C'NANO 2018
THE NANOSCIENCE MEETING
TOULON December, 11, 12 and 13
Palais des Congrès Neptune
In partnership with: Club nanoMétrologie LNE RENATECH

Laurence, Masson
Professor at Aix Marseille University
CINaM Laboratory (Aix Marseille Université, CNRS)
Campus de Luminy case 913- 13288 Marseille cedex 9 France
Website: http://www.cinam.univ-mrs.fr/cinam/index.php
Email: masson@cinam.univ-mrs.fr

Biography

Prof. Laurence Masson obtained her thesis in solid state physics in 1994 (University Paris-Sud – Orsay) and defended her HDR diploma in materials science in 2007 (Aix-Marseille 2 University). She is head of the "Nanomaterials" research department at CINaM and the coordinator of the master's degree Nanoscience and Nanotechnology, recently implemented at AMU. She is also currently member of the department of physics' council of Aix Marseille University.

She is specialist of nanopatterning of templates using bottom-up approaches and scanning probe microscopy for nanoscale structural characterization. Her main field of interest concerns the elaboration of ultrathin films and self-organized nanostructures on metal and semiconductor surfaces with potential original structural, electronic and magnetic properties. She is co-author of 43 publications in international peer-reviewed journals.

SURFACE TEMPLATED GROWTH OF NANOSTRUCTURES

Nanostructuring of surfaces using their intrinsic structural properties has received great interest over the last past two decades, with the aim at creating atomically controlled large scale templates. This step of nanopatterning is a promising route to produce by template-directed growth high densities of true atomic dimension nanostructures with controlled geometries, regular sizes and spacings and specific physical properties related to their structure. The method applies for inorganic nanostructures and more recently for molecular arrangements.[1-4] Moreover, the properties of interest of these highly dense and uniform surface-supported nanostructures such as electronic, optical or magnetic properties can be investigated using either local probes or integrating techniques.

In a first part, significant examples of surface nanopatterning will be presented. It will be shown that a high degree of structural control can be achieved in the subsequent growth of nanostructures. In a second part, recent results concerning the epitaxial growth of nanopatterned 2D Si layers on the anisotropic Ag(110) surface will be presented.[5] These layers correspond to self-assembled nanoribbons exhibiting an original Si phase composed of pentamer chains lying in the missing rows of the reconstructed surface.[6] Finally, it will be shown that this highly perfect nanoscale template can be advantageously used for the self-organized growth of transition metal nanolines exhibiting magnetic properties.[7]

References: [1] H. Brune, M. Giovannini, K. Bromann and K. Kern, Nature **394**, 451 (**1998**); **[2]** P. Gambardella, A. Dallmeyer, K. Maiti, M. C. Malagoli, W. Eberhardt, K. Kern and C. Carbone, Nature **416**, 301 (**2002**); **[3]** S. Clair, S. Pons, H. Brune, K. Kern and V. Barth Johannes, Angew. Chem. **44**, 7294 (**2005**); **[4]** Q. Fan, J. Dai, T. Wang, J. Kuttner, G. Hilt, J. M. Gottfried and J. Zhu, ACS Nano **10**, 3747 (**2016**); **[5]** M. Daher Mansour, R. Parret and L. Masson, J. Vac. Sci. Technol. A **36**, 061402 (**2018**); **[6]** G. Prévot, C. Hogan, T. Leoni, R. Bernard, E. Moyen and L. Masson, Phys. Rev. Lett. **117**, 276102 (**2016**); **[7]** L. Michez, K. Chen, F. Cheynis, F. Leroy, A. Ranguis, H. Jamgotchian, M. Hanbücken and L. Masson, Beilstein J. Nanotechnol. **6**, 777 (**2015**)

Keywords: Surfaces, self-assembly,1D nanostructures, ultrathin films, atomic structure, nanomagnetism scanning tunneling microscopy, grazing incidence x-ray diffraction, x-ray magnetic circular dichroism

11, 12 & 13 septembre
Session (Nanomaterials)
On-surface reactions, nanowires, Scanning Tunneling Microscopy

On-surface Synthesis of Molecular Nanowires

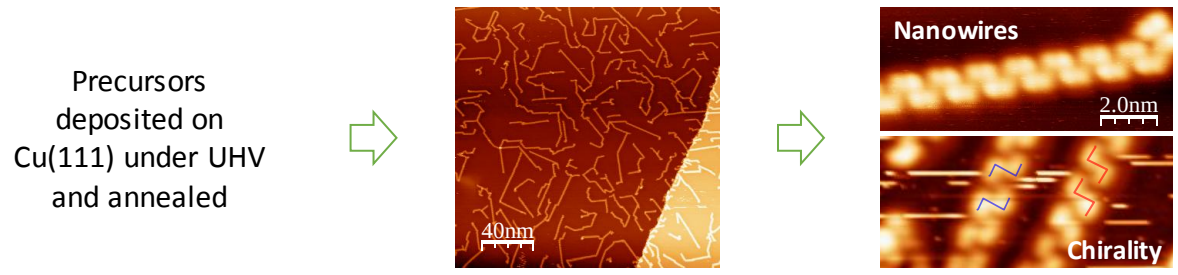
A. Lombana[1,2], K. Gratzer[1,2], L. Nony[1], F. Bocquet[1], F. Para[1], C. Loppacher[1], L. Giovanelli[1], T. S. Balaban[2], O. Chuzel[2], J.-L. Parrain[2] and S. Clair[1]

