Rencontres Jeunes du C'Nano Grand-Sud-Ouest

EN LIGNE

7 juillet 2022

Programme & Abstracts

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Horaire : 14h – 17h
Format : visioconférence

PROGRAMME

13h45 – Accueil et présentation du C'Nano

14h00 – Remise du Prix C'Nano Grand-Sud-Ouest

14h25 – Conférence de Laura Thévenard (CNRS – INSP)
"Magneto-acoustics : how nano-earthquakes can control the magnetization"

15h05 – 15h15: PAUSE

15h15 – Présentations des doctorant.e.s

- **Lijun ZHANG,** (China Scholarship Council – LCC)
  "Wavelength-tunable resonances in plasmonic nanocavities using a molecular spin-crossover film"
- **Quentin GRESIL, (**CNRS– LP2N**)**
  " Extended depth-of-field single-particle-tracking for the nanoscale exploration of the brain extracellular space"
- **Felipe WASEM KLEIN,** (Université de Montpellier – LCC)
  " Synthesis of MoS2 by DLI-CVD as a method for obtaining a high photoluminescent layer on wafer-scale"
- **Auriane BAGUR,** (Université de Bordeaux – CRPP)
  "DNA mediated self-assembly of patchy nanoparticles"

16h30 – Clôture de l'événement

Abstracts disponibles ci-dessous

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Résumé de Laura THEVENARD

(CNRS – INSP)

Rencontres Jeunes
du C'Nano Grand-Sud-Ouest
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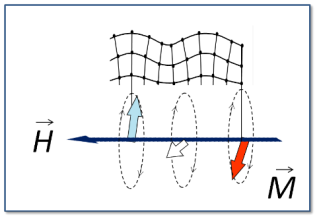
First Name, Family Name: Laura, THEVENARD
Title: Directrice de Recherche
Employer, Laboratory: CNRS, Institut des Nanosciences de Paris
City: Paris

Magneto-acoustics : How nano-earthquakes can control the magnetization

Abstract

Based on an intrinsically quantum concept, spin, magnetism is all around us, from motors to computers, up to medical diagnosis systems. I will briefly go over some key magnetism and magnetic resonance phenomena, highlighting the material parameters governing two properties relevant for both applications and fundamental physics: the time-scales involved, and relaxation phenomena. I will then give an overview of the different approaches followed to actuate on the magnetization, i.e to trigger magnetization dynamics, or even fully reverse a magnetic state, a particular crucial point for the magnetic data storage industry. These naturally fall into remote/local, resonant/non-resonant categories. I will stress the importance of resonant coupling in solid state physics, drawing upon examples of nanoscience and nanotechnology.

I will then describe in more detail the work we have been doing at INSP, using more particularly Rayleigh surface acoustic waves travelling on nanometric films of ferromagnetic semiconductors. Weakly attenuated waves travelling at the surface of a semi-infinite medium, the sub-Hertz waves are typically those responsible for earthquakes. In the GHz range, they are widely used in the fields of semiconductors physics, nanophotonics, quantum optomechanics, as well as magnetism. I will show how their resonant coupling to magnetic eigenmodes can be used passively to probe magnetic phenomena or actively to switch magnetization [1,2], but can also be an interesting tool to tune properties of the acoustic waves themselves, for signal processing or sensing applications for instance.



[1] L. Thevenard, C. Gourdon et al., Phys. Rev. B 90, 094401 (2014).
[2] P. Kuszewski, J.-Y. Duquesne, L. Becerra et. al., Phys. Rev. Appl. 10, 034036 (2018).
[3] M. Kraimia, P. Kuszewski, J.-Y. Duquesne et al., Phys. Rev. B 101, 144425 (2020)
[4] J.-Y. Duquesne, P. Rovillain, C. Hepburn, M. Eddrief, P. Atkinson, A. Anane, R. Ranchal, and M. Marangolo, Phys. Rev. Applied 12, 024042 (2019)

