# CONFERENCE HANDBOOK

# ESCC 2024

## 19th EUROPEAN STUDENT COLLOID CONFERENCE

BORDEAUX 24-27 JUNE, 2024

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# Introduction

**Welcome!**

The European Colloid & Interface Society (ECIS), the University of Bordeaux (UBx) and the Centre national de la recherche scientifique (CNRS) organize the 19th European Student Colloid (ESC) Conference in Bordeaux, FRANCE, from 24 to 27 June 2024.

After having been organized in many wonderful places in Europe, the ESC Conference is back to France, 27 years after its successful edition held in Strasbourg in 1996. These bi-annual meetings are dedicated to motivated students at PhD and MSc level and postdocs, who are conducting research at a European university or in collaboration with European research groups. The aim of these meetings is to enable students and postdocs to present their work to their peers and to promote scientific and social interaction.

The program will include **7 plenary lectures and 2 parallel sessions** on topics at the interface of various research areas in colloidal science, nanotechnology, polymers…

**Moreover, around 100 additional scientific contributions are expected** through oral and poster presentations.

I wish you a pleasant and scientifically stimulating congress!

Serge Ravaine

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# ABSTRACTS
# OF
# PLENARY SPEAKERS

# Plenary Speakers

## Marleen KAMPERMAN

Professor

*University of Groningen, The Netherlands*

### BIOGRAPHY

Marleen Kamperman heads the Polymer Science group within the Zernike Institute for Advanced Materials at the University of Groningen. Her group focuses on the bioinspired design of polymeric materials. She is particularly interested in mimicking spider silk processing, using microfluidics to understand the design rules and using novel 3D printing techniques to produce the bioinspired silk. Kamperman received her PhD in Materials Science & Engineering from Cornell University, Ithaca, NY, where she worked in the group of Prof. dr. Wiesner. From 2008 to 2010, she was a postdoctoral researcher in the Functional Surfaces group of Prof. dr. Arzt at INM – Leibniz Institute for New Materials in Saarbrücken, Germany. She started her group 'Bioinspired Functional Polymers' as Assistant Professor at Wageningen University in the Physical Chemistry and Soft Matter department in September 2010. In 2018 she was appointed Full Professor in Polymer Science at the University of Groningen.

### BIOINSPIRED ADHESIVES: A COMPLEX (COACERVATE) AFFAIR

Adhesive technology in orthopaedic medicine has great potential, but it remains challenging because of the wet and dynamic environment inside the body. In the aquatic world, several organisms have developed strategies to overcome very similar challenges as the adhesion problems faced by biomedical adhesive developers. These organisms are able to bond dissimilar materials together under seawater using protein-based adhesives. In this talk I will present our efforts mimicking the adhesive secretions of marine animals such as P. californica (sandcastle worm) and M. edulis (mussel) by creating synthetic polymeric systems or by using biopolymers. Characteristic of the proteins found in the adhesive plaque of mussels and sandcastle worms is a high proportion of cationic, anionic and catecholic residues. The anionic and cationic residues are often said to be involved in a secondary interaction that aids cohesion, namely complex coacervation. This is an attractive phase separation of mixtures of polyanions and polycations that results in a highly polyelectrolyte-rich phase in equilibrium with almost pure solvent. For a given polyelectrolyte couple, depending on the salt concentration of the medium, a complex coacervate either behaves as a free-flowing viscoelastic fluid or a rigid polyelectrolyte complex solid or anything in between. This outstanding versatility has made polyelectrolyte complexes good candidates for underwater adhesives. We aim to reproduce the working mechanism of mussels and sandcastle worms by developing a new class of underwater adhesives based on complex coacervates reinforced with physical interactions.

## Pawel MAJEWSKI

Professor
*University of Warsaw, Poland*

### BIOGRAPHY

Pawel Majewski is a professor in the Department of Chemistry at the University of Warsaw, Poland. He received his PhD in Chemical Engineering from Yale University in 2013 for studies of anisotropic charge transport in magnetically-ordered soft materials under the guidance of Prof. Chinedum Osuji. In the same year, he joined Prof. Oleg Gang's group at Brookhaven National Laboratory where he worked as a postdoctoral researcher under the supervision of Dr. Kevin Yager investigating laser-induced self-assembly of BCP thin films using synchrotron X-ray scattering methods. Since 2016 he has been leading an experimental group that focuses on structure and functional properties of soft materials at the University of Warsaw. His research interests include studies of photothermally directed self-assembly of block copolymers and liquid crystals, development of rapid methods for BCP patterning, and soft-material templated synthesis of functional nanostructured materials.

### PHOTOTHERMAL EFFECTS IN DIRECTED SELF-ASSEMBLY, SHAPING AND ACTUATION OF FUNCTIONAL SOFT MATERIALS

Illumination with an intense beam of light can be used as a convenient method to locally heat up a material and alter its internal structure by inducing local melting, recrystallization, or enhancing the mixing and diffusion of additives and dopants. In my talk, I am focusing on soft materials, including polymers, liquid crystals, and polymer-colloid hybrids, whose self-assembly can be controlled by laser light. In particular, the first discussed example is the self-assembly and photothermal alignment of block-copolymer (BCP) thin films, where laser-induced temperature gradients are utilized to guide otherwise defective morphologies into uniaxially ordered anisotropic domains. Such ordered BCP films can be further used as a convenient synthetic templates for aligned arrays of metallic or metal oxide nanowires.[1][2] The second example are liquid crystal (LC) thin films formed by molecules spontaneously forming chiral, right- or left-handed supramolecular helical arrangements displaying strong optical activity (circular dichroism and circular birefringence). I show how spatially-modulated laser light can be used to aid the selection of the sense of chirality in these films and thus enable writing of chiral two-dimensional patterns undetectable to an unaided eye and visible under illumination with circularly polarized light.[3] Next, I discuss the process of self-assembly of a colloidal system consisting of gold nanoparticles and DNA origami superlattices.[4] We use laser light to establish spatial and temporal control over their shape and growth direction through laser-controlled processes such as annealing, sculpturing, and promoted growth. Finally, I highlight the application of modulated laser radiation as a facile way to induce rapid responses in highly resilient ultrathin polymeric membranes made of materials sensitive to environmental factors such as humidity or the presence of polar organic vapors.[5]

### REFERENCES

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[2] Leniart, A. A.; Pula, P.; Sitkiewicz, A.; Majewski, P. W. ACS Nano (2020)
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[5] Krysztofik, A.; Pula, P.; Pochylski, M.; Zaleski, K.; Gapinski, J.; Majewski, P.; Graczykowski, B. Advanced Materials (2024)

## Agustin MIHI

Tenured Scientist CSIC
*Instituto de Ciencia de Materiales de Barcelona, Spain*

### BIOGRAPHY

Agustín's research focuses on the creation of nanophotonic structures using a scalable nanofabrication technique called soft nanoimprinting lithography. This method involves the use of elastomeric pre-patterned stamps to nanostructure a wide range of materials, including colloids, biopolymers, and semiconductors. The resulting patterned structures can cover areas as large as 1 $cm^2$ and showcase photonic properties such as lasing, circular dichroism, and enhanced light absorption or emission.

Dr. Mihi earned his Ph.D. in physics in 2008 from the Institute of Materials Science of Seville (Spain). He was awarded a Beckman postdoctoral fellowship in 2008 at the University of Illinois at Urbana-Champaign (USA) after which he joined the Institute of Photonic Sciences ICFO with a Marie Curie COFUND fellowship in 2011. Since 2015, he is part of the Institute of Materials Science of Barcelona (ICMAB-CSIC) leading a research group dedicated to the creation of large-area nanophotonic architectures to improve the performance of optoelectronic devices. Agustín leads several Spanish national projects and also, he has been awarded an ERC Starting Grant, an ERC proof of concept and participates in two EIC Pathfinder actions.

### CRAFTING LIGHT WITH NANOPHOTONIC ARCHITECTURES MADE BY SOFT NANOIMPRINTING LITHOGRAPHY

Nanophotonic architectures have the remarkable ability to control the propagation of light through optical resonances, facilitating optical phenomena beyond the capabilities of traditional lenses and mirrors. These nanostructures hold the potential to enhance the light absorption of solar cells and photodetectors, as well as to advance light emission technologies. Yet, the practical integration of these exciting photonic properties into emerging optoelectronic devices necessitates large-scale, cost-effective manufacturing processes to reduce production costs and increase efficiency. To fully harness the potential of these photonic structures in improving these devices, they must be processed in a manner consistent with the devices themselves.

In this presentation, I will illustrate how the technique of soft nanoimprinting lithography (NIL) provides an exciting opportunity for the fabrication of nanostructures in a scalable, fast and inexpensive way. In soft nanoimprinting lithography, we make use of pre-patterned soft elastomeric stamps to corrugate a variety materials such as resists, biopolymers, colloids and nanomaterials in general. In all cases, the resulting photonic architectures can exhibit a resolution below 100 nm while covering areas of 1 cm2 and allow for optical properties such as enhanced light absorption, enhanced light emission, high Q-factor optical resonances, chiral light emission, and more. This fabrication route allows us to combine the photonic properties of the pattern with those of the original material resulting in a new generation of inexpensive photonic components.

