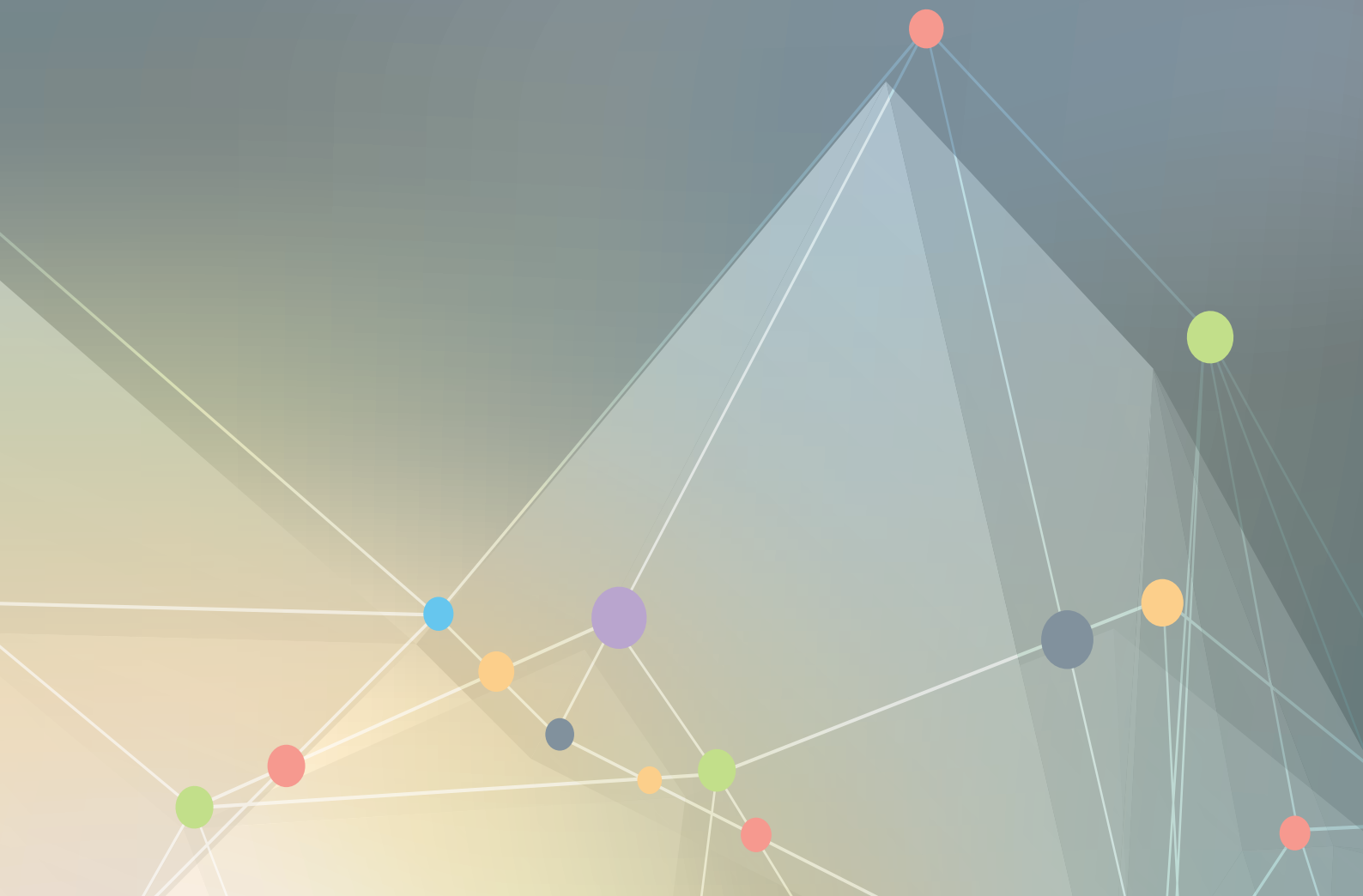
BOOK OF ABSTRACTS

Poster Presentations



POSTERS AREA 2

A2

Check the map at the end of the document

Thematic sessions

- Nanophotonics & Nano-optics
- Nanoscale Heat Transfer

List of Poster Presentations

AREA - 2

A2 - NANOPHOT&NANOPTICS I NANOSCALE HEAT TRANSFER

A2-01	Advanced superstructures of nanoparticles in liquid crystal topological defects	Lamya ESSAOUI • *Sorbonne Univ. - INSP , France*
A2-02	Characterization of silicon vacancies in hexagonal silicon carbide formed by ion implantation of nitrogen and aluminum.	Enora VUILLERMET • *UTT - L2n, France*
A2-03	Controlling dichroism, diffraction and colors of nanomaterials with laser processing	Van Doan LE • *Univ. Lyon - Lab. Hubert Curien, France*
A2-04	Design and investigation of a low-threshold organic laser diode using mixed-order dfb cavities	Yara EL DROUBI • *Univ. Sorbonne Paris Nord - LPL, France*
A2-05	Design of metasurfaces by capillary assisted assembly of nanoparticles and their applications.	Juan XIN • *UTT - L2n, France*
A2-06	Facile InP/ZnS QDs encapsulation in MOF-5 matrices: towards solid state luminescence	Alexis TRAN • *Clermont Auvergne Univ. - ICCF, France*
A2-07	Full control of the electric and magnetic light-matter interactions through a plasmonic mirror on a near-field tip	Eric CHARRON • *Sorbonne Univ. - INSP, France*
A2-08	Hierachical structures of gold nanoparticules in topologica defects of smectic liquid crystals	Caterina TOSARELLI • *CNRS - INSP, France*
A2-09	Nanophotonic structures by photopolymerization of functional inks	Ludovic BELHOMME • *Univ. of Bordeaux - CRPP*
A2-10	Qualitative characterization of Au et Ag thin films by near-field optical microscopy	Valentin ALLARD • *Univ. Aix-Marseille - Fresnel Institute France*
A2-11	Room temperature synthesis of lead-free perovskite inspired manganese halides - from bulk to nano	Pierre MARTIN • *Clermont Auvergne Univ. ICCF, France*
A2-12	TERS Characterization of Functionalized Gold Nanostructure for Improved Biosensors.	Jean-François BRYCHE • *CNRS - LN2, France*
A2-13	Thermal management of VECSEL-GAAS for high-power single-mode emission	Abdelmounaim HAROURI • *CNRS - C2N*
A2-14	Ultrafast Direct Currents Generated by an Inverse-designed Plasmonic Antenna	Ye MOU • *Sorbonne Univ. - INSP, France,*
A2-15	Use of the OAD technique for high-efficiency nanostrutcured multilayer thin films polarizers	Etienne PANCHOUT • *CNRS - Pprime Inst., France*
A2-16	Impact of Ultra-thin-film Coatings on the Radiative Properties of Dual Functionality Black-Silicon	Elissa AKIKI • *Univ. Gustave Eiffel - ESYCOM, France*
A2-17	Nanoscale Heat Anisotropy in Gold Nanocrosses	Vega Marlo • *Univ. Sherbrooke - LN2, France*