Keywords (4-5) : Surface acoustic waves (SAWs), ferromagnetism, magneto-optical effects, magnetic resonance

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Résumé de Mario Alfonso PIEDRAHITA BELLO

(CNRS-LCC)

Rencontres Jeunes
du C'Nano Grand-Sud-Ouest
EN LIGNE
7 juillet 2022

First Name, Family Name: Mario Alfonso, PIEDRAHITA BELLO
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Supervisor(s): Lionel Salmon, Bertrand Tondu
City: Toulouse

Fabrication of spin crossover nanocomposites and devices for electromechanical applications

Abstract
In order to synergistically exploit the volume change of spin crossover (SCO) materials, polymeric SCO composite materials were fabricated thanks to molecular engineering and nanosciences. These materials were conceived with two applications in mind: thermal energy harvesting and artificial muscles. Regarding thermal energy harvesting applications, a series of SCO@P(VDF-TrFE) composites were elaborated. The volume change of the spin crossover phenomenon activates the piezoelectric P(VDF-TrFE) copolymer matrix when thermally stimulated. This leads to a current discharge at the spin transition temperatures, showing a synergistic effect between the piezoelectric polymer matrix and the SCO filler material. These materials can thus be used to recover electrical energy from small thermal excursions around the spin transition temperature. Regarding the fabrication of materials for the development of artificial muscles, a bilayer approach was used to amplify the effect of the volume change associated with the SCO phenomenon. Two different strategies were used to obtain these bilayer materials: 3D printing and solvent casting. 3D printing techniques allowed for the reproducible fabrication of SCO printed composites with very high control over their morphology, allowing us to obtain geometries never before seen for this kind of materials. Thermally activated bilayer actuators were successfully fabricated and their mechanical properties proved competitive with other materials in the field. Solvent casting techniques allowed us to obtain electrically conductive SCO bilayer actuators. These actuators were optimized via smart material design by the inclusion of aligned anisotropic spin crossover nanoobjects. These devices, electrically activated via Joule effect, are highly controllable, and closed-loop operation showed that they are highly resilient, robust, precise and efficient. A gripper demonstrator device was thus fabricated, showing the applicability of these materials in robotic devices. Finally, we successfully fabricated composite materials which exploit the volume change of the SCO phenomenon and which have applicability in electromechanical devices.

Keywords (4-5): Spin, crossover, Nanocomposites, Actuators,Polymers

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Résumé de Lijun ZHANG

(CHINA SCHOLARSHIP COUNCIL- LCC)

Rencontres Jeunes du C'Nano Grand-Sud-Ouest

EN LIGNE

7 juillet 2022

First Name, Family Name: Lijun, ZHANG
Title : PhD student 2nd year
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Supervisor(s): Gabor Molnar, Karl Ridier, Lionel Salmon
City: Toulouse

Wavelength-tunable resonances in plasmonic nanocavities using a molecular spin-crossover film

Abstract

Molecular spin-crossover (SCO) compounds represent a promising novel class of phase-change materials with high potential for active photonics applications.[1,2] These transition metal complexes display reversible switching between their low-spin (LS) and high-spin (HS) electronic configurations under various external stimuli (such as temperature, pressure, light radiation, etc.). This switching of the molecular spin state is accompanied by a sizeable change of the optical properties and, in particular, of the refractive index of the material (Δn = 0.2–0.04 in the UV-Vis-NIR spectral ranges). [3]

In this work, we harness this refractive index switching between the LS and HS states in molecular thin films of the SCO complex [Fe(HB(1,2,4-triazol-1-yl)3)2], which display an abrupt and well-reproducible spin transition around 65°C, to fabricate wavelength-tunable Ag/SCO plasmonic nanocavities. As shown in Figure 1, the resulting cavities show spectrally tunable resonances due to the spin-crossover phenomenon, providing scope for photonics applications such as switches, sensors, etc.