# Plenary Speakers

## Katherine ELVIRA

Associate Professor

*University of Victoria, Canada*

### BIOGRAPHY

Katherine is the Canada Research Chair in Microfluidics for Drug Discovery and Health Care, a Michael Smith Health Research BC Scholar in partnership with the Canadians for Leading Edge Alzheimer Research (CLEAR) Foundation, and an Associate Professor in the Department of Chemistry at the University of Victoria, Canada. Her group develops microfluidic (lab-on-a-chip) technologies to build bespoke artificial cells and tissues for drug discovery and development applications.

### BUILDING CUSTOMISABLE ARTIFICIAL CELLS ON A CHIP FOR DRUG DISCOVERY AND OTHER APPLICATIONS

The cell membrane (the "skin" of a cell) plays a crucial role in choreographing interactions between a cell and the outside environment, for example by allowing or prohibiting the access of molecules from the cell exterior to the cell interior. Here I will describe how we build bespoke human-mimetic artificial cell membranes, using both microfluidic and non-microfluidic methods, and how they can be used to help explain a variety of biological mechanisms. We have used these artificial cells to mimic how an orally administered drug moves from the intestine into an intestinal cell, and then from the cell into the blood stream, and to mimic how the cell membrane changes during cancer. I will also show how artificial cell membranes can be built to mimic the cell membrane composition found in male and female cells, and how this creates a clear difference in the permeability of the cell membrane. More broadly, we have also investigated how nanoplastics found in the environment can disturb the cell membrane and change its permeability helping in the risk assessment of these materials and their potential toxicity to humans. Finally, I will briefly describe our work on micro-brewedics, where we put beer on a chip to investigate the stabilisation of hop oils in IPAs in collaboration with a local microbrewery.

## Debora BERTI

Professor

*University of Florence, Italy*

### BIOGRAPHY

Debora is Full Professor of Physical Chemistry at the Department of Chemistry, University of Florence, where she leads the BioSoftMatter group. Debora's work focuses on Soft Matter systems, from design to applications in several areas, mainly in biologically relevant fields. Throughout her career, Debora has pioneered the application of radiation scattering methods, such as small angle scattering and reflectivity, to characterize the structural details of self-assemblies with biological relevance. Her research topics include hybrid nano and micro particle/lipid assemblies for responsive drug delivery, interaction of nanostructured assemblies with model membranes, design and application of nanostructured fluids. Debora Berti has a well-established track record of her work, with more than 120 authored or co-authored research papers and several chapters contributed in specialized books. She is co-Editor of the Journal of Colloid and Interface Science (Elsevier), member of the Ownership Board of the journal Physical Chemistry Chemical Physics, (Royal Society of Chemistry), member of the Review Panel of the Partnership for Soft Condensed Matter(PSCM, ILL-ESRF). She was the President of the European Colloid and Interface Society (2013–2015), member of the Soft Matter group of the scientific panel of the HZB–Berlin and member of the Elettra Proposal Review Panel for the SAXS beamline.

### EXPLORING NANOPARTICLE-LIPID HYBRID SYSTEMS: FROM FUNDAMENTAL INSIGHTS TO BIOMEDICAL APPLICATIONS

Interactions at the nano-bio interface (i.e., where engineered nanoparticles (NPs) meet biological interfaces, such as biomembranes) have been intensively investigated in the recent past, research aimed at understanding NPs' cytotoxicity and advancing their clinical translation. This contribution will provide an overview on hybrid soft matter assemblies, composed of inorganic nanoparticles and lipid bilayers, where these interactions, explored in biomimetic systems, were exploited to inform the design of synthetic hybrid systems with high structural control and potential use in biomedical and biotechnological applications.

Specifically, we will review the design of hybrid nanostructured materials composed of lipid bilayers and some classes of inorganic NPs, with particular emphasis on the effects on the amphiphilic phase diagram and on the additional properties contributed by the NPs. Building upon these insights, we will show how we can control the spontaneous self-assembly of Au or Au-Fe3O4 nanoparticles and synthetic liposomes. In particular, the lipid membrane's bending rigidity and fluidity govern the clusterization of nanoparticles on the membrane, consequently influencing the colloidal stability and size distribution of the hybrids. By finely tuning the lipid vesicles' composition and concentration, we achieve precise control over the plasmonic (or magnetoplasmonic) properties, thus opening avenues for tailored multifunctionality in imaging and drug delivery application.

In addition, we will show how NPs can serve as nanosized properties of otherwise elusive membrane properties. Leveraging the surface plasmon resonance of citrated gold nanoparticles adsorbed on lipid vesicles, we propose a plasmon-based "stiffness nanoruler" for quantitatively assessing the mechanical properties of synthetic and biogenic nanosized lipid vesicles. This innovative approach offers a facile and high-throughput method for characterizing vesicle stiffness, with implications for various

physicochemical and biological processes. Finally, we show how this controlled aggregation of plasmonic nanoparticles can be exploited to design "LipoGold Tags," where the AuNPs' clusters self-assembled on lipid vesicle membranes provide a groundbreaking platform for surface-enhanced Raman scattering (SERS), and demonstrate their efficacy in specific biomolecular detection, showcasing their potential for precision medicine applications.

**Frank SMALLENBURG**

CNRS junior scientist

*Laboratoire de Physique des solides, France*

## BIOGRAPHY

Frank Smallenburg is a computational statistical physicist, whose research focuses on many-body systems in soft matter. He received his PhD in 2012 at Utrecht University (Netherlands), with a thesis on self-assembly in colloidal systems. After that, he worked as a post-doc at La Sapienza University (Rome, Italy) and at the Heinrich Heine University Düsseldorf (Germany). Since 2017, he is a CNRS researcher at the Laboratoire de Physique des Solides in Orsay. His current research lines include the structure and dynamics of glassy fluids, the self-assembly of a variety of colloidal systems, and crystal nucleation.

## PREDICTING SELF-ASSEMBLY IN COLLOIDAL SYSTEMS: THE CASE OF HARD-SPHERE QUASICRYSTALS

One of the core goals of the computational study of colloidal soft matter is predicting the equilibrium phase behavior of particles with a given shape or interaction potential. For this, we can use a wide array of different techniques, ranging from brute-force simulations to see which phase forms, to full free-energy calculations. In this talk, I will give a brief overview of common methods for determining phase boundaries in colloidal model systems, and then illustrate their use in the exploration of hard-sphere quasicrystals.

Quasicrystals are exotic materials that break the traditional rules of crystallography. Although typically found in metallic alloys, recent years have revealed a number of soft-matter systems that can spontaneously form quasicrystals. Here, we will explore how quasicrystals can be stabilized by entropy alone, using a simple model system consisting of hard spheres on a plane. Using packing and entropy arguments, we predict that by mixing two sizes of spheres, we should be able to stabilize a quasicrystal with twelve-fold rotational symmetry. Brute-force simulations then indeed confirm the spontaneous self-assembly of the predicted quasicrystal... as well as another unexpected quasicrystal. Using free-energy calculations, we determine the phase boundaries of the dodecagonal quasicrystal and reveal the reason for its stability: the configurational entropy arising from the high number of possible realizations that make up the same quasicrystal phase. Finally, I will briefly highlight recent experiments demonstrating the self-assembly of a granular quasicrystal of millimeter-sized steel spheres.

## Jan VERMANT

**Professor**

*ETH Zurich, Switzerland*

### BIOGRAPHY

Dr. Vermant studied Chemical Engineering at KU Leuven in Belgium, obtaining the doctoral degree in 1996 under the supervision of Prof. Jan Mewis. He was a postdoctoral fellow of Elf Aquitaine and the Fund for Scientific Research – Vlaanderen. In 2000 he joined the faculty at the department of Chemical Engineering at KU Leuven, becoming a full professor in 2005. In 2014 he joined the Materials Department at the ETH Zürich where he now heads the laboratory of Soft Materials and is vice rector for Curriculum development. He's been a recipient of the Lars Onsager Medal and Professorship (NTNU, Norway), the Weissenberg Award of the European Society of Rheology (EU), the ECIS Colloid & Interface Science Award, sponsored by Solvay (EU) and the Bingham medal of the Society of Rheology (USA)

His research at the ETH Zürch focuses on the rheology and applications of complex fluid-fluid interfaces, colloidal suspensions and the development of novel experimental methods and soft matter applications in materials science.

### EFFICIENT PROCESSING PATHWAYS FOR SUSTAINABLE HIGH INTERFACE MATERIALS.

Generating interfaces in materials (emulsions,foams, polymers) can be used to impart a myriad of functional properties, but thermodynamics will not be your friend. Often high intensity flows are needed to generate sufficiently fine structures. Here I will discuss processing schemes that use laminar flow to direct the organization of multiphase structures or concentration gradients across samples. Inspired by techniques used to structure polymeric melts, we design custom millifluidic devices, which we call advective assemblers, that force disparate streams through serpentine splitting, rotation, and recombination elements. Advective assembly shifts the focus from traditional thermodynamic constraints to rheological constraints, enabling new possibilities in material design. It has practical applications in enhancing 3D printing technologies, allowing for the production of structured, multi-material filaments that overcome common challenges like throughput limitations and interlayer adhesion. Additionally, the method improves the efficiency of product formulation processes through its continuous operation and scalability. It can even be used for efficient emulsification of disparate materials or replacement meat analogues.