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

Thematic Session: Nanophotonics & nano-optics, nanomaterials
Keywords: liquid crystals, nanoparticle, topological defects, optical properties
Disciplinary fields involved: Chemistry, Physics, Optics

Advanced superstructures of nanoparticles in liquid crystal topological defects

Lamya Essaoui[1], Haifa Jeridi[12], Alina Vlad[3], Alessandro Coati[3], Sébastien Royer[1], Ian Vickridge[1], Michel Goldmann[13], Doru Constantin[4], Yves Garreau[35], David Babonneau[6], Bernard Croset[1], Emmanuel Lhuilier[1], Claire Abadie[1], Emmanuelle Lacaze[1].

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It is still a challenge to obtain a well-assembled network of nanoparticles (Nps) which is similar everywhere and most importantly, oriented along a unique direction. Confining fluorescent Nps into the topological defects of smectic liquid crystals may allow to tackle this issue and ultimately may lead to the emergence of new optical properties. For example, when fluorescent nanorods are concerned, a fixed orientation of the nanorods allows for the control of the polarization of NP emitted light.

By using optical microscopy, fluorescence microscopy and synchrotron-based grazing incidence X-ray scattering (GISAXS) we study the coupling between smectic liquid crystals defects and fluorescent nanorods. We try to understand whether the assembly of Nps arrange itself in one-dimensional -1D (dislocations) or two-dimensional – 2D (grain boundaries) defects depending on Np concentration. We demonstrate that in both kinds of defects the average orientation of the nanorods is fixed, leading to a unique emitted light polarization all over the sample[1]. We observe the effect of the temperature on the Np organization and thus on the Nps optical properties, in relation with the evolution of the defect structure close to the smectic phase transition. We also follow the dynamics of the nanorods in the defects.

Our findings open up a route for collective behaviors between NPs that could emerge in relation to the well-ordered close packing of Nps confined within the smectic liquid crystal defects.

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We thank Synchrotron SOLEIL for providing the beam on the SIXS beamline and all the HERMES beamline members for the technical support. We also acknowledge the help of Y. Prado and E.Lhuilier for the sample preparation.

C'Nano
THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
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Thematic Session: Nanophotonics & Nano-optics
Keywords: Silicon vacancy, cathodoluminescence, KPFM, ion implantation
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: Industry, innovation & infrastructure (Goal 9)

Characterization of silicon vacancies in hexagonal silicon carbide formed by ion implantation of nitrogen and aluminum.

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High quality of crystal growth and advanced fabrication technology of silicon carbide (SiC) in power electronics, enables the control of optically active defects in SiC, such as silicon vacancies (V_{Si}) [1]. In this paper, V_{Si} are created in hexagonal SiC (4H and 6H) samples by ion implantation of nitrogen or aluminum, respectively the *n* and *p*-type dopants for SiC. The presence of silicon vacancies within the samples is studied by cathodoluminescence at 80K. KPFM measurements are also realized to determine the surface potential of the samples after activation of the dopants. For the 6H-SiC samples Al-implanted (Fig. 1.a) and annealed at different temperatures, ZPLs of V_{Si} are difficult to observe, however the characteristic phonon sidebands are visible [2]. For the 4H-SiC studied samples, the ZPL characteristic of the V1 center of Vsi is intense even before annealing but only for the N-implanted samples [3]. To the conference, annealing and characterization of the 4H-SiC samples will be done.

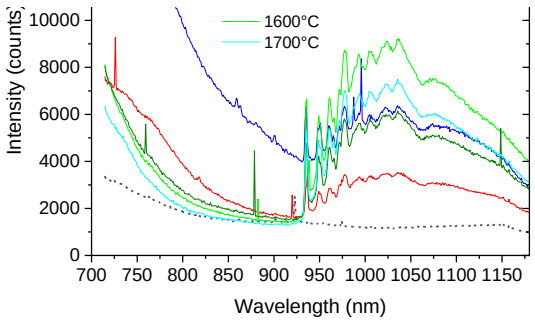

Fig. 1. Cathodoluminescence spectra of 6H-SiC samples Al-implanted at 300°C and annealed at different temperature (from 1100 to 1700°C) for 30min.

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Acknowledgment: The experiments were carried out within the Nanomat platform (www.nanomat.eu)

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

Thematic Session: Nanophotonics & nano-optics
Keywords: Laser-induced nanomaterials, structural colors, plasmonics, dichroism, diffraction.
Disciplinary fields involved: Physics, Chemistry
Sustainable Development Goals* eventually involved in your research: Industry, innovation & infrastructure (Goal 9)

Controlling dichroism, diffraction and colors of nanomaterials with laser processing

Van Doan Le[1], Balint Eles[1], Nicolas Dalloz[1,2], Manuel A. Flores Figueroa[1], Francis Vocanson[1], Christophe Hubert[1], Yaya Lefkir[1], Nathalie Destouches[1]

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Structurally colored materials are of great interest owing to their durability, non-bleaching and environmental-friendly properties. However, it is still challenging to fabricate these materials on a large scale. Laser processing has recently demonstrated its potential for high-end applications such as secured color printing or anticounterfeiting [1–3]. Contrary to other techniques, where each nanoelement is well-defined, laser modifies simultaneously several geometrical parameters of nanostructures including constituent material thickness, refractive indices, nanoparticle size, shape and self-organized patterns. The latter involves self-organization of nanoparticle arrays or periodic surface modulations. Here, we produce quasi random Ag:TiO_2 nanomaterials using laser processing and investigate the morphological features and mechanisms that lead to diffractive or dichroic, diffractive and dichroic, and non-diffractive non-dichroic colors. Electromagnetic simulation unveils the coupling effect between plasmonic and photonic modes that leads to the dichroism, and demonstrate the influence of scattering by nanoparticles and coherent couplings on the diffractive and dichroic properties. Finally, we show the potential of the method for high-throughput applications on display technology, information security or data storage by printing plasmon-color images that can be observed in different modes.