1. Aix Marseille Univ, Univ Toulon, CNRS, IM2NP, Marseille, France
2. Aix Marseille Univ, CNRS, Cent Marseille, ISM2, Marseille, France

andres.lombana@im2np.fr

Research and applications in nanoscience rely on the elaboration of highly-organized nanostructures. On the one hand, molecular self-assembly on planar surfaces provides means to tailor soft matter into networks from nanometrically defined units. On the other hand, practical applications of this concepts require robust systems and electronic communication between molecules. For these reasons, the field of on-surface reactions and formation of covalent molecular networks has gained great interest in the last years [1] and numerous on-surface reactions involving heteroatoms [2,3] or featuring C-C couplings [4] have been demonstrated recently.

We have synthesized an original carbazole precursor containing a 1,1-dichloroalkene moiety and deposited it on Cu(111) surface in ultrahigh vacuum (UHV). Scanning Tunneling Microscopy (STM) studies show that the molecule readily forms chiral nanowires after annealing. However, the obtained STM images cannot be explained by polymers bearing covalent bonds only. In fact, X-ray Photoemission Spectroscopy shows that the chemical nature of the nitrogen on the molecule changes after adsorption which could be explained by coordination to copper adatoms.



All our evidence points towards the formation of a novel covalent/coordination polymer. Future studies will deal with the nature of the coordination bonds, with the origins of the observed chirality.

References:
[1] J. V. Barth, *Annu. Rev. Phys. Chem.* 58, 375 (2007).
[2] S. Clair, M. Abel, L. Porte, *Chem. Commun.* 50, 9627 (2014)
[3] G . Franc, A. Gourdon, Phys. *Chem. Chem. Phys.* 13, 14283 (2011).
[4] Q. Sun, V. Tran, L. Cai, H. Ma, X. Yu, C. Yuan, M. Stöhr, W. Xu, *Angew . Chem.* 129, 12333 (2017).

Congrès 2018, Toulon

11, 12 & 13 septembre
Session Nanophysics and nanochemistry on surfaces
Keywords: nano-island, charge transfer, NC-AFM, KPFM

Controlling the electric charge of gold nanoplatelets on an insulator by field emission nc-AFM

B. BARIS[1], M. ALCHAAR[1,2], J. PRASAD[1], S. GAUTHIER[1], E. DUJARDIN[1] and D. MARTROU[1]

1. *Centre d'élaboration de matériaux et d'études structurales, CEMES-CNRS, UPR 8011, Nanosciences Group, 29 rue Jeanne Marvig, F-31055 Toulouse, France*
2. *Université Toulouse III, UPS, 118 route de Narbonne, F-31062 Toulouse, France*

Flat metallic islands on an insulating substrate can be used as electrons reservoir to contact a molecule or a graphene nanoribbon in a planar geometry for molecular applications. The challenge is then to stabilize the charge on a metallic nanocrystal for a time long enough to perform in-plane operations. Here, we report on the controlled charging in UHV environment of 2D Au nanocrystals deposited on a SiO_2 insulating substrate. We image the platelets in the nc-AFM mode [1] and characterize their charge state by Kelvin Probe Force Microscopy (KPFM) [2,3]. Our results demonstrate that the charge can be controlled by electron field emission to or from the tip of a nc-AFM by monitoring Δf(V) spectroscopy curves. The procedure works for both polarities, electrons being emitted by the tip or the substrate. As shown by an analytical model and complementary numerical simulations, the rise of the island's potential upon charging leads to a constant charging current and tip-island electric field [4]. Our measurements suggest that this method can be used to set the island's potential with a single-electron precision. The procedure is robust and opens the way to original experiments, such as establishing a bias at the extremities of a molecule connected between two islands or exploring locally the charge leaking mechanisms across an insulating layer.