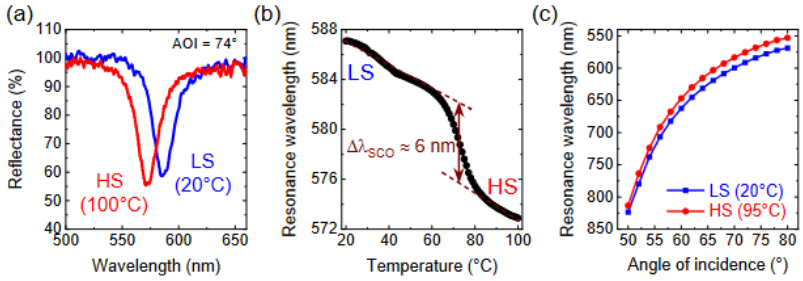

Figure 1. (a) Angle-dependent reflectance spectra of a Ag (73 nm)/SCO (42 nm) plasmonic cavity at 20°C (LS state) and 100°C (HS state). (b) Temperature dependence of the resonance wavelength. (c) Dispersion curves of the cavity in the LS and HS states.

References

[1] G. Molnar, et al., Adv. Mater. 30, 17003862 (2018)
[2] G. Félix, et al., J. Am. Chem. Soc. 133, 15342 (2011)
[3] Y. Zhang, et al., J. Mater. Chem. C 8, 8007 (2020)

Keywords (4-5) : spin-crossover, phase-change materials, plasmonic cavity, active plasmoics

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Résumé de Quentin GRESIL

(CNRS - LP2N)

Rencontres Jeunes
du C'Nano Grand-Sud-Ouest
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7 juillet 2022

First Name, Family Name: Quentin, GRESIL
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Employer, Laboratory: CNRS, Laboratoire Photonique, Numérique et Nanosciences
Supervisor(s): Laurent Cognet
City: Bordeaux

Extended depth-of-field single-particle-tracking for the nanoscale exploration of the brain extracellular space

Abstract
The brain extracellular space (ECS) is a heterogeneous and complex maze delimited by cellular walls where ions and signaling molecules diffuse. Recent progress in single-particle-tracking of fluorescent probes enables the nanoscale exploration of the ECS and has demonstrated that brain pathology alters the topology and rheology of the ECS [1]. Yet, detecting fluorescent nanoparticles using conventional single-particle-tracking is restricted to the imaging focal plane, contributing to broaden apparent diffusion coefficient distributions [2]. In this work, we perform single-particle-tracking using a bi-annular phase mask [3] that lengthens the point-spread function (PSF) in the axial direction over five microns. As such, the engineered PSF permits imaging diffusing nanoparticles in a volume without adapting the tracking algorithm. We demonstrate that the extension of the depth-of-field allows for elongated trajectories and apply this method to the nanoscale exploration of the ECS.

[1] Soria, F.N., Paviolo, C., Doudnikoff, E. et al. Synucleinopathy alters nanoscale organization and diffusion in the brain extracellular space through hyaluronan remodeling. Nat Commun 11, 3440 (2020).
[2] Saxton, M.J. Single-Particle Tracking: The Distribution of Diffusion Coefficients. Biophysical Journal 72, no 4 1744-53 (1997).
[3] Olivier Lévêque, Caroline Kulcsár, Antony Lee, et al. Co-designed annular binary phase masks for depth-of-field extension in single-molecule localization microscopy. Opt. Express 28, 32426-32446 (2020).

Keywords (4-5) : Single-particle-tracking, diffusion, phase masks, extracellular space

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Résumé de Felipe WASEM KLEIN

(Université de Montpellier – L2C)

Rencontres Jeunes
du C'Nano Grand-Sud-Ouest
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7 juillet 2022

First Name, Family Name: Felipe, WASEM KLEIN
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Supervisor(s): Périne Landois & Matthieu Paillet
City: Montpellier

Synthesis of MoS_2 by DLI-CVD as a method for obtaining a high photoluminescent layer on wafer-scale