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Acknowledgment:

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

Thematic Session : Nanophotonics & nano-optics
Keywords : Si nanoparticles, Capillary force, Smart Force, Metasurface
Disciplinary fields involved : Chemistry, Physics
Sustainable Development Goals* eventually involved in your research: Applications in OLED

Design of metasurfaces by capillary assisted assembly of nanoparticles and their applications.

Juan Xin[1,*], Julien Proust[1], Jérémie Béal[1], Anne-Laure Baudrion[1], Abdelhamid Hmima[1], and Jérôme Plain[1,*]

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Abstract
The metasurfaces consist of arrays of sub-wavelength nanostructures, called meta-atoms. The periodic arrangement of these meta-atoms plays a key role in determining the functionality of the metasurface device.[1] In this project, nanoparticles are synthesized in solution and assembled by a capillary force-based technique, overcoming some of the drawbacks of the top-down approach. Thus, we demonstrated the development of an aggregation-free colloidal dispersion of spheroidal-shaped Si nanoparticles using a kitchen blender,[2] based on exfoliation processes without addition of surfactant. We obtained crystalline Si NPs with controlled diameters in the range of 45-200 nm. This year, Castilla et al [3] report the production of spherical and size-controlled crystalline Al NPs from commercial Al foils and without the use of a catalyst. I will use this method as a reference to prepare Al NPs

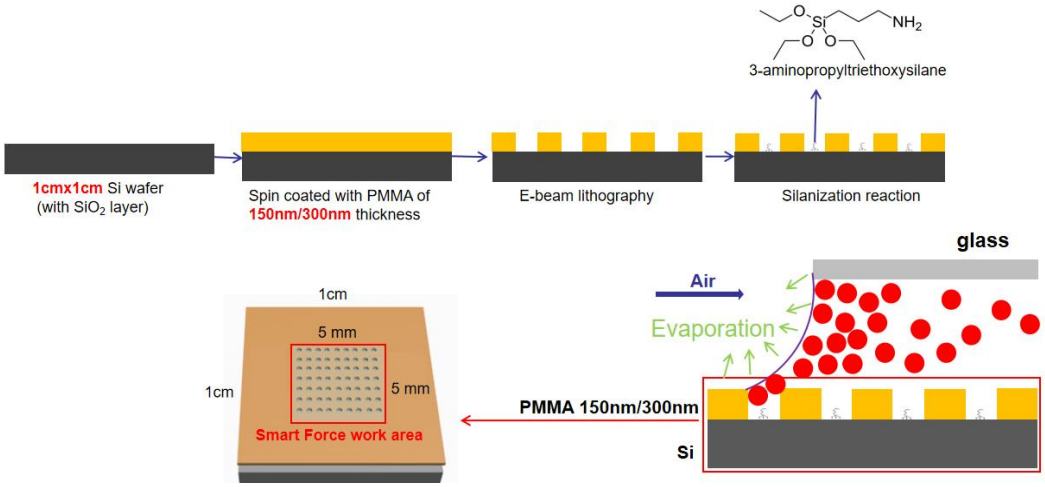

Figure 1. Experimental flow chart of nanoparticle assembly.

A schematic representation of the experimental process is shown in **Fig.1.** In the present experiment, we successfully assembled Si NPs in the nanostructure by the principle of capillary force assembly, as shown in **Fig.2.** An image of the grating obtained in dark field is also shown in **Fig.2.** The polarization, phase and amplitude of the incident light can be controlled by the metallic metasurface composed of metallic structural elements. The proposed dielectric metasurface avoids the metal metasurface loss problem and the theoretical basis for the structural and functional design of the dielectric metasurface is Mie scattering. To explore the differences in optical properties of the prepared metasurface structures from the individual differences of the nanoparticles and the application in the display.

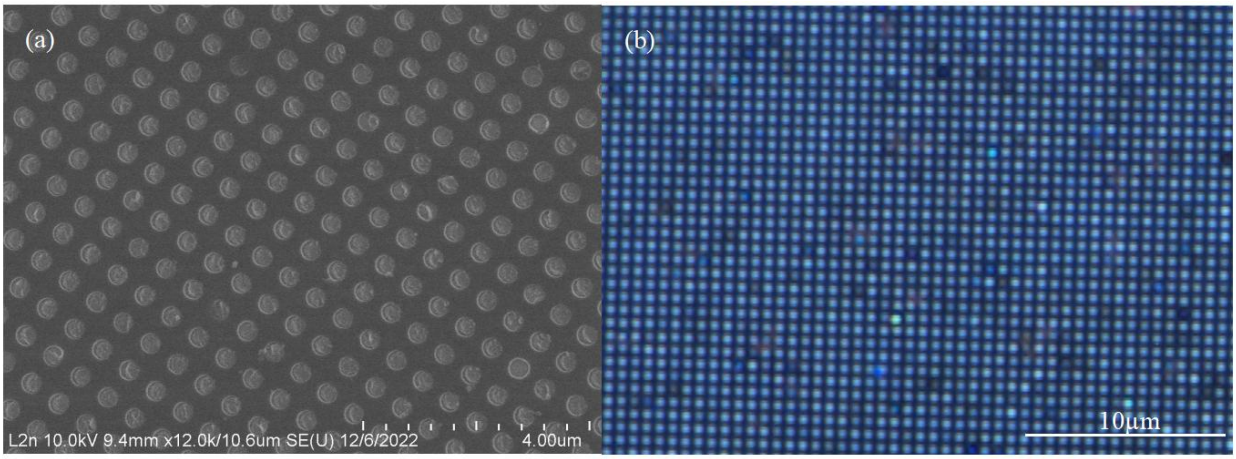

Figure 2. (a SEM image of the structure assembled by SmartForce. (b Dark field optical image of the corresponding structure.