# ABSTRACTS
# OF
# ORAL PRESENTATIONS

# Day 1

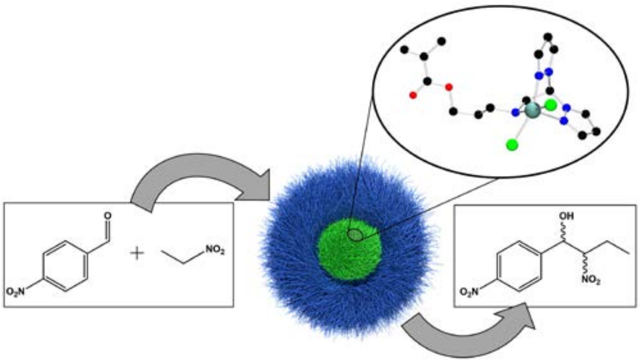
**June 24th / Monday**

|  |  |  |
|---|---|---|
|  | Amphi 1 |  |
| 8:40-9:00 | Welcome Remarks |  |
| 9:00-10:00 | Marleen Kamperman |  |
|  | Amphi 2 | Amphi 3 |
|  | Chair: M. Przeradzka | Chair: C. Courtine |
| 10:00-10:20 | Frédéric Grabowski | Kevin Ballu |
| 10:20-10:40 | Adeline Delaporte | Lars Kuerten |
| 10:40-11:00 | Coffee break |  |
|  | Chair: A. Salem-Tabet | Chair: A. Bagur |
| 11:00-11:20 | Guillaume Gimenez | Christopher G Passmore |
| 11:20-11:40 | Nadja Wolter | Weronika Zając |
| 11:40-12:00 | Sarrah Mezdari | Xin Yin |
| 12:00-13:30 | Lunch |  |
|  | Amphi 1 |  |
| 13:30-14:30 | Pawel W. Majewski |  |
|  | Amphi 2 | Amphi 3 |
|  | Chair: F. Grabowski | Chair: M. Soula |
| 14:30-14:50 | Jyoti Gupta | Alan Francisco Mejia |
| 14:50-15:10 | Sara Beldarrain | Simone Russo |
| 15:10-15:30 | Magdalena Przeradzka | Hamid A Hassan |
| 15:30-16:00 | Coffee break |  |
|  | Chair: M. Parker | Chair: E. Layan |
| 16:00-16:20 | Chiara Ferlito | Silvia Argelia Peraza Ku |
| 16:20-16:40 | Tin Klačić | Sumi Murali |
| 16:40-17:00 | Nadia Batool | Allan Salem-Tabet |
| 17:00-19:00 | Poster session and Meet and Greet |  |

# Catalyzed Henry Reaction by Compartmentalized Copper-Pyrazolyl-Complex Modified Microgels

*Frédéric Grabowski[1,2], Fabian Fink[3], Walter S. Schier[1,2], Sven Soerensen[3], Alexander V. Petrunin[4], Walter Richtering[4], Sonja Herres-Pawlis[3], and Andrij Pich[1,2]*

1) *Institute of Technical and Macromolecular Chemistry, RWTH Aachen University, Germany*
2) *DWI – Leibniz-Institute of Interactive Materials, Germany*
3) *Institute for Inorganic Chemistry, RWTH Aachen University, Germany*
4) *Institute of Physical Chemistry, RWTH Aachen University, Germany*



Through compartmentalization of homogeneous catalysts, the catalytic performance can be enhanced and even improve selectivity. Microgels, which are three-dimensional crosslinked polymers, serving as catalyst carriers that provide both effective compartmentalization and facilitate accessibility to the catalyst enabling the recyclability and re-usability. However, systematic study of incorporating organometallic complexes into microgels has been lacking in detailed insight in their structure and catalytic performance**.**

In this study, we synthesized microgels with controlled number and localization of versatile copper(II)-pyrazolyl-complexes.[1-2] To obtain an insight into complex formation in microgels, we combined XRD and EPR studies of the copper(II) complexation of pyrazolyl-modified monomers with spectroscopic analysis of the copper(II)-pyrazolyl-complex modified microgels. This comprehensive approach enabled us to identify predominant complex in the microgel and to determine complex content. Next, the catalytic activity of these microgels was evaluated in industrially relevant batch nitroaldol reactions (Henry reaction), demonstrating significantly higher yields compared to pure copper(II)-pyrazolyl-complexes. Notably, microgels with the copper(II)-pyrazolyl complexes localized in the core exhibited higher product yields than those with complexes in the shell. Further, the best performing microgel catalyst was used in a 200-fold continuous model process by using a tangential flow filtration (TFF) system. During this process, leaching of copper was detected, but reactivation of the microgel catalyst was achieved by copper re-loading. This resulted in significantly higher average yields over a period of 15 cycles than in the batch process.[2]

Our results demonstrate that microgel catalyst can be re-loaded, reactivated, and re-used in industrially relevant reactions (e.g. Henry reaction) and systems, leading to high yields.

References:

[1] F. Grabowski, V. S. Petrovskii, F. Fink, D. E. Demco, S. Herres-Pawlis, I. I. Potemkin, A. Pich, *Adv. Sci.*, 9, 2204853, **2022**.

[2] F. Grabowski, F. Fink, W. S. Schier, S. Soerensen, A. V. Petrunin, W. Richtering, S. Herres-Pawlis, A. Pich, **2024** [manuscript submitted].

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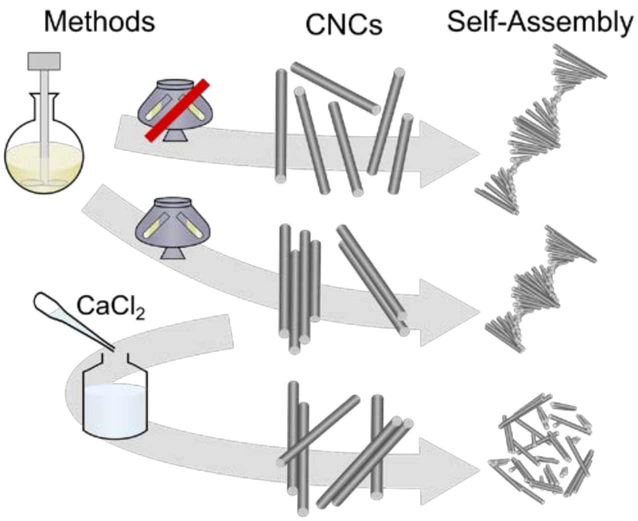
**Frédéric Grabowski** (grabowski@dwi.rwth-aachen.de). I am a PhD student in macromolecular chemistry and currently in the last year of my PhD. During this journey, I focused on the incorporation of metal complexes into microgels. Therefore, I synthesized several ligands and functionalized them to monomers for microgel synthesis. This allowed me to work with many different analytical methods and to cooperate with PhD students from all fields of chemistry in an interdisciplinary way. Besides working in the lab, you can find me either playing rugby or having a drink with friends.

# Directed Aggregation of Cellulose Nanocrystals: Impact on Morphology and Self-Assembly Behaviour

K. Ballu,[1] J. H. Lim,[3] T. G. Parton,[1,2] B. Frka-Petešić,[1] R. M. Parker,[1] Y. Ogawa,[3] S. Vignolini[1,2]

1) *Yusuf Hamied Department of Chemistry, University of Cambridge, UK*
2) *Max Planck Institute of Colloids and Interfaces, Potsdam, Germany*
3) *Univ. Grenoble Alpes, CNRS, CERMAV, Grenoble, France*



Natural cellulose can be hydrolyzed by sulfuric acid to yield elongated and negatively charged nanoparticles called cellulose nanocrystals (CNCs). Above a threshold concentration, CNC suspensions are known to spontaneously self-assemble into a cholesteric liquid crystalline phase, however, the origin of the chiral interactions between the individual particles remains elusive.[1]

Classic CNCs contain a proportion of particles made up of laterally associated crystallites which can be referred to as bundles. Recently, the bundle content of CNC suspensions was correlated to their cholesteric characteristics,[2] implying a pivotal role of this subgroup of particles in the chiral behavior of CNCs.

In this work, we investigated the origin of these associated crystallites using post-hydrolysis centrifugation and salt-induced aggregation. We investigated the morphological characteristics of the CNCs and related them to their chiral behavior. This work revealed that both methods lead to different crystallite associations, influencing both their morphology and their effectiveness as chiral dopants. This offers new insight into the importance of post-hydrolysis treatments for applications involving CNC self-assembly or their surface properties.

References:

[1] B. Frka-Petesic, T. G. Parton, C. Honorato-Rios, A. Narkevicius, K. Ballu, Q. Shen, Z. Lu, Y. Ogawa, J. Haataja, B. E. Droguet, R. M. Parker, S. Vignolini, S. *Chem. Rev.* 123, 12595–12756, (2023).

[2] Parton, T. G.; Parker, R. M.; van de Kerkhof, G. T.; Narkevicius, A.; Haataja, J. S.; Frka-Petesic, B.; Vignolini, S. *Nat Commun,* *13*, 2657, (2022).

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Kevin Ballu (*kb741@cam.ac.uk*).

Kevin Ballu is a PhD student at the University of Cambridge (UK) under the supervision of Prof. Silvia Vignolini and Prof. Alexei Lapkin. He completed an M.Sc. degree in Material Chemistry from the University of Bordeaux (France) and another in Food Sciences from the University of Nantes (France). His current research focuses on the production of cellulose nanocrystals for self-assembly applications.

# Innovative natural coacervates for the encapsulation of lipophilic compounds: the example of α-tocopherol

*Delaporte Adeline*, Grisel Michel, Gore Ecaterina*
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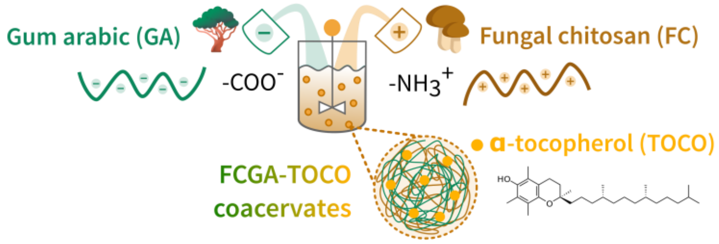

Bioactive substances derived from nature, like vitamins, polyphenols, and essential oils, are commonly added to beauty products because of their diverse range of qualities such as antioxidant, anti-aging, regenerative, and anti-inflammatory effects [1]. Nonetheless, several challenges such as poor solubility, restricted skin absorption, susceptibility to environmental factors, and instability frequently impact the performance of these substances. This can decrease the overall efficiency of the product formulation while posing potential risks for users.

**Complex coacervation** is a promising method for encapsulation, involving the self-assembly of two oppositely charged polymers through electrostatic interactions. This strategy allows for high levels of encapsulated active ingredient and efficiency, while also improving oxidation stability and controlling the release of biologically active compounds [2].

This study focuses on the potential of **fungal chitosan (FC)**, a cationic polysaccharide derived from fungal sources, combined with **gum arabic (GA)** for the encapsulation of **α-tocopherol** by complex coacervation. The effectiveness of this method is evaluated in terms of encapsulation efficiency and yield, and the physicochemical properties of the coacervates are analyzed. Additionally, stability tests were conducted to determine its retention under storage conditions.

In addition to its encapsulation capabilities, fungal chitosan offers multiple bioactive properties such as antimicrobial, anti-inflammatory, and wound healing effects, which can improve the efficacy of cosmetic products [3]. Its fungal origin also makes it an ecologically sustainable and environmentally friendly choice for encapsulation in cosmetic formulations [4].

References:

[1] S. Silva, M. Ferreira, A. S. Oliveira, C. Magalhães, M. E. Sousa, M. Pinto, J. M. Sousa Lobo, and I. F. Almeida, *Int. J. Cosmet. Sci.* 41, 378 (2019).
[2] Y. P. Timilsena, T. O. Akanbi, N. Khalid, B. Adhikari, and C. J. Barrow, *Int. J. Biol. Macromol.* 121, 1276 (2019).
[3] T. Huq, A. Khan, D. Brown, N. Dhayagude, Z. He, and Y. Ni, *J. Bioresour. Bioprod.* 7, 85 (2022).
[4] V. Ghormade, E. K. Pathan, and M. V. Deshpande, *Int. J. Biol. Macromol.* 104, 1415 (2017).

**DELAPORTE Adeline** (*adeline.delaporte@doct.univ-lehavre.fr*). Adeline Delaporte holds a Master's degree in Chemistry and Engineering of Formulation from Université de Lille. With a background as an engineer at the UCCS laboratory in Lille, she is actually a Ph.D. student from the University Le Havre Normandie. Her research in the URCOM laboratory is focused on the encapsulation of cosmetic actives for topical application. Her research involves understanding the interaction between encapsulated actives, cosmetic matrices, and skin using natural polymers. Specifically, her work centers on innovatively encapsulating tocopherol in a gum arabic - fungal chitosan matrix through a complex coacervation technique.

# Making the hard sphere nucleation discrepancy disappear

*Lars Kürten[1], Antoine Castagnède[2], Frank Smallenburg[2] and C. Patrick Royall[1]*
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Crystal nucleation and self-assembly are the underlying mechanisms of a variety of natural phenomena and technical applications. Consequently, significant scientific effort has been devoted to understanding these fundamental processes over the last few decades. Despite continuous progress in this field, a substantial disagreement persists between nucleation rates measured experimentally and those predicted by simulations. This 'second-biggest' discrepancy in physics of several orders of magnitude is observed across different systems, including water, molecules in solution, and especially, the most investigated system, colloidal hard spheres [1]. Figure 1 (a) provides an overview of the reduced nucleation rates calculated from various experiments and predicitons by simulations of colloidal hard sphere suspensions [2].

In contrast to the experiments conducted in the last millennium, we, for the the first time, investigated density matched systems at the single-particle level, with confocal imaging to calculate nucleation barriers from the particle-resolved data. Advances in structural analysis methods enabled us to precisely map our results to hard sphere simulations and compare nucleation barriers for identical state points. With our method, the nucleation barriers show reasonable agreement, leading to the disappearance of the discrepancy (Figure 1 (b)).

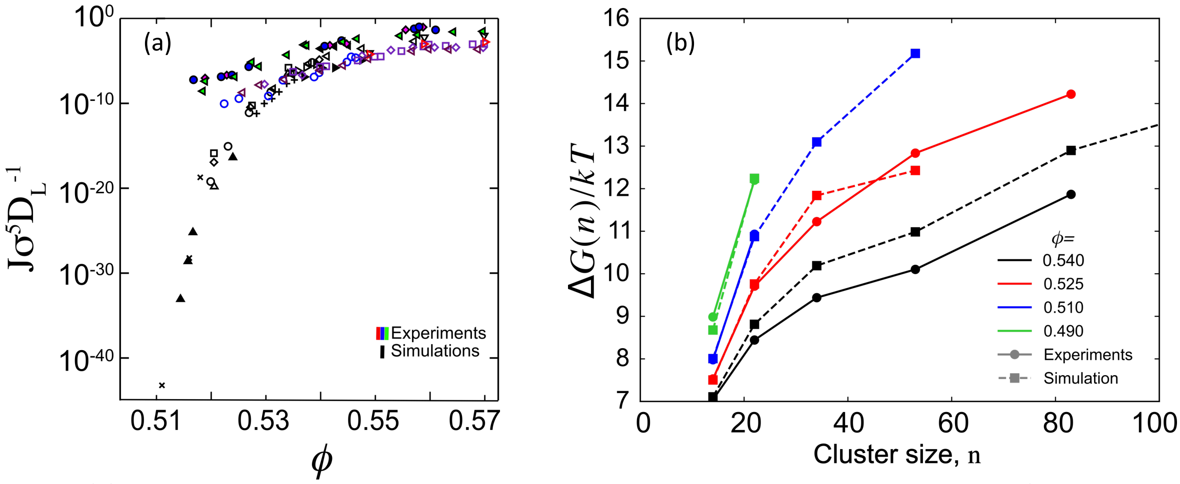

Figure 1: (a) Reduced nucleation rates as a function of volume fraction, comparing experiments (colored symbols) with simulations (black symbols) [2]. (b) Nucleation barriers for experiments (solid lines) and simulations (dashed lines).

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**Lars Kürten** (*lars.kuerten@espci.fr*)

I completed my studies in Medical Physics at Heinrich-Heine-Universität in Düsseldorf, earning a Masters degree in February 2022.

Thesis: 'Mobility and Organisation in Colloidal Trimer-Monomer Mixtures' (supervisor: Prof. Egelhaaf)

Currently, I am pursuing my PhD in Physics at the ESPCI Paris under the guidance of C.P. Royall, delving into the exploration of direct visualisation of nucleation in colloidal systems.

# Study of the interactions between simple coacervates and molecules for water depollution by self-coacervation

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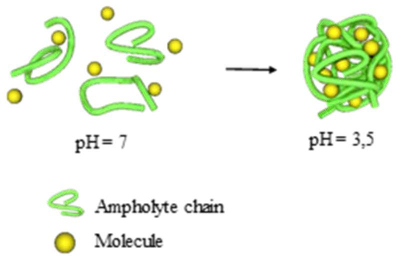

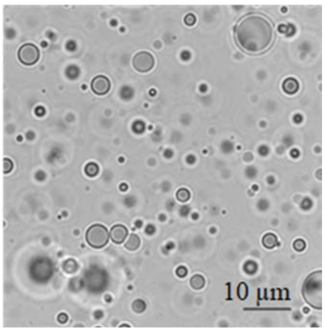

The ever-increasing global water pollution has raised serious concerns in the scientific community. Organic, inorganic pollutants and suspended solids, which result from textile, pharmaceutical or agricultural industries have a dramatic impact on the aquatic environment.

The use of microextraction or sequestration is an interesting approach to extract complex systems from polluted water. In this context, simple coacervates can be used as sequestration agents for water depollution because they have demonstrated a remarkable ability to sequester various chemicals and colloids [1],[2]. Simple coacervates are spherical micrometric structures resulting from a phase separation of two aqueous phases, called “self-coacervation”, which is driven by polymer assembly under certain physico-chemical conditions. These structures can interact with various entities including organic molecules, ions or metal complexes. The exact nature and strength of the interactions between coacervates and molecules depend on different factors such as charge, concentration, environmental conditions and specific chemical properties of the coacervate components. Understanding these interactions is crucial in a number of areas, particularly in water purification processes.

In this project, the process of “self-coacervation” is investigated by using a single polymer to form the simple coacervates. Indeed, a polyampholyte with a tunable charge ratio, called PAA-$DA_{15}$, was synthesized by grafting 15% of positively charged diamine (DA) groups onto negatively charged polyacrylic acid (PAA) chains. Here, the self-coacervation is triggered by decreasing the pH to the isoelectric point of PAA-$DA_{15}$ ($pH \approx 3.5$) (**see Figure**). The formation of the coacervates is attributed to electrostatic attraction between positively charged diamine groups and negatively charged carboxyl groups of PAA close to the isoelectric point of the polyampholyte. Coacervation is only observed for a certain amine-to-acid ratio. Otherwise precipitation is observed. [1]

The interactions between these coacervates and different molecules (dyes, metal cations and salts) were studied. In order to highlight the role of charge and solubility of the introduced molecules, we analyzed the sequestration capacity of the coacervates and their stability.

References:
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I am currently a 2nd year PhD student under the supervision of Dr. Adeline Perro at the *Institut des Sciences Moléculaires* (ISM) of the University of Bordeaux. I work with the NSysA team of ISM which is located at the Engineering School of Chemistry of Bordeaux (ENSMAC). My thesis focuses on the self-coacervation of polyampholytes for many different applications such as water clean-up, enantiomeric separation or bio-inspired adhesives. I am very interested by the physico-chemistry of polymers and colloids and by soft matter science.

# Advancing Colloidal Crystal Manufacturing

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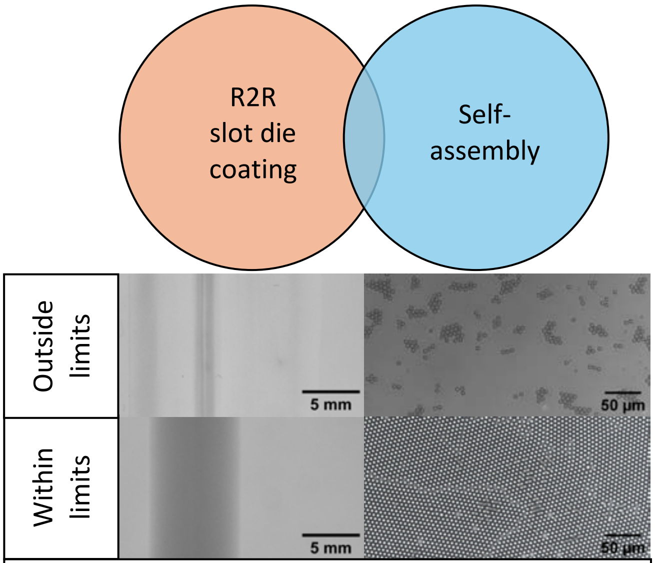

Schematic illustrating operating limits of roll-to-roll slot die coating and colloidal self-assembly. Underneath on the left are wide angle images of coatings and on the right are 20 x magnification microscope images of colloids.

Colloidal crystals are ordered arrays of monodisperse colloidal particles, with the potential to significantly advance devices in the applications of sensors, energy storage and energy generation.[1]

Existing fabrication techniques such as drop casting, static volume sedimentation, and spin coating are not conducive to large scale production, posing a critical limitation for real world applications.[2] To address this challenge the potential of roll-to-roll slot die coating as an industrial scale manufacturing method for colloidal crystals is explored, leveraging its high throughput and exceptional coating uniformity.[3]

Despite slot die coating's promise, the integration of this technique with colloidal crystal synthesis has remained unexplored in literature. This, is due to inherent challenges in self-assembly and continuous coating, such as lack of repeatability, stringent hygiene requirements, and narrow operating windows.

In this study, a roll-to-roll slot die coater is employed, equipped with a wide-angle transmission camera for precise coating measurements and transmission microscope for colloidal crystal structure measurements, to map the physical limits of colloidal crystal manufacture. Key physical constraints inherent to self-assembly and roll-to-roll slot die coating, such as colloidal volume fraction and maximum wet coating thickness, provide only a narrow window where roll-to-roll slot die coating can manufacture colloidal crystals.

We investigate the impact of binder, solvent choice, and surfactant on self-assembly and coating stability. Our findings reveal that the addition of binder alters viscosity, influencing sedimentation kinetics and colloidal mobility during self-assembly. While this formulation adjustment pose challenges, it also extends the operating limits for roll-to-roll slot die coating, expanding the range of feasible coating parameters. The introduction of surfactant, affects surface tension and coating window as anticipated, but also induces the formation of secondary crystals around colloids.

In conclusion, this study explores the potential of roll-to-roll slot die coating as an industrial-scale manufacturing method for colloidal crystals. Through the investigation of key parameters the interplay between formulation adjustments and coating stability is uncovered, thus expanding the operating limits for roll-to-roll slot die coating and advancing the feasibility of large scale colloidal crystal production.

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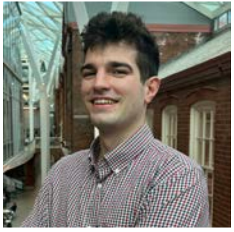

**Christopher Passmore** (*cgpassmore1@sheffield.ac.uk*) studied Chemistry at the University of Birmingham with his final year project investigating the effect of coatings on Na-ion battery anode materials. He completed a year in industry at DuPont Teijin Films. Chris is now investigating large-scale manufacture of colloidal crystals.

# Non-Covalent Crosslinking Strategies – Utilizing the Self-Assembling Phe-Phe Peptide Motifs in Microgels

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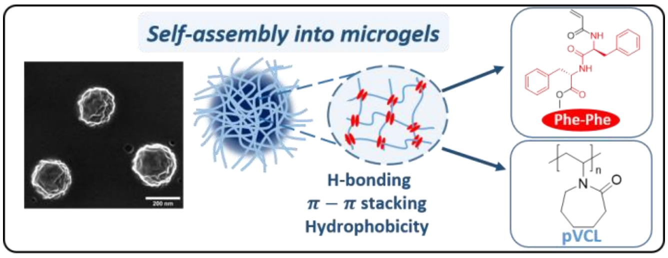

Over the last years, there has been a growing interest in the synthesis of functionalized microgels with tailored properties due to their wide range of applications. Stimuli-responsive microgels consist of colloidal polymeric networks that are typically crosslinked via covalent bonds. However, the properties of those microgels such as their mechanical softness or degradation are significantly influenced by the specific nature of crosslinking within the polymeric network. As an alternative for covalent crosslinks, supramolecular, hydrophobic, or electrostatic interactions can be used.[1]

Supramolecular assemblies facilitating non-covalent crosslinking are prevalent within the material class of aromatic peptides. Inspired by biological systems, where self-assembly is crucial, extensive research has been dedicated to the molecular self-assembly of short aromatic peptides, driven by the potential to create complex, functional nanostructures. The short aromatic dipeptide derivative diphenylalanine, bearing the Phe-Phe motif, has been utilized as an extremely versatile self-assembling building block in nanotechnologies for potential applications in the field of biomaterial chemistry, sensors, and bioelectronics. It relies on the self-assembly driven by hydrogen bonding and π-π stacking interactions.[2,3]

In this work, we study the synthesis and properties of temperature-responsive poly-*N*-vinylcaprolactam-based microgels prepared via precipitation polymerization by introducing a Phe-Phe based co-monomer. We show that the covalent crosslinks in the microgels can be replaced by non-covalent interactions from the Phe-Phe motif. The co-monomer content of the microgels was studied by Raman spectroscopy and $^1$H-NMR. The morphology of the microgels was investigated by electron microscopy, and dynamic light scattering. Further, we explored the degradation of microgels through ultrasonication or solvents, potentially allowing for controlled release and delivery of biomacromolecules.[4] In addition to exploring intermolecular interactions within the microgels, we are also examining the potential for external interactions among multiple microgels.

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**Nadja Wolter** (*nwolter@dwi.rwth-aachen.de*). As a fourth-year PhD student at RWTH Aachen University in Germany, I specialize in macromolecular chemistry at the DWI – Leibniz Institute for Interactive Materials. I obtained my master's degree in chemistry also from the RWTH, where my studies concentrated on synthesis and catalysis. Within my current research, I am dedicated to the synthesis and characterization of thermoresponsive microgels featuring asymmetric or anisotropic shapes. This involves utilizing liquid crystalline monomers or peptides for self-organization. Beyond the laboratory, I'm passionate about practicing cheerleading or acrobatics in the gym.

# Chameleon Photonic Crystals: acid-induced emission and absorption shifts for sensor applications.

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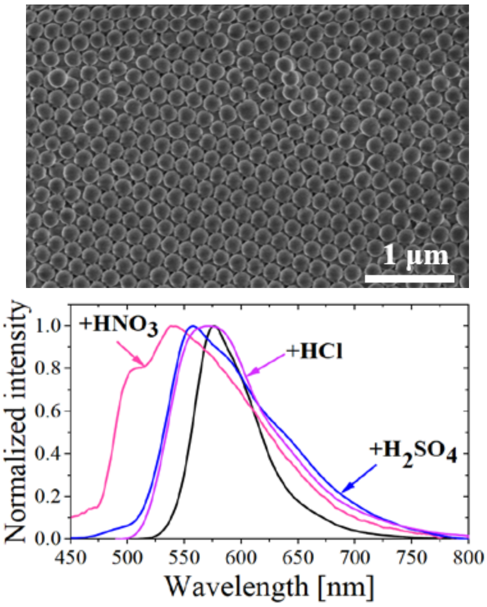

Figure 1. a) SEM image of the synthesized dye-doped PMMA spheres, b) Normalized emission spectra of the ethyl esoin-doped opal before and after the contact with selected acids vapor.

The growing industry necessitates the development of efficient and cost-effective technologies for detecting various types of contaminants to prevent their negative impact on human health and the environment. The answers for this demand could be using of photonic crystals as a detection and analysis medium. Photonic crystals (PCs) are a very interesting group of modern materials due to their optical properties. Their applicability is further enhanced by the possibility of doping them with stimuli-responsive compounds [1, 2].

PCs doped with ethyl eosin luminescent dye were prepared and characterized. The colloidal material obtained was characterized using SEM (Figure 1a) and optical Bragg reflectance measurements, among other methods. By doping with this dye, a material with sensor features and unique optical properties such as angle-dependent emission was obtained. The study focused on determining the luminescence properties of opals and dyes, specifically their quantum yield (QY). Moreover, obtained photonic crystals exhibit a rapid change in luminescence properties and color after a contact with vapors of inorganic acids commonly used in industry (Fig. 1b). Furthermore, the three-dimensional opal doped with ethyl eosin reacts selectively in the presence of nitric acid(V), unlike the dye solution. The luminescent and sensing properties, coupled with reversibility, render this material fascinating.

Additionally, a series of photonic crystals doped with other luminescent dyes were prepared. Photoluminescence characterization, including QY measurements, was performed. Luminescent 3D opal with angle-dependent emission spectra in different spectral regions were obtained by optimizing the size of the dye-doped spheres. The use of these materials allows the design of completely new and difficult to counterfeit security features.

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Founding Sources:

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Graduate of master's studies in the field of Instrumental Analysis at the Faculty of Chemistry, University of Wrocław. She is a PhD candidate in the field of natural sciences in the discipline of chemical sciences at the Faculty of Chemistry of the University of Wroclaw, as part of the Implementation Doctorate Program. She participated in the 3 research projects financed by the National Science Center, National Center for Research and Development.

Since 2021, she has been working at the Łukasiewicz Research Network – PORT Polish Center for Technology Development. Her main research interests are photonic crystals that change their properties under the influence of a specific analyte and photonic crystals doped with luminescent dyes.

# Hydrogels based on ionene polyelectrolytes: dynamics of matrix and charged guest species

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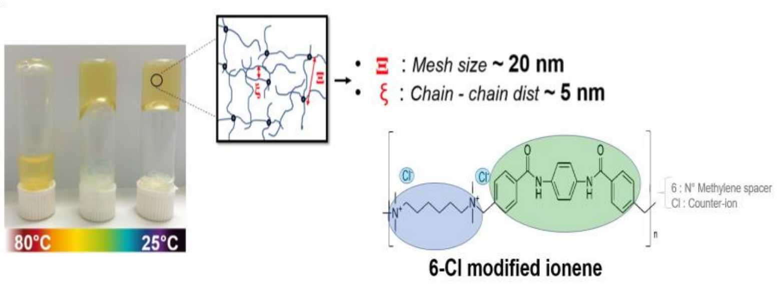

We study hydrogels based on modified ionenes, cationic polyelectrolytes forming physically crosslinked hydrogels.

Stable gels are formed as a result of a combination of electrostatic repulsions between the charged chains, and hydrogen bonding, π–π stacking, and anion−π and cation−π attractive interactions, leading to cross-links between the chains. The typical distance between the crosslinks (mesh size) is ~ 20 nm)[1]. The structural and rheological properties of ionene-based hydrogels show strong counterion specific effects, including the characteristic mesh size [2].

We have explored the consequence of counterion specific effects on matrix dynamics by means of NMR, looking at chemical shifts and diffusion coefficients (PFG-NMR). The focus was on systems with two different monovalent halide counterions ($F^-$ or $Cl^-$) [3]. A significant up-field shift was observed for the fluoride counter-ion with a broad signal intensity at the critical gel concentration (0.036M; 20g/L) compared to its original position at -122.22 ppm in NaF aqueous solution. This confirmed the formation of the hydrogel network through interchain physical interactions involving the counterion[3]. Furthermore, self-diffusion coefficients of ionene polyelectrolyte chains in gel networks were found to be sensitive to the nature of the counter ion: for gels with $Cl^-$ counter ions, chains show a faster diffusion, by a factor of 2, compared to gels with $F^-$ ions[3] (strongly hydrated counter-ions). This correlates with a denser mesh-size for the F-gels, as seen previously by scattering techniques[2]. Local fluctuations of the polymer matrix can be one of the parameters influencing the diffusion of guest species. Fluorescence correlation spectroscopy (FCS) was used to monitor the diffusion coefficients of rhodamine B (a zwitterionic molecule at neutral pH of the gel, 1nm in size). Depending on the gel concentration (and thus mesh size), we observed a slowing down of the translational diffusion coefficient of rhodamine B by a factor of up to 10, with respect to its bulk diffusion in water. However, no significant difference was found between its diffusion in F- gels and Cl- gels. We are currently measuring diffusion of larger guest species, with sizes similar to the gel mesh-size. We can incorporate isotropic (silica) nanoparticles and anisotropic (clay) nanoplatelets, either of positive or negative surface charge. These modify the rheological properties of the gel, and equally act as obstacles for the diffusion of any guest species. These are promising directions in the tuning of the gel permeability and pave the way to potential applications for controlled release of active substances.

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Education

PhD Student at Sorbonne university (Nov 2021 - Oct 2024) :

Hydrogel based on ionene polyelectrolytes: dynamics of matrix and charged species.

Characterization techniques: PFG-NMR, FCS, SAXS and Rheology.

Software: Igor Pro, Top-spin, Zotero, Prezi, Latex

*« I plan my hole day*
*arround the possibility of a nap. »*

# Programmable self-assembly of DNA Origami Diamond Cubic lattice

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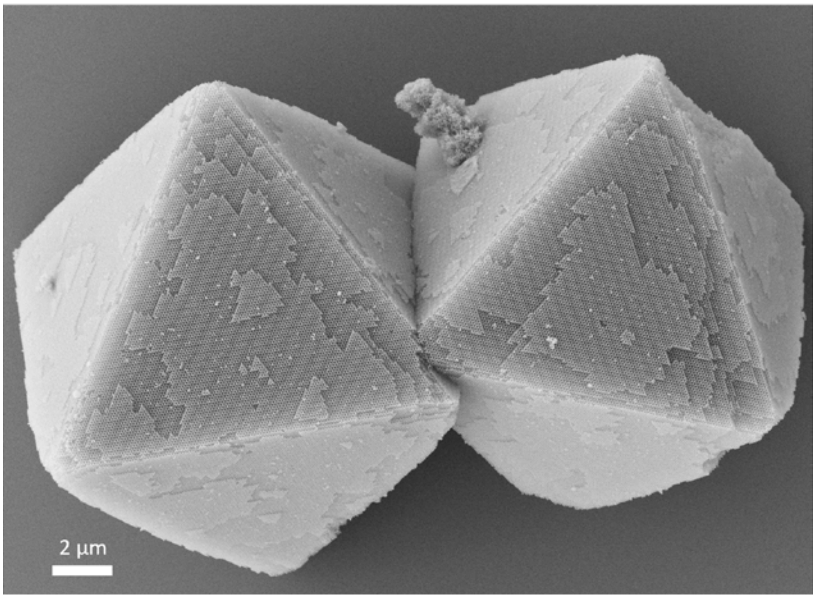

It has long been challenging to form intended supercrystal structures from anisotropic colloidal-sized building blocks, which is of special interest for synthesizing porous materials and photonic bandgap materials. [1] DNA origami, which allows rational design of complex structures, [2] is a powerful tool for achieving this goal.

Here we demonstrate a direct rod-connected diamond cubic lattice assembled from DNA origami. A tetrapod DNA origami structure is designed as the building block for the lattice structure. By stretching out carefully designed complementary DNA strands (sticky bits) and repelling strands (fuzzy bits) from it, these tetrapod monomers can work as precisely programmable patchy colloids. A controlled temperature annealing protocol is crucial for not only successfully formation of a crystal structure, but also the tuning of its size and morphology. Later, in-situ small angle x-ray scattering (SAXS) measurement is applied to study the thermodynamics of the system.

Meanwhile, this structure can serve as a scaffold for hosting various materials for a wide range of applications. Silica ($SiO_2$) can be first grown on the surface of DNA origami via wet chemistry method and thus increase the mechanical stability of the structure. [3] High refractive index materials for example $TiO_2$ can then be deposit on top with atomic layer deposition (ALD), which helps the structure yield a photonic bandgap in the UV range. [4] Due to the addressability of DNA origami, we can also attach gold nanoparticles to the structure, which gives the potential of applications in plasmonic related fields.

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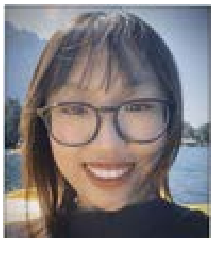

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I hold a Bachelor's in Materials Science and Engineering from Tianjin University in China and a Master's in Materials Science from RWTH Aachen University in Germany. Currently, I'm a second-year Ph.D. student at Ludwig-Maximilians University physics department supervised by Prof.Dr.Tim Liedl. I am focusing on self-assembly of dna origami lattice and the modification of its surface.

# Bio-based itaconate ester as a tool to increase the bio-based content of acrylic emulsion polymers

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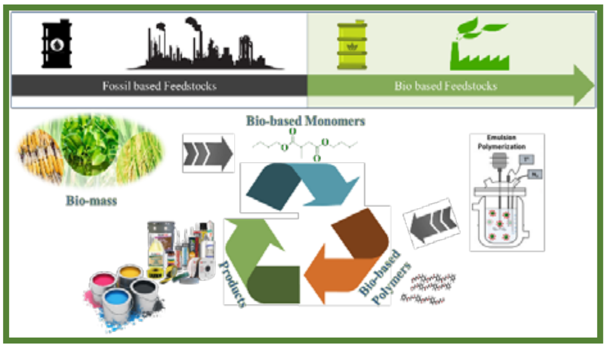

Currently, crude oil, natural gas, and coal are the principal raw resources used in polymer synthesis. However, rising petroleum prices, consumer demands, and environmental concerns have led to the development of sustainable alternatives. Biomass resources are the most viable option due to their renewable nature and contribute to decreasing the release of fossilized carbon,[1–3] although the low large-scale availability remains the main challenge for practical applications. Polymeric derivatives of itaconic acid (IA) are gaining interest as a high-potential bio-based alternative to petroleum-based monomers due to their versatility, renewable nature, commercial availability, and cost-effectiveness, making them a promising alternative for research and industry.[4,5]

In this work, IA has been selected as the main precursor to produce 100% bio-based itaconate ester (IE) monomers and to use them to increase the bio-based content of (meth)acrylic emulsion polymers. Nevertheless, the incorporation of IE is not straightforward due to IE's low propagation rate, unfavorable reactivity ratios with the (meth)acrylates and depropagation process.[6] To overcome these challenges, seeded semi-batch emulsion polymerization of dibutyl itaconate, methyl methacrylate, and butyl acrylate was implemented. Consequently, 30 wt% itaconate ester was successfully incorporated within waterborne (meth)acrylates in a short reaction time of 4h. The results demonstrate that itaconate monomer incorporation has a negative impact on instantaneous monomer conversion, as well as, the polymer's microstructure and mechanical properties. By employing a bio-based crosslinker, also developed from IA, improved process kinetics and mechanical characteristics of the polymers were achieved. This approach enables increase of bio-based content of the conventional (meth)acrylic polymers while preserving the high-performance requirements for adhesive and coating industries.

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# Bio-Inspired Design of Tunable Hybrid Colloids with Star and Surfactant-like Architectures.

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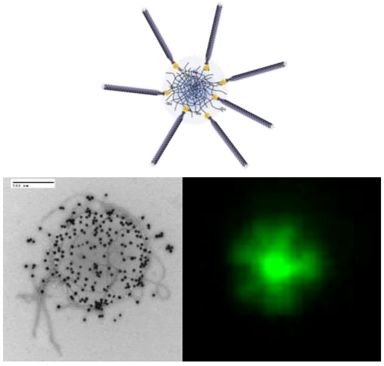

This study explores the design of bio-inspired hybrid colloids mimicking star-shaped and surfactant-like architectures. We achieve this by conjugating thermoresponsive poly(N-isopropylacrylamide) (PNIPAM) microgels with various functional groups on their surface with bioengineered filamentous viruses (fd viruses).

This approach offers remarkable flexibility, enabling targeted coupling with gold nanoparticles (AuNPs) and the fd virus tip[1,2], leading to well-defined hybrid structures. We investigate how microgel properties, including the type of incorporated functional groups, affect the conjugation efficiency with AuNPs. AuNPs serve as bridging elements due to their affinity for both the functional groups on the microgel and the modified virus tip, enabling covalent linkage. The conjugation yield and temperature-dependent behaviour of the assemblies will be evaluated using multiple microscopy and light scattering techniques.

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**Alan Francisco** (*francisco@pc.rwth-aachen.de*).

Alan Francisco is a highly motivated chemical engineer with a passion for research. He has a strong track record of success in both academia and industry.

Francisco received his bachelor's degree in chemistry from the Universidad Autónoma de Santo Domingo, where he graduated with honors. He then went on to earn a master's degree in process engineering from INSA Rouen in France, where he conducted a research internship at the Cobra laboratory, developing biopolymers in microfluidic reactors. He is currently pursuing a PhD in physical chemistry at the RWTH Aachen University in Germany, where his research focuses on the design and self-assembly of thermo-responsive star colloids, as well as the bioconjugation of colloids.

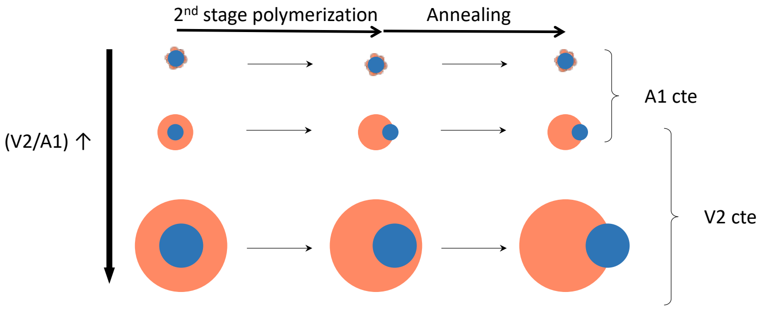
Alan Francisco's research has the potential to support a variety of fields, including drug delivery, cosmetics, biophysics, and nanomaterials. He is eager to use his skills and knowledge to make a positive impact on his field.

# Synthesis of Snowman particles by two-step semibatch emulsion polymerization

S. Beldarrain, S. Hamzehlou, J.R. Leiza, E. González

POLYMAT, Kimika Aplikatua Saila, Kimika Falkultatea, University of the Basque Country, UPV/EHU, Joxe Mari Korta Zentroa, Tolosa Hiribidea 72, 20018 Donostia/San Sebastián, Spain.

In aqueous polymer dispersions, the morphology of the particles is developed during the polymerization reaction, and it is governed by the interplay of thermodynamic and kinetics. When two different polymeric phases are combined, core-shell, inverted core-shell or hemispherical morphologies can be obtained[1–3]. Nevertheless, equilibrium morphologies are still limited for some application properties[4–6]. For example, when an anisotropic behavior is required non-spherical particles must be used. In this work, snowman particles are sought. The production scale still places limitations on the methods employed, despite the fact that multiple strategies have been reported to produce this type of particle morphology. To create snowman particles, a two-step semibatch emulsion polymerization method is presented in the current work. We have found that for systems where crosslinked 1st stage polymer is used and where the 1st stage polymer is more hydrophilic than the 2nd stage polymer, snowman morphology is easily obtained if the volume of the 2nd stage polymer per unit area of 1st stage polymer *(V2/A1)* is in certain range.



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Sara Beldarrain (sara.beldarrain@ehu.eus)

I obtained a degree in chemistry and a master degree in applied chemistry and polymers from the University of the Basque Country (UPV/EHU). Since 2020, I am carrying out my PhD at UPV/EHU – POLYMAT, where I aim to develop functional latexes and latexes of certain morphology that can be used as dispersants and spacers of inorganic particles in waterborne coating formulations.

# Surface modification of colloidal fluorine-doped ZnO Quantum Dots with glycomolecules to engineer amphiphilic nanoformulations

Simone Russo[1], Giuseppe Junior Mosca[1], Chiara Iovino[1], Diego Colombo[2], Laura Morelli[2], Giuseppe Vitiello[1,3]

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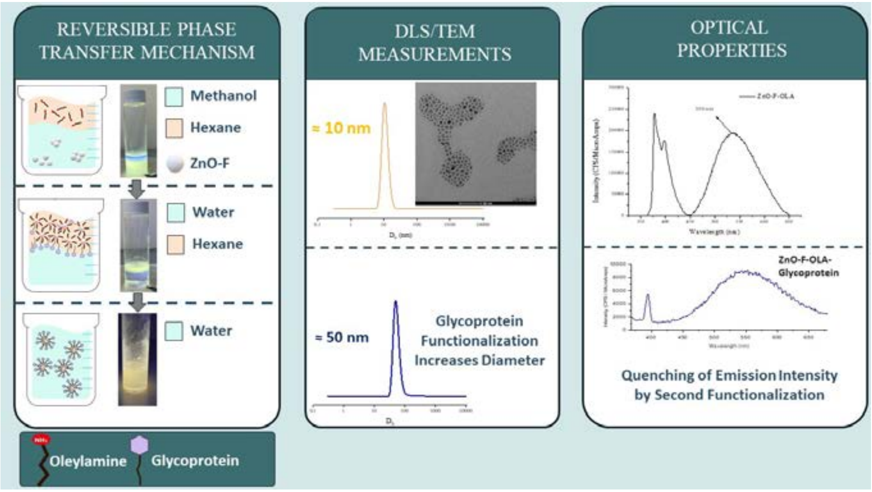
The increasing life expectancy has prompted extensive research into early-stage diagnosis and medical problem detection. Current medical treatments require continuous monitoring, localized drug application, and early assessment of treatment efficacy [1]. Semiconductor quantum dots (QDs) offer promising prospects in biomedical applications due to their unique attributes, including a broad absorption band, narrow emission band, size-adjustable emission spanning from visible to near-infrared (NIR) regions, superior brightness, extended fluorescent lifetime, and high resistance to photobleaching [2]. Among them, ZnO-QDs are highly favorable owing to their ability to dissolve slowly under physiological pH conditions [3], leading to minor alterations in extracellular zinc concentrations, thereby mitigating cytotoxicity concerns [4]. However, uncoated quantum dots cannot be directly utilized in biological applications due to challenges like colloidal instability in aqueous environments and low biocompatibility [2]. In this context, the surface modification with amphiphilic molecules, such as carbohydrates and lipids, can represent a promising strategy to develop biocompatible and stable QDs-based formulations for biomedical applications [1].

In this work, we synthesized fluorine-doped ZnO quantum dots (ZnO-F QDs) containing a nominal content of doping agent equal to 5 at. % via precipitation method which were dissolved in methanol. In order to create amphiphilic nano-formulations, a bi-layered shell was built on the surface of ZnO-F QDs employing a reversible phase transfer functionalization technique. By exploiting hydrophobic interactions, the first layer was composed by oleylamine while the second one was alternatively composed of oleic acid or synthetized glyceroglycolipids. Through a comprehensive physicochemical analysis based on transmission electron microscopy (TEM), dynamic light scattering (DLS), Fourier-transform infrared (FT-IR), UV-visible and photoluminescence (PL) spectroscopies, the physicochemical properties of such nanoformulations were defined, also proving the successfulness of the functionalization protocol. In particular, DLS analysis confirmed that the amphiphilic-functionalized QDs were stable in aqueous medium for a long time, while fluorescence spectroscopy displayed a broad emission peak at 550 nm in the yellow region confirming that the emission behavior was preserved. These preliminarily evidences proposed them as fluorescent nanoformulations for biomedical and biosensing applications.



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**Simone Russo** (*Simone.russo@unina.it*) I'm a chemical and sustainable engineer who has a strong interest in environmental challenges and new eco-friendly ideas and technologies. I am currently a Ph.D. student and my project is guided by green chemistry and circular economy principles. My research journey centres on designing and synthesizing metal oxides/chalcogenides Quantum Dots (QDs) and Carbon Dots (CDs) from raw materials. The core objectives include chemical synthesis, functionalization with organic molecules, and doping with metals or rare earth metals. The outcome? Crafting 2D and 3D hybrid composites as advanced chemo- and bio-sensors for environmental applications. A unique focus of my work involves exploring photoelectrochemical processes. Here, the photocatalytic properties of quantum dots extend beyond conventional optical signals. I'm fascinated by the idea of changing light signals into electric signals to detect pollutants. It could change how we address environmental challenges.

I have always been passionate about reading since I was a kid. My favorite books include "Notes from Underground" by Dostoevskij, "Meditations" by Marcus Aurelius, and "Ossi di Seppia" by Eugenio Montale. These three books have stimulated my growth path and developed my critical thinking.

# Yield-stress fluids of thermo-responsive microgel suspensions

Magdalena Przeradzka [1,2], Chiara Marraffa [3], Michel Cloître [3], Véronique Schmitt [2] and Valérie Ravaine [1]
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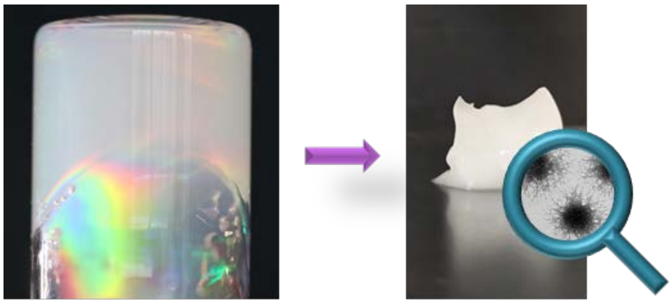
3) Laboratoire Matière Molle et Chimie, (UMR 7167, ESPCI-CNRS) ESPCI ParisTech 10 rue Vauquelin, 75005 Paris, France



Substances like mayonnaise, toothpaste or clay act like elastic solids at rest or upon small stresses and flow after exceeding a certain value of stress [1]. The transition between these two states is called yielding, it exhibits similar features at macroscopic scale for various materials, indicating common microscopic origin [2]. This kind of behavior can be also observed in systems of soft colloids like microgels, polymer cross-linked three-dimensional networks in a solvent. In the present work, we focus on poly(N-isopropylacrylamide) (pNIPAM) microgels. We synthesized a range of microgels using precipitation polymerization and characterized the resulting particles using dynamic light scattering. These microgels have a more cross-linked core and dangling chains at the periphery. We systematically modified their structure by incorporating different cross-linking ratio [3], thereby altering their swelling ratio, elasticity, and the presence of dangling chains. We investigated the impact of these parameters on the rheological behavior of the suspensions at different volume fractions by measuring the storage and loss moduli as well as the yield stress of the suspensions. In the dilute state, microgel suspensions behave as Newtonian fluids. However, they display yield stress and shear thinning behavior when the concentration exceeds a certain packing fraction, resulting in colloid deformation, microgel compression, and interpenetration [4]. Furthermore, we examined their yielding behavior at constant low shear rates, observing the occurrence of double yielding for microgels with dangling chains, likely due to the disentanglement of overlapping polymer chains between neighbors.

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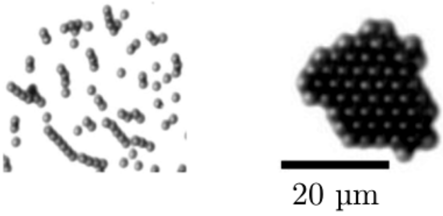
**Magdalena Przeradzka** (magdalena.przeradzka@enscbp.fr)

Since May 2021, I have been undertaking a challenging and enriching role as a PhD candidate at the University of Bordeaux in France. My academic journey began with a Bachelor of Science in Nanotechnology, specializing in Functional Nanomaterials, at Lodz University of Technology (Poland) in September 2011. I pursued further academic career, obtaining a Master of Science in Nanotechnology from the same institution in 2017. In that, a special contribution had a research internship at the University of Twente (The Netherlands), where I worked for a year on synthesis and development of the novel functionalized polymer mixtures for medical applications, using them for preparation of designed scaffolds by stereolithography. During the period between studies and the PhD, I gained valuable industrial experience that significantly contributed to my professional growth and knowledge enhancement.

# Dynamics of self-assembled anisotropic magnetic particles

*Hamid A.Hassan, Hong Xu, David Gonzalez-Rodriguez and Lydiane Bécu*
*LCP-A2MC, Lorraine University, Metz, France*



We investigate experimentally the self-assembly of colloids of magnetic particles under the influence of a high-frequency rotating magnetic field. Our research focuses on the formation and dynamics of 2D aggregates composed of magnetic colloidal beads. Previously, our team studied the dynamics of circular aggregates formed by independent, isotropic magnetic beads[1,2]. Currently, we are synthesizing rigid rods by cross-linking magnetic beads and analyzing their rotation dynamics based on their characteristics and the applied magnetic field. In particular we study the dependence of their angular velocity on their length and the properties of the external magnetic field. We investigate the motion of the rods under a rapidly rotating field, a regime that to our knowledge has not been studied before. We also investigate the dynamics of binary clusters resulting from mixing a system composed of varying proportions of anisotropic rods and isotropic beads. Additionally, we develop theoretical models to explain and predict experimental observations. By combining theory and experiments, we unveil the existence of viscoelastic phenomena underlying the motion of our colloidal systems. Certain phenomena observed experimentally present some analogies with living systems, and could thus offer new opportunities to understand the highly recurrent process of self-assembly in biological systems.

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**Hassan** (*abdelkerim-hassan.hamid@univ-lorraine.fr*).

PhD student, currently in the second year at the University of Lorraine in Metz, France. I am working on a research project titled "Self-assembly of anisotropic magnetic particles". Previously, during several internships, I had the opportunity to work on characterizing chiro-optical waveguides for integrated circuits, optical chaos generators, as well as on measuring dust along the closest line of sight.

### *Education*

- Master's degree in Applied Physics and Physical Engineering with a specialization in Photonics and Optics for Materials, obtained from the University of Lorraine and Centrale Supélec, Metz, France.
- Bachelor's degree in physics from Sorbonne University, Paris, France.
- Baccalaureate from Hadjer Lamis High School, N'djamena, Chad.

*Occasionally, I am a camel herder in the Sahara.*

# Influence of Halloysite from different deposits on organic molecules degradation

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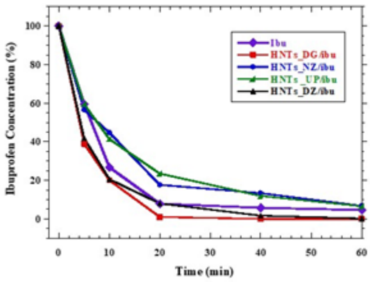
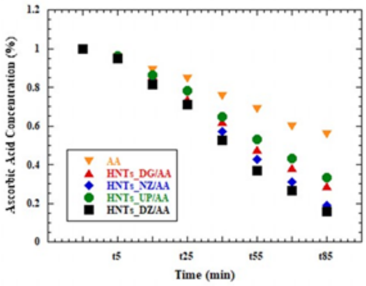
*1) Dipartimento di Fisica e Chimica 'Emilio Segrè', Università degli Studi di Palermo, Viale delle Scienze, pad. 17, 90128 Palermo, Italy*
*2) Dipartimento di Scienze e tecnologie biologiche, chimiche e farmaceutiche (STEBICEF), Sezione di Chimica, Università di Palermo, 90128 Palermo, Italy.*





In this work, a catalytic system was investigated using halloysite nanotubes