Abstract

Monolayer MoS2 has many potential applications due to its semi-conductor nature with a direct band gap, allowing it to be used in next-generation optoelectronic and switching devices [1,2]. Among other techniques, chemical vapor deposition (CVD) is often used for the synthesis of this material, usually resulting in the deposition of triangular flakes of MoS_2 onto a substrate [1,3,4]. However, challenges are still present for large scale applications, specially related to increasing flake size and density, as well as creating reproducible protocols for its synthesis [4]. We demonstrate the synthesis of an inch scale homogeneous deposit of MoS_2 on Si/SiO2 substrates through Direct Liquid Injection (DLI-CVD) [5]. Using this method, it was possible to control the thickness and surface coverage, as demonstrated by spectroscopy (Raman, optical reflectance, photoluminescence) and microscopy (optical, AFM) techniques. Especially, optimization of the thickness around the monolayer results in a photoluminescence (PL) yield of the same order of magnitude as the exfoliated monolayer (Figure 1). The high quality of the synthesized layer as well as the possibility to easily adapt this technique to different substrates may make it a useful tool for future applications.

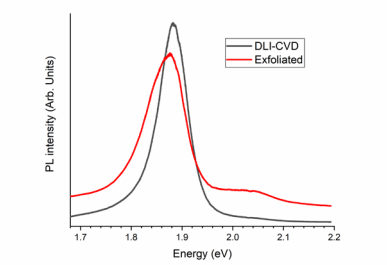

Figure 1: PL intensity of the MoS2 obtained through DLI-CVD (black) compared to that of exfoliated 1L MoS2 (red)

References:

[1] Li, X. and Zhu, H. J. Mater. 2015 [2] Gupta, D. *et al.*, R., Inorg. Chem. Commun. 2020
[3] Cai, Z. *et al.*, Chem. Rev. 2018 [4] Seravalli, L. and Bosi, M., Materials (Basel). 2021
[5] Astié, V. *et al.*, IntechOpen 2019

Keywords (4-5) : Molybdenum disulfide, 2D materials, DLI-CVD, optical properties

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Résumé d'Auriane BAGUR

(Université de Bordeaux- CRPP)

Rencontres Jeunes
du C'Nano Grand-Sud-Ouest
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7 juillet 2022

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Supervisors: Etienne Duguet, Serge Ravaine, Etienne Duct
City: Bordeaux

DNA mediated self-assembly of patchy nanoparticles

Abstract

The self-assembly of nanoparticles into well-organized nanostructures has attracted strong interests over the last decade as a strategy to access elusive materials with exciting electronic or photonic properties [1]. In this context, building blocks with designed geometries and encoded directional interactions, like patchy particles, are the starting point of such self-assembly pathways [2]. We report here a synthetic strategy to silica nanoparticles of ~100 nm presenting either entropic or enthalpic patches. This route includes sol-gel nucleation and growth, and seed-growth emulsion polymerization of styrene, allowing a fine control of the number and location of patches. Typically, a morphological yield of 97 % was obtained for bipods, particles presenting two slightly crosslinked PS nodules at their surface [3]. To guide the assembly, we rely on DNA coatings as a programmable glue to encode the interactions between particles. To that mean, an amphiphilic azide terminated block copolymer (PS-PEO) is trapped at the surface of a polystyrene patch through a selective swelling-deswelling process with THF. DBCO-terminated DNA strands are then coupled to the resulting azidated patches via a SPAAC reaction. We show that these DNA-coated patchy nanoparticles can reversibly self-assemble upon thermal annealing [4]. We envision the assembly of colloidal chains of precise sequence and morphologies, as well as 2D and 3D lattices, depending on the shape and specific coatings of the building blocks.

References

[1] X. Bouju et al, Adv. Mater. 30 (2018) 1706558.
[2] W. Li et al, Chem. Soc. Rev. 49 (2020) 1955.
[3] B.Liu et al, ACS Macro Lett. 11 (2022) 156-160.
[4] J. Oh et al, Nat. Commun. 10 (2019) 3936

Keywords (4-5): Patchy nanoparticles, Self-assembly, DNA