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Acknowledgment:

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

Thematic Session: Nanophotonics & Nano-optics
Keywords: Quantum Dots, Metal-Organic Frameworks
Disciplinary field involved: Chemistry

Facile InP/ZnS QDs encapsulation in MOF-5 matrices: towards solid state luminescence

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Quantum dots are phosphors widely used in numerous applications such as bio-imaging, LED devices or anti-counterfeiting marking [1]. To avoid the use of toxic elements (Cd, Pb…), involved in the majority of QDs, indium phosphide (InP) QDs are a suitable alternative.

For this study, InP QDs have been synthesized by hot-injection method from aminophosphines and indium halides in oleylamine. After deposition of a ZnS shell, the obtained InP/ZnS QDs are characterized by high fluorescence quantum yields and narrow emission bands. However, they exhibit major limitations due to their poor thermo- photo- or chemical stability.

To address this issue, QDs can be embedded in inorganic matrices such as silica, LDH or metal-organics frameworks (MOFs) [2]. MOFs are self-assembled solids with a porous crystalline structure based on metal ions and organic ligands, which entail considerable versatility. The most described MOF in the literature is zinc-based with terephthalate ligands (MOF-5) [3]. Two simple QDs encapsulation routes with a "*bottle around the ship*" and "*ship in the bottle*" approach will be described here. The luminescence properties of the materials obtained by the two different ways will be compared. The stability of QDs under thermal stress was investigated by recording the emission spectra of the different samples after thermal treatment at 100°C.

References:

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

Thematic Session: Nanophotonics & Nano-optics
Disciplinary Fields involved: Scanning near field optical microscope (SNOM), plasmonic nanostructure

Full control of the electric and magnetic light-matter interactions through a plasmonic mirror on a near-field tip

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Light-matter interactions are often considered to be mediated by the optical electric field only, discarding the optical magnetic field. Although interactions between light and magnetic dipole (MD) transitions are very weak, they can be studied in a certain class of materials. For instance, it was demonstrated that MD-emission in Eu^{3+} could be manipulated by tuning the local magnetic quantum environment using dielectric or plasmonic nano-structures [1,2]. As well, it is possible to manipulate the excitation of the ED and MD by controlling the electric and magnetic fields' spatial distribution[3].

Here, by manipulating the spatial distributions of the electric & magnetic optical fields and their local density of states, we report the selective excitation and emission control of ED and MD transitions.

Using a scanning near-field optical microscope (SNOM), a plasmonic nanomirror at the end of an optical fiber tip is placed on top of a Eu^{3+} doped Y_2O_3 nanoparticle (Figure 1). The 3D scanning properties of the SNOM allow to couple, in space, the electric and magnetic nodes and anti-nodes of the standing wave to the electric or magnetic transitions of the Eu^{3+} ions. By collecting luminescence, we imaged both electric and magnetic nodes and anti-nodes of a standing wave (Figure 2) with their associated local density of states and demonstrated an increase in the collected luminescence by magnetic excitation with respect to a far-field excitation.

Finally, we demonstrated that we could also control the luminescence emission by manipulating the quantum environment solely through magnetic or electric excitation.

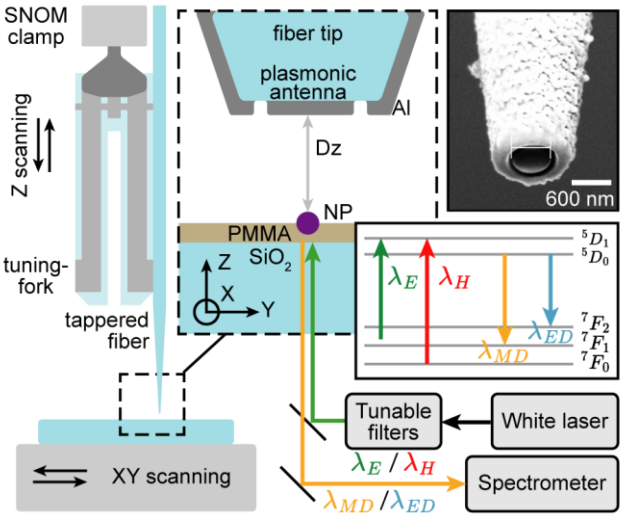

Figure 1 : Schematic of the experimental set-up. A plasmonic-mirror antenna at the end of a fiber tip is approached in close proximity to a Y_2O_3:Eu^{3+} doped nanoparticle using a SNOM, which allows us to position the antenna at the nanoscale with respect to the nanoparticle. Selective electric or magnetic excitation is controlled by tunable filters. The luminescence is collected and analyzed by a spectrometer for each antenna-particle position.

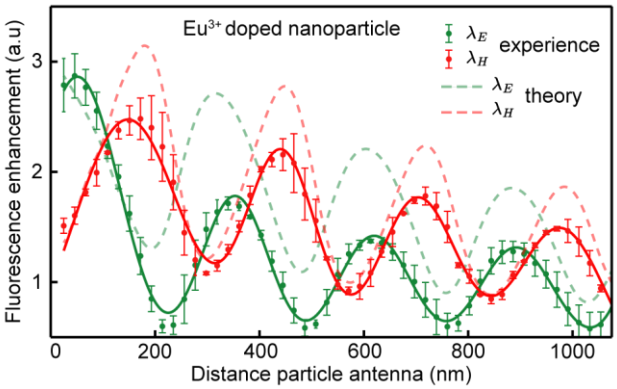

Figure 2 : Luminescence enhancement of a nanoparticle excited at either λ_E or λ_H, in function of the particle-antenna distance. The electric and magnetic nodes and anti-nodes of the standing wave are imaged.

References:

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

Thematic Session: Nanophotonics & Nano-optics
Keywords: Liquid crystals, gold nanoparticles, topological defects, LSPR
Disciplinary fields involved: Physics, Chemistry
Sustainable Development Goals* eventually involved in your research: -

Hierarchical structures of gold nanoparticles in topological defects of smectic liquid crystals

C. Tosarelli[1], H. Jeridi[1,2], J.D. Niyonzima[1,3], L. Essaoui[1], A. Vlad[4], A. Coati[4], D. Constantin[5], Y. Garreau[4,6], D. Babonneau[7], B. Croset[1], I. Trimaille[1], S. Royer[8], M. Goldmann[1,4], C. Abadie[1] , E. Lhuillier[1], M. Treguer-Delapierre[10] and E. Lacaze[1].

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Abstract:

A liquid crystal (LC) is a state of the matter that presents properties of both liquids and solid crystals, so that its molecules are free to move as in a fluid, but oriented as in a crystal lattice. Under certain conditions, thin films of liquid crystal can form an array of hemicylinders (Figure1) that present topological defects able to trap nanoparticles and to orient them [1]. In particular, here 1D and 2D defects (respectively dislocations and grain boundaries)

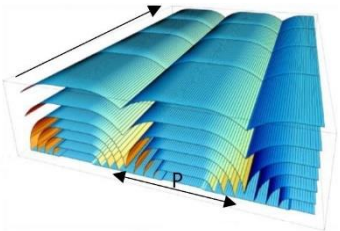

Figure 3. Schematic of LC forming hemicylinders.

are used to transmit their geometrical shape to gold nanoparticles in order to form oriented networks. Absorption measurements can reveal the arrangement of the nanoparticles thanks to their Localized Surface Plasmonic Resonance (LSPR)(see Figure 2). Gold nanosphere can form chains in the 1D defects and hexagonal networks in the 2D defects, exhibiting a red-shifted LSPR when the incident light is polarized along the defects [1]. When using gold nanorods, we demonstrate that there are different ways to assemble them, in particular in the 2D defect. Playing with sizes, shapes and ligands of the nanoparticles we can control the way they arrange and, as a result, the light absorption of the composite made of liquid crystal and gold nanorods. The orientation of nanoparticles in the defects was confirmed by Xray diffraction measurements performed at SOLEIL synchrotron facility [2] (Figure 3).

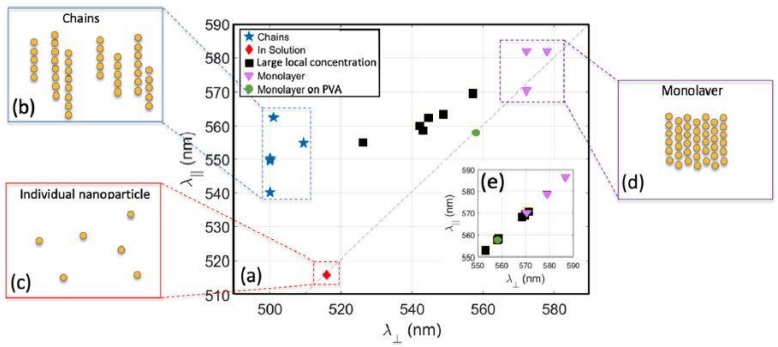

Figure 1. Red shift of LSPR of gold nanospheres depending on the arrangement. At low concentration NP form chains in the 1D defect, while at high concentration they start to fill the 2D defect forming ribbons showing a LSPR close to the one of monolayer[1].

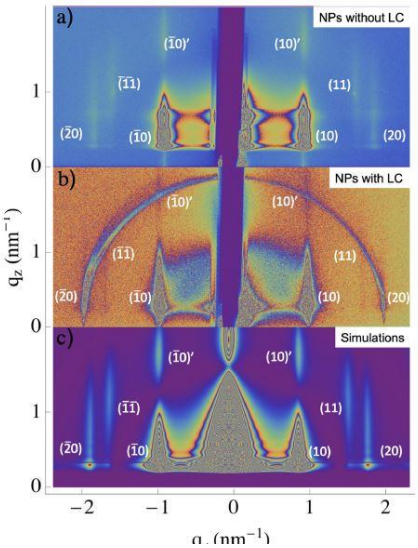

Figure 2. XRay GISAXS image showing presence of oriented networks of NP in the topological defects of the liquid crystal[2].

References:

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[2] Haifa Jeridi, Jean de Dieu Niyonzima, Charbel Sakr, Amine Missaoui, Sharif Shahini, Alina Vlad, Alessandro Coati, Nicolas Goubet, Se´bastien Royer, Ian Vickridge, Michel Goldmann, Doru Constantin, Yves Garreau, David Babonneau, Bernard Croset, Bruno Gallas, Emmanuel Lhuillier and Emmanuelle Lacaze Unique orientation of 1D and 2D nanoparticle assemblies confined in smectic topological Defects, *Soft Matter*, 2022, 18, 4792.

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

Thematic Session: Nanophotonics & Nano-optics
Keywords: nanophotonics, nanoparticles, photopolymerization
Disciplinary field involved: Chemistry
Sustainable Development Goals eventually involved in your research: not applicable

Nanophotonic structures by photopolymerization of functional inks

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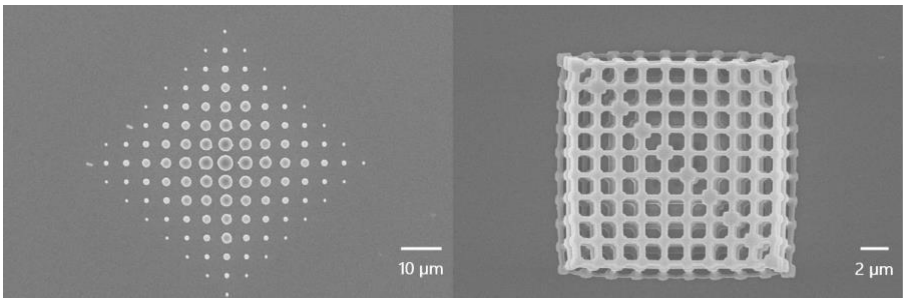
In a context where new technologies require the development of an increasing number of multifunctional devices, functional nanoparticles with unique photoelectric, mechanical, magnetic, and chemical properties have attracted considerable attention. However, the transformation of functional nanoparticles into scalable, controllable, and affordable functional devices remains challenging. Printing is a promising additive manufacturing technology for fabricating devices from NP building blocks because of its capabilities for rapid prototyping and versatile multifunctional manufacturing [1]. In this context, we aim at fabricating two- and three-dimensional nanophotonic structures through the photopolymerization of inks made functional by the incorporation of fluorescent, plasmonic or photochromic nanoparticles. A synergy of the properties of the structure thus formed and of the functional ink is targetted.



Examples of two- and three-dimensional structures produced by two-photon polymerization.

Reference:
[1] W. Zhao et al (2022) The Innovation 3: 100253

Acknowledgment: L.B. thanks the financial support of the IdEx University of Bordeaux / Grand Research Program "GPR LIGHT"

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

Thematic session: Nanophotonics & nano-optics
Keywords: near-field microscopy, s-SNOM, visible microscopy, thin film
Disciplinary fields involved: Physics, Plasmonics, Optics
Sustainable Development Goals eventually involved in your research: None

Qualitative characterization of Au et Ag thin films by near-field optical microscopy

Valentin Allard[1], Riley Shurvington[1], Fabien Lemarchand[1], Antonin Moreau[1], Julien Lumeau[1], Aude Lereu[1].

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Abstract:

We will report about optical near-field images of Au and Ag thin films obtained by using a scattering Scanning Nearfield Microscope (s-SNOM). The "apertureless" s-SNOM used here involves light scattering from a nanometer sharp tip and therefore has no wavelength-related spatial resolution limit. In fact, the main limitation is due to the radius *a* of the probing tip ($a \approx 20$ nm) resulting in a spatial resolution of 10 nm in the visible [1]. By illuminating both the apex of the tip and the sample with a visible laser ($\lambda = 633$ nm), it is possible to collect the evanescent waves at the surface of the sample and at the interface of thin films. Resonant materials can be particularly well highlighted due to their high near-field response. *Krutokhvostov and al* demonstrated the possibility to recover near-field signals of Au plots embedded in a SiO_2 layer under IR illumination [2]. To collect a pure near-field signal, the s-SNOM uses pseudo-heterodyne detection involving both a mechanical demodulation at higher harmonic and an optical demodulation using a Michelson interferometer. This system allows the s-SNOM to routinely and simultaneously collect both the amplitude and the phase of optical near-field and mechanical signals. Au and Ag samples were elaborated by electron beam deposition on glass substrates. These samples were made to obtain a range of colors as function of the thickness of material deposited when combined with dielectric layers. Characterization upon these samples were made to enlighten the growth process of these layers.

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Acknowledgment:

The authors want to acknowledge the Attocube-Neaspec GmbH, Munich Germany for their fruitful discussions.

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

Thematic Session: Nanophotonics & nano-optics
Keywords (max. 4-5)**:** Manganese, perovskite, metal halide, nanocrystals
Disciplinary fields involved: Chemistry, material science
Sustainable Development Goals eventually involved in your research: Avoid use of rare or toxic chemical elements

Room temperature synthesis of lead-free perovskite inspired manganese halides – from bulk to nano.

Pierre MARTIN[1], Audrey POTDEVIN[1], Geneviève CHADEYRON[1], Damien BOYER[1]

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Abstract

Since 2015, when their first hot-injection synthesis at the nanoscale was reported[1], lead halide perovskites, with a formula $CsPbX_3$ (X=Cl, Br, I) have triggered a great research interest as evidenced by an increasing number of publications[2]. For instance, in 2021, these materials inspired more than 570 articles partly due to their exciting properties (high quantum yields and absorption, adjustable emission across the entire visible spectrum, …). Their synthesis at room temperature has been made possible thanks to their intrinsic ionic nature, and their optical performances are currently comparable with those of nanocrystals obtained through other routes.

However, lead substitution is presently one of the major challenges, driven by an increasingly stringent regulation. In this context, the identification and synthesis of safer halides has motivated plenty of investigations in recent years[3]. If numerous candidates have been reported, manganese-based compounds remain under-researched. Contrary to $CsPbBr_3$, it seems that the antiperovskite Cs_3MnBr_5 gives rise to green emission with suitable quantum yields both at the micron-scale[4] and at the nanoscale[5].

In this work, the influence of particle size on optical properties of the two above mentioned halides will be discussed and compared. Micro and nanocrystals will be produced through an antisolvent precipitation method with or without capping agents, at room temperature, which has not yet been reported in the case of manganese compounds.

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Acknowledgment

This work was supported by the International Research Center « Innovation, Transportation, and Production systems » of the I-SITE CAP 20-25.

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

Thematic Session: Nanophotonics & Nano-optics
Keywords: Plasmonics, biosensors, TERS
Disciplinary fields involved: Physics, Biophysics

TERS Characterization of Functionalized Gold Nanostructure for Improved Biosensors

J-F Bryche[1,2], M. Vega[1,2,3], A. Tempez[4], T. Brulé[4], T. Carlier[4], J. Moreau[3], PG. Charette[1], M. Chaigneau[4], M. Canva[1,2]

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2. *Institut Interdisciplinaire d'Innovation Technologique (3IT), Sherbrooke, Canada*
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4. *Horiba FRANCE SAS, Palaiseau, France*

Plasmonic gold nanostructures are being used to develop high-performance biosensors. The confinement of electromagnetic fields far beyond the diffraction limit has led in recent design to single-molecule detection through surface-enhanced Raman spectroscopy (SERS) [1]. Tip-Enhanced Raman Spectroscopy (TERS) characterization, which has emerged as a powerful analytical technique providing high chemical sensitivity for surface molecular mapping with nanoscale spatial resolution, can provide nano-spatially resolved response and help in designing highly sensitive and high-resolution biosensing structures. This work examined the TERS performance of functionalized gold nanodisk arrays on a gold-coated glass substrate. These samples have shown results in SERS [2] upon coupled plasmonic modes: the gold layer sustains propagative surface plasmons while the nanostructures sustain localized surface plasmon resonances. Coupling between them can occur in specific conditions and give rise to hybrid modes [3]. Nano-resolved TERS response distribution from grafted thiophenol molecules on nanodisks of 110 and 220 nm diameter feature strong signal localization on the periphery of the nanostructures, in agreement with numerical modeling [4]. This highlights the importance of grafting molecules on high electric field locations to optimize detection sensitivity and speed at low molecular concentrations.

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[4] J-F Bryche, M. Vega, A. Tempez, T. Brulé, T. Carlier, J. Moreau, M. Chaigneau, PG. Charette, M. Canva. ***Nanomaterials***. 2022; 12(20):3586.

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

Thematic Session: Nanophotonics & Nano-optics
Keywords : Laser,VECSEL,Thermal management
Disciplinary field involved : Physics
Sustainable Development Goals* eventually involved in your research: -

Thermal management of VECSEL-GaAs for high-power single-mode emission

A.Harouri[1], F.Bouamrane[2], D.Bourrier[3], A. Garnache[4], N. Isac[1], G. Beaudoin[1], K. Pantzas[1], I. Sagnes[1]

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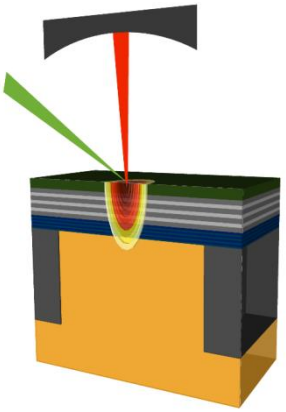
Information and communication technologies have revolutionized our world and reshaped our industries. Vertical emission in external cavity lasers (VECSEL) combine simultaneously high-power and highly coherent tunable single-frequency laser emission. VECSELs are promising candidates for various applications such as transmitter, sensors.

In our study, we are interested in reducing the thermal impedance of our ½ VECSELs on GaAs substrate, emitting between 800 and 1100nm. Part of the power of the optical pump is converted into a significant heating of the component. This heating reduces the gain of the QWs and induces a shift of the emission wavelength towards longer wavelengths [1]. In the literature, many strategies to improve the heat dissipation for ½ VECSEL are proposed [2][3]. In our case, our approach is to integrate a heat sink as close as possible to the Bragg mirror by dry etching and electrolytic metal growth. As a first step, we studied both the diameter of the aperture and the metal material to be used in order to have a good mechanical stability of the semiconductor structure while ensuring very good heat dissipation



Integrated heat sink on VESCSEL

References:

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Acknowledgment

The work was partly supported by the French Renatech network

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

Thematic Session: Nanophotonics & Nano-optics
Keywords: plasmonic nanoantenna, inverse Faraday effect, inverse design, light–matter interactions, ultrafast direct current
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: Affordable and Clean Energy (Goal 7)

Ultrafast Direct Currents Generated by an Inverse-designed Plasmonic Antenna

Ye Mou[1], Xingyu Yang[1], Bruno Gallas[1], Mathieu Mivelle[1*]

1. *Sorbonne Université, CNRS, Institut des NanoSciences de Paris, INSP, F-75005 Paris, France*

The inverse Faraday effect allows the magnetization of metals through the generation of stationary direct currents, known as drift currents, through optical excitation only [1,2]. This light–matter interaction results from the nonlinear forces that light applies to the conduction electrons in metals [1]. Here we demonstrate, via the manipulation of light in the near field by an inverse-designed plasmonic nanoantenna, the generation of ultrafast direct currents flowing in a single direction (Figure 1). Specifically, using a genetic algorithm based on topology optimization, we inversely design a plasmonic nanoantenna (Figure 1a), creating, through this optical rectification process and under circularly polarized light excitations only, an ultrafast direct current within the femtosecond range (Figure 1b). This ultrafast current is due to the generation of two opposite spin densities (different helicity of the light) on both sides of the plasmonic nanoantenna (Figure 1c) [3]. The results presented here are remarkable since the plasmonic approach is nowadays the only one allowing the generation of stationary currents flowing in the same direction at the nanoscale and at the femtosecond timescale [4]. This would find applications in ultrafast data storage and processing or terahertz junction detectors [5], for instance.

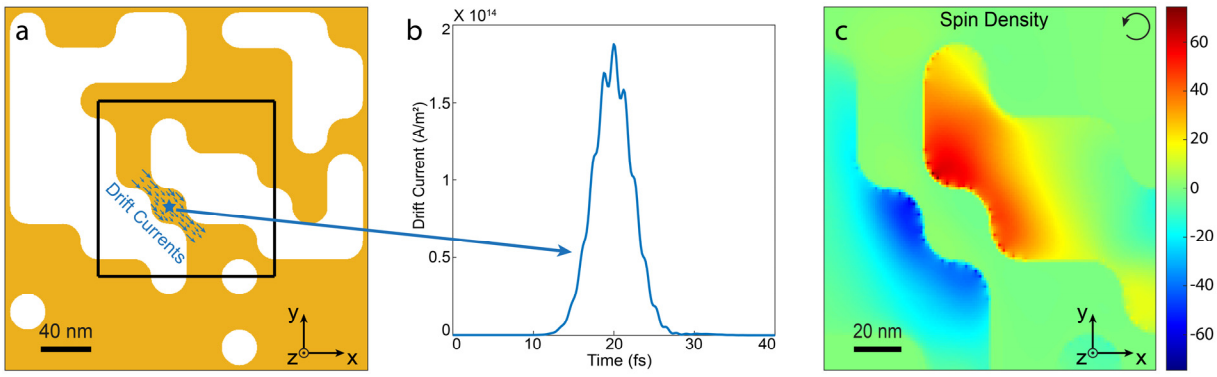

Figure 1. The inverse-designed plasmonic nanoantenna. a) Schematic, in an XY plane, of the GA-optimized nanoantenna. b) Time response of drift current at one point shown as the blue star in a). c) Spatial distribution of spin density oriented along Z and generated in the Z-center of the nanoantenna shown in a) under a right circular polarization of plane wave excitation with power density 10^{12} W/cm^2 and pulse length 5.3 fs.

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Acknowledgment:

We acknowledge the financial support from the Agence National de la Recherche (ANR-20-CE09-0031-01), from the Institut de Physique du CNRS (Tremplin@INP 2020). Two of the authors (Y.M. and X.Y.) acknowledge the support of the China Scholarship Council.

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

Thematic Session Nanophotonics & Nano-optics
Keywords: nanostructuration, fabrication, characterization
Disciplinary fields involved: Physics, Optics, Material science

Use of the OAD technique for high-efficiency nanostructured multilayer thin films polarizers

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The growing interest in real-time augmented imaging (hyperspectral or polarimetric) has recently led to the development of DoFP (Division of Focal Plane) polarimeters with several polarimetric filters placed directly on top of the photometric sensor. Metallic wire-grids are generally used because of their small thickness to polarize the incident light for polarimetric imaging, and are deposited directly on the sensors [1], usually in a matrix of four pixels, in order to capture several polarization directions. Unfortunately, wire-grid polarizers suffer from a poor extinction coefficient and low transmitted flux compared to thicker polarizers. The use of a new type of polarizer, known as a Polarimetric Filter by Reflection (PFR), can in theory remove a technological lock and achieve a very high extinction coefficient and close to no flux loss [2]. PFR can be realized by OAD (Oblique Angle Deposition), which enables the fabrication of porous and anisotropic thin films by controlling deposition parameters such as the deposition rate, the angle of incidence α or the azimutal rotation of the substrate φ (Fig. a). By finely controlling these parameters, it is possible to create thin films with different morphologies, such as Helical Columns (Fig. b) that exhibit properties for the circular polarization [3] or Anisotropic Normal Columns (Fig. c, d) that exhibit properties for the linear polarization. In addition, with the control of the α angle we can precisely control the porosity, making a wide range of optical indices in the three dimensions of the layers.

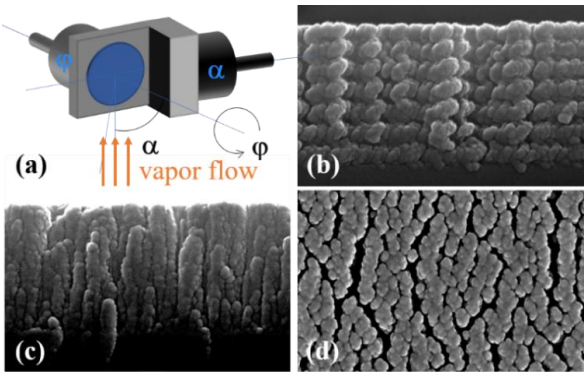

Fig: a) sample holder for OAD; b) cross section of Helical Columns; c) cross section and d) plane view of Anisotropic Normal Columns

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

Thematic Session: Nanoscale Heat Transfer
Keywords: radiative properties, black-silicon, thin-film coating, dual-functionality
Disciplinary field involved: Physics
Sustainable Development Goals* eventually involved in your research: Affordable clean energy (Goal 7), Clean water and sanitation (Goal 6), Reduced Inequality (Goal 10), Sustainalble cities and communities (Goal 11)

Impact of Ultra-thin-film Coatings on the Radiative Properties of Dual Functionality Black-Silicon

Elissa Akiki[1], Armande Hervé[1], Georges Hamaoui[1], Xiaoyi Liu[2], Frédéric Marty[1], Philippe Basset[1], Elyes Nefzaoui[1,*], Tarik Bourouina[1,3]

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Abstract

Black Silicon is well-established for its low reflectance and high absorptance from the visible range to the band-gap limit at 1,1 µm [1]. Further functionalization by means of doping and/or ultra-thin film coating led to the extension of the spectral range up to 2.5 µm. Our group recently demonstrated ultra-black silicon over a ultra-broadband spectrum up to 20 µm [2], and applications to energy-passive water desalination by enhanced steam generation [3] and to atmospheric water harvesting [4] based on radiative cooling.

The two latter applications require not only excellent emissive properties but they also require the control of the wetting properties, for providing additional funcationality of the surface to behave either superhydrophobic or hydrophilic [5]. The control of those wetting properties is enabled by coating the black-silicon with an ultra-thin film of a functional material such as Teflon or silicon dioxide, respectively. However, such coating may have an impact on the degradation of the intrinsically excellent radiative properties of pristine black-silicon, with respect to absorptance level and wavelength range.

In this paper we report on dual functionality optofluidic black silicon surfaces. More specifically, we elaborate on the impact of ultra-thin film coating on the resulting radiative properties of black-silicon. Different materials are considered along different coating techniques including Atomic Layer Deposition (ALD) and Physical Vapor Deposition (PVD).

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THE NANOSCIENCE MEETING
Poitiers
March, 15, 16 and 17
2023

Thematic Session: Nanoscale Heat Transfer
Keywords: Pump-probe spectroscopy, nanoscale heat transfer, 2-Temperatures model, gold nanostructures, plasmonics.
Disciplinary field involved: Physics

Nanoscale Heat Anisotropy in Gold Nanocrosses

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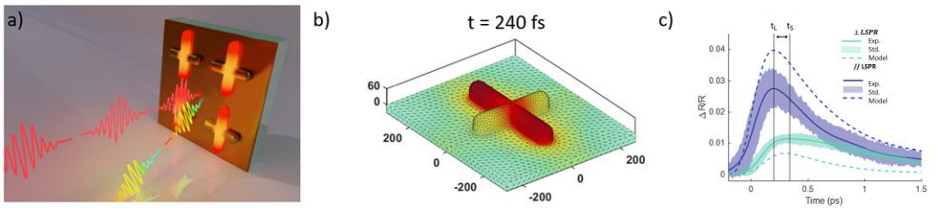
Nanoparticles (NPs) can absorb and convert light into heat, making them useful as localized sources of heat. However, the dynamics of heat distribution inside NPs must be better understood and modelled. This is a challenging task due to the time and space scale involved in the photothermal process (femtosecond and nanometer scale). In this work, we predict with our numerical model [1] heat transfer inside cross-shaped gold nanoparticles and confirm it with femtosecond transient spectroscopy measurement. This NP geometry is known to support a polarization dependent localized plasmonic resonance (LSPR) along each of its branches. By selectively exciting one LSPR, we can heat only the wished branch, then, the heat will propagate along the other branch. By measuring the temporal delay between the modulation of LSPR intensity of each branch, we put in evidence the thermal inhomogeneity inside the cross-shaped NP. Good agreement was found between simulations and experiments. An illustration of the experiment is shown in figure 1.a. Figure 1.b shows a simulation of the asymmetric electronic temperature distribution reached inside the nano cross few femtoseconds after the excitation. Figure 1.c shows the measured optical response delay between the longitudinal and transverse LSPR.



Reference:
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Poitiers
March, 15, 16 and 17
2023

Map of Stands & Posters Exhibition