanisms involved. In our study, we consider bi-metallic Cu/Ag multilayers in which different types of semi-coherent interfaces coexist, as observed experimentally. The global response of the whole system is computed, and new elementary mechanisms involved in the formation and growth of mechanical twins are identified. Special attention is given to the role of the misfit interfacial dislocations mesh in these mechanisms.

C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Thematic Session: Nanomechanics: surface/interface, composite nanomaterials, hybrid nanomaterials
Keywords: focused ion beam, electron microscopy, EELS, time and position sensitive detectors

Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: -

Improved nanometric control of ions and electrons via laser ionization and coincident detection

Clelia Bastelica, Yan Picard, Daniel Comparat

Université Paris-Saclay, CNRS, Laboratoire Aimé Cotton, 91405, Orsay, France

Our projects aims at achieving breakthroughs in focused ion and electron beams, exploiting monochromaticity in the low-energy domain (eV-keV). Using ionization of a neutral atomic species and on the simultaneous production, detection and control of both the ion and the electron we propose to develop three innovative prototypes:

1. A focused ion beam using feedback control with unprecedented focused properties. This will be used to realize semiconductor circuit-editing at the (sub-)nm scale.
2. A deterministic source of (potentially) any type of ion for controlled implantation at the nm level. This will be used for on-demand doping of quantum devices.
3. A high-resolution electron-energy-loss microscope (HREELM) with precise knowledge of the electron energy and the position on the sample. It be used to realize both imaging and vibrational spectroscopy for surface analysis.

References:

Cesium Rydberg-state ionization study by three-dimensional ion-electron correlation: Toward a monochromatic electron source; R Hahn, A Trimeche, C Lopez, D Comparat, YJ Picard; Physical Review A 103 (4), 042821 (2022); https://doi.org/10.1103/PhysRevA.103.042821

Ion and electron ghost imaging; A. Trimeche, C. Lopez, D. Comparat, and Y. J. Picard; Phys. Rev. Research 2, 043295 (2020);https://doi.org/10.1103/PhysRevResearch.2.043295

Real-time trajectory control of deterministically produced ions; C. Lopez, A. Trimeche, D. Comparat, Y.J. Picard; Phys. Rev. Applied 11 064049 (2019); https://doi.org/10.1103/PhysRevApplied.11.064049

Design for a high-resolution electron energy loss microscope; M. Mankos, K. Shadman, R. Hahn, Y. J. Picard, D. Comparat, O. Fedchenko, G. Schönhense, L. Amiaud, A. Lafosse, N. Barrett; Ultramicroscopy, 207 112848 (2019); https://doi.org/10.1016/j.ultramic.2019.112848

Ion microscopy based on laser-cooled cesium atoms; M. Viteau, M. Reveillard, L. Kime, B. Rasser, P. Sudraud, Y. Bruneau, G. Khalili, P. Pillet, D Comparat, I. Guerri, A. Fioretti, D. Ciampini, M. Allegrini, F. Fuso; Ultramicroscopy 164, 70 (2016); https://doi.org/10.1016/j.ultramic.2015.12.007

Acknowledgment:

This project has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement No. 101055250). This work was also supported by the ANR FIBback (ANR-21-CE42-0010).

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Council. Neither the European Union nor ERC can be held responsible for them.

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Nanomechanics: surface/interface, composite nanomaterials, hybrid nanomaterials
Keywords: Nanomechanics, molecular dynamics, load vs displacement-control, nanoparticles
Disciplinary fields involved : Physics, Computer science

Load versus displacement controlled nanomechanics : insights from atomistic simulations

Hugo Iteney[1*], Olivier Thomas[1], Thomas W. Cornelius[1], Jonathan Amodeo[1]

1. Aix Marseille Univ, Univ Toulon, CNRS, IM2NP UMR 7334, Marseille, France

The characterization of nano-objects takes a particular interest due to their enhanced mechanical properties when compared to bulk materials. In nanomechanical experiments, two ways of controlling the load are currently available depending on the brand device used *i.e.,* namely the load and the displacement-controlled modes. Most of SEM compression setups used for compression tests on pillars or nanoparticles are load-controlled or benefit of a software-based feedback loop on displacements that is less accurate than the scarcer intrinsic displacement-control setups. On the other hand, displacement-control molecular dynamics (MD) simulations are generally designed for the sake of simplicity.

Thus, the comparison between simulations and experiments is not always straightforward. On one hand, simulations where the displacement of the indenter is monitored show a huge stress drop when the first dislocations nucleate while huge strain bursts are observed in load-controlled experiments.

In this study we present an original load-control MD setup to discuss load vs displacement control experiments and simulations. Here we apply our approach to the cases of Wulff-shaped Au and Ag nanoparticles (NPs) recently investigated using experimental nanocompression tests [1, 2]. First, the mechanical response of Au NPs obtained using the load-control model is investigated. In contrast with the displacement-controlled simulations, the strain bursts are captured and the magic "pancake" shape of metal NPs often observed at the end of nanocompression experiments is now explained. A specific attention is paid to the evolution of the dislocation microstructure during the test in comparison to the displacement-controlled simulations. A similar approach is then applied to Ag NPs for which the load-control analytical model proposed in ref. [1, 2] is directly faced to the simulation's outcomes. In the both cases, implications for nanomechanics experiments are discussed.

References:

[1] Y. Feruz, D. Mordehai, Towards a universal size-dependent strength of face-centered cubic nanoparticles, Acta Mater., Volume 103 (2016). doi : 10.1016/j.actamat.2015.10.027

[2] A. Sharma, J. Amodeo, N. Gazit, Y. Qi, O. Thomas, E. Rabkin, When More Is Less: Plastic Weakening of Single Crystalline Ag Nanoparticles by the Polycrystalline Au Shell, ACS Nano 2021, 15, 9, 14061–14070. doi : 10.1021/acsnano.1c02976

C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

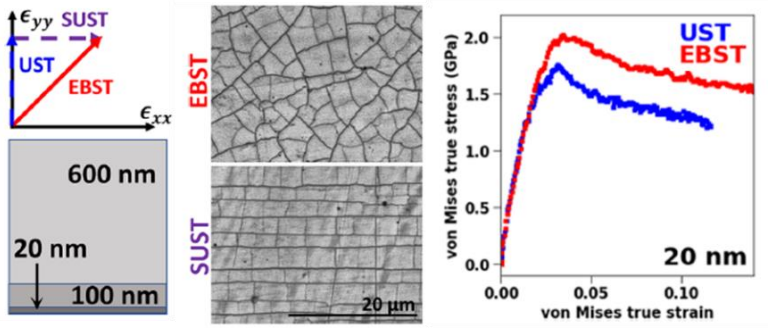
Thematic Session: Nanomechanics: surface/interface, composite nanomaterials, hybrid nanomaterials
Keywords: cracking, plasticity, nickel, thin film, X-ray diffraction
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: none

Strain ratio and thickness effects on plasticity and cracking of nickel thin films

Pierre Godard[1], Fatih Zighem[2], Dominique Thiaudière[3], Damien Faurie[2], Pierre-Olivier Renault[1]

1. *Institut Pprime, Université de Poitiers, Poitiers, France*
2. *Université Sorbonne Paris Cité, LSPM - CNRS, Villetaneuse, France*
3. *Synchrotron SOLEIL, Gif sur Yvette, France*

We are interested in the cracking of nickel thin films deposited on flexible substrates. We have in particular illustrated that an equibiaxial loading leads to an isotropic ("dried mud") pattern, whereas if one loads first in one direction, then in the perpendicular direction, the cracks form a rectangular network. We can therefore apply the same (ε11,ε22) strain but having different crack patterns [1]. This study is completed by a thickness effect, with films of 20, 100 or 600 nm [2].
We combine digital optical image correlation to characterize the applied strain with X-ray diffraction to measure the stresses in the film. First, well-known effects are found: for example, the thinner a film, the greater its mechanical resistance, or the fact that the nucleation of cracks appears at increasingly large strains as the film thickness decreases.



We have also shown that the mechanical resistance, the elastic limit and the cracking limit depend on the loading path. However, the average spacing between two cracks, on these three tests, is very well approximated by 125h, where h is the thickness of the film.

References:
[1] D. Faurie et al, In situ x-ray diffraction analysis of 2D crack patterning in thin films, Acta Mater., 177-182, 165, (2019)
[2] P. Godard et al, Strain ratio and thickness effects on plasticity and crack patterns of Nickel thin films, Scr. Mater., 114638, 213, (2022)

Acknowledgment:
This works was funded by the French National Research Agency, grant reference ANR-19-CE08-0007. This work also pertains to the French government program "Investissements d'Avenir "(LABEX INTERACTIFS, reference ANR-11-LABX-0017-01 and EUR INTREE, reference ANR-18-EURE-0010).

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Nanomechanics: surface/interface, composite nanomaterials, hybrid nanomaterials
Keywords : Iron oxide nanoparticules – Thermal decomposition – Nucleation and growth control – Nanocomposite – Mechanical properties.
Disciplinary fields involved : Chemistry, Mechanics
Sustainable Development Goals* eventually involved in your research: Positively impact the thermal and mechanical characteristics of the packaging material.

Study of the mechanical properties of polymers reinforced with nanoparticles of adjustable size,shape and surface chemistry

Sakina MEFTAH[1,2] , Fahmu BEDOUI[1], Djimédo KONDO[3] , Anh-tu NGO[2], Isabelle LISIECKI[2]

1. Roberval Laboratory for mechanics, Compiègne University of Technology , Rue du docteur Schweitzer, 60200 Compiègne, France
2. Monaris Laboratory for nano-objects, Sorbonne université, 4 Place de Jussieu, 75005 Paris, France
3. Institut Jean-Le-Rond-d'Alembert for mechanics, Sorbonne université, 4 Place de Jussieu, 75005 Paris, France

Researchers are mainly interested in finding solutions to improve the properties of polymers by incorporating nanoparticles (NPs). The central point of the development of such materials lies in the understanding of the polymer/NP interface which plays the key role in the improvement of its properties. For this purpose, we plan to study the evolution of the mechanical properties of these materials as a function of the structural and chemical characteristics of the incorporated nanoparticles (size, shape, surface chemistry). To achieve this, we prepare our model samples of iron oxide nanoparticles by thermal decomposition of an organometallic precursor [1] through the expertise of MONARIS laboratory in colloidal chemistry [2][3]. The size of the nanoparticles (3, 6 and 12 nm) is controlled by adjusting several parameters: nature of the solvent, reaction temperature, reaction time, moisture and purety of the reagents. For each NP size, we use three different coating ligands (acids) characterized by different hydrocarbon chain lengths (C8, C12 and C18). The surface chemistry of the NPs is studied by infrared spectroscopy. We will also study other forms of nanoparticles (cubic and triangular) obtained by adding 'impurities' in the precursor. The flexibility of this system will allow a comprehensive study of the performances of these materials at the Roberval laboratory [4][5]. A final step of modelization by scale shifting is required to interpret and optimize the development factors of the material. This approach already developed at the institut Jean Le Rond D'Alembert, will be adapted to the materials studied in this thesis.

References:

[1] W. Baaziz, B. Pichon, S. Fleutot, Y. Liu, C. Lefevre, J. M. Greneche, M. Toumi, T. Mhiri, S. Begin-Colin the Journal of Physical Chemistry C, 2014, *Vol 118*, 3795– 3810.

[2] S. Costanzo, G. Simon, J. Richardi, P. Colomban, I. Lisiecki the Journal of Physical Chemistry C, 2016, *Vol 120*, 22054– 22061.

[3] S. Costanzo, A. T. Ngo, V. Russier, P. A. Albouy, G. Simon, Ph. Colomban, C. Salzemann, J. Richardi, I. Lisiecki Nanoscale, 2020, *Vol 12*, 24020–24029.

[4] A. S. Blivi, F Benhui, J. Bai, D. Kondo, F. Bedoui *Polymer testing,* 2016 *Vol 56*, 337-343.

[5] S. Navarro Oliva, L. Picart, C.Y. Leon-Valdivieso, A. Benalla, L. Lenglet, A. Ospina, J. Jestin, F. Bedoui Polymer Composites, 2012 *Vol 42 (3),* 1565-1573.

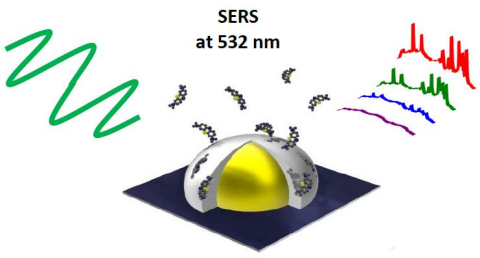
C'Nano
THE NANOSCIENCE MEETING
2023
Poitiers
March, 15, 16 and 17

Thematic Session: Nanomechanics: surface/ interface, composite nanomaterials, hybrid nanomaterials
Keywords: Gold nanoparticles, Molecularly Imprinted Polymers, nanosensors
Disciplinary fields involved: Physical chemistry
Sustainable Development Goals* eventually involved in your research: simple approach for synthesis of hybrid nanoparticles

Synthesis of molecularly imprinted polymer-based hybrid nanosensors by optical near-field photopolymerization

Amine Khitous[1, 2], Céline Molinaro[1, 2], Simon Gree[1, 2], Karsten Haupt[3], Olivier Soppera[1, 2*]
1 Université de Haute-Alsace, CNRS, IS2M UMR 7361, F-68100 Mulhouse, France
2 Université de Strasbourg, France
3Université de Technologie de Compiègne, France
E-mail:olivier.soppera@uha.fr

A new simple, fast and versatile method for the functionalization of gold nanoparticles (AuNPs) by a nanoscale layer of molecularly imprinted polymers (MIPs) was developed. The key step is based on near-field radical photopolymerization of a MIP pre-polymerization mixture. This allows the preparation of hybridAuNPs@MIPs nanoparticles which are used as substrates for LSPR and surface enhanced Raman spectrometry (SERS) analyses with excellent sensitivity and specificity. To demonstrate the performance of AuNPs@MIPs, MIPs specific to methylene blue (MB) were prepared. The sensitivityof spectroscopic detectionis in the range of 10 nM. Specificity is demonstrated by comparing the response with a control non-imprinted polymer (NIP) and by interference tests with two analogues (Rhodamine 6G and Rhodamine 110). This fabrication method allowed us to obtain robust and recyclable sensing surfaces with high sensitivity and selectivity. The nanometric thickness of MIP allows a short analysis time (10 min), which improves the performance of MIP-based sensors and opens new perspectives to detect molecules at very low concentrations.



References:

[1] Khitous, A et al, submitted.
[2] Khitous, A et al, ACS Applied Nano Materials 2021, 4 (9), 8770-8780.
[3] Kameche, F et al, The Journal of Physical Chemistry C 2021, 125 (16), 8719–8731.
[4] Paruli, E et al, ACS Applied Polymer Materials 2021, 3 (10), 4769–4790.

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

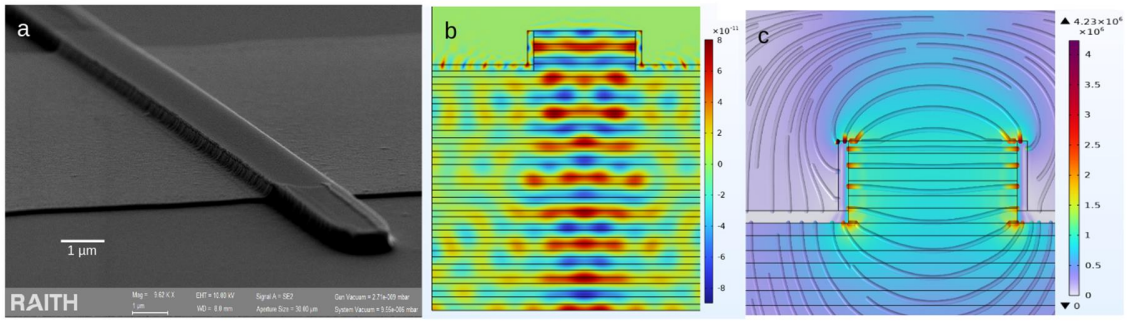
Thematic Session: Nanomechanics & Nano-electronics
Keywords: Phononic resonator, Simulations, Piezoelectricity , Mechanical qubit
Disciplinary fields involved : Physics

Towards an electrically driven high Q, GHz mechanical resonator for quantum information applications

Marie Joly[1], Paola Atkinson[1], Daniel Garcia-Sanchez[1]

1 *Sorbonne Universités, UPMC Univ. Paris 06, CNRS-UMR 7588, Institut des NanoSciences de Paris, F-75005 Paris, France*

In recent years, efforts have been put towards realizing a mechanical qubit by coupling a macroscopic mechanical resonator with a transmon qubit [1, 2]. One of the challenges here is to create a mechanical resonator that has both a high quality factor and which can be strongly coupled to the transmon. Here, we discuss different strategies to achieve a high frequency, high Q, electrically driven mechanical resonator based on a GaAs/AlAs superlattice[3]. This consists of a succession of different layers forming acoustic mirrors with a central cavity which confines phonons with specific wavelengths. We will describe in detail the fabrication of a micropillar where a lateral electrical field is applied to generate a mechanical mode, and present models of the displacement field and electrical impedance of the different designs.



(a): SEM image of a GaAs micropillar with side Au electrodes, (b-c): Displacement field along Y (out of plane) and electric field across a GaAs/AlAs superlattice with lateral gold electrodes, Comsol simulations.

References: [1]: F. Pistolesi and al., Proposal for a Nanomechanical Qubit, 0.1103/PhysRevX.11.031027, [2]: K. J. Satzinger and al., Quantum control of surface acoustic wave, [3] D.Garcia-Sanchez and al. , Acoustic confinement in superlattice cavities, 10.1103/PhysRevA.94.033813 phonons

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Map of Stands & Posters Exhibition