References

1. F. J. Giessibl, Rev. Mod. Phys. **75**, 949 (2003).
2. M. Nonnenmacher, M. P. O'Boyle, and H. K. Wickramasinghe, Appl. Phys. Lett. **58**, 2921 (1991).
3. Shin'ichi Kitamura and Masashi Iwatsuki, Appl. Phys. Lett. **72**, 3154 (1998).
4. B. Baris *et al.*, Appl. Phys. Lett. **112**, 113101 (2018)

11, 12 & 13 septembre
Nano-optics, nanophonics and plasmonics
Keywords: wavefront shaping, plasmonics, local enhanced fields, disordered metasurface

Far-field wavefront optimization of the optical near-field in nanoscale disordered plasmonic metasurfaces

G. Roubaud[1], S. Bidault[1], S. Gigan[2], S. Gresillon[1]

1. Institut Langevin, ESPCI Paris, PSL Research University, CNRS, Sorbonne Université, Paris
2. Laboratoire Kastler Brossel, ENS, CNRS, Sorbonne Université, Paris, France

Plasmonic nanoantennas featuring nanoscale gaps can exhibit strongly enhanced optical near-fields that have been extensively used in surface enhanced spectroscopy (Raman and Fluorescence) and in biosensing. However, deterministic nanostructures do not provide numerous degrees of freedom to control optically these local field enhancements. By comparison, wavefront shaping techniques in disordered scattering media provide numerous degrees of freedom to control light focusing in space and time [1]. To associate local field enhancements and far-field wavefront control, we use disordered plasmonic surfaces close to the percolation threshold that feature both hotspots [2] and delocalized plasmon modes that can be controlled using a spatial light modulator [3].

In this presentation, we demonstrate how controlling the phase of an incoming femtosecond pulsed laser on a disordered gold surface allows us to optimize the two-photon induced luminescence (TPL) at a chosen position. Importantly, the TPL signal has been shown to provide a far-field image of local field enhancements in nanoantennas [4]. Our results therefore demonstrate a far-field optimization of the optical near-field in disordered plasmonic metasurfaces.

The average TPL intensity enhancement reaches 30 for disordered metal metasurfaces that are close to percolation. When the filling fraction of gold is far from percolation, the enhancement factors decrease dramatically, demonstrating that the morphology and level of disorder at the nanoscale of the plasmonic surface play an essential role. Furthermore, we show that TPL intensities can be enhanced at any position of a percolated film. These results open exciting perspectives for the wavefront engineering of plasmonic hot-spots in nanoscale disordered metasurfaces.

[1] M. Mounaix, D. Andreoli, H. Defienne, G. Volpe, O. Katz, S. Grésillon, S. Gigan, Phys. Rev. Lett. 116, 253901 (2016).

[2] S. Grésillon and al, Phys. Rev. Lett. 82, 4520 (1999).

[3] P. Bondareff, G. Volpe, S. Gigan and S. Gresillon, ACS Photonics 2, 12 (2015).

[4] P. Ghenuche, S. Cherukulappurath, T. H. Taminiau, N. F. van Hulst, and R. Quidant, Phys. Rev. Lett. 101, 116805 (2008)

Congrès 2018, Toulon

11, 12 & 13 septembre
Session Nano Materials
Keywords: Carbon Nanotubes, Synthesis, Selectivity, Modeling

Growth modes and chiral selectivity of Single-Walled Carbon Nanotubes

Y. Magnin[1], H. Amara[2], F. Ducastelle[2], A. Loiseau[2] and C. Bichara[1]

1. *Aix Marseille Univ, CNRS, CINaM, Campus de Luminy, Case 913, 13288, Marseille, France*
2. *Laboratoire d'Etude des Microstructures, ONERA-CNRS, UMR104, Université Paris-Saclay, BP 72, 92322 Châtillon Cedex, France*

Recent experimental progress [1, 2] in the selective synthesis of Single Walled Carbon Nanotubes (SWNTs) have lead us to revisit our understanding of their formation mechanisms. Driven by the properties of the interface between the tube and the catalyst, perpendicular and tangential growth modes have been identified [3], the former giving rise to an enhanced selectivity [4]. In order to identify catalysts enabling a selective SWNT growth, we developed a thermodynamic modeling of the tube / catalyst interface [5]. It shows that, at low temperature, only zigzag or armchair tubes are stable. Chiral tubes become stable at higher temperature because of the configurational entropy of the tube edge in contact with the catalyst, that is a key element of the model. This enables us to produce chiral stability maps and phase diagrams to link the catalyst interfacial properties and the temperature with the resulting equilibrium chiral distribution. It accounts for number of experimental observations (near armchair distributions, temperature evolution of the chiral distributions, ⋯) and suggests ways to design new, selective catalysts.

References:

[1] Yang, F. *et al.* Nature **510,** 522‑524 (2014).
[2] Wang, J. *et al.* Nat. Catal. **1,** 326‑331 (2018).
[3] Fiawoo, M.-F. C. *et al.* Phys. Rev. Lett. **108,** 195503 (2012).
[4] He, M. *et al.* Nanoscale **10**, 6744, (2018)
[5] Magnin Y. *et al.*, Science, to be published (Oct. 2018) - https://arxiv.org/abs/1803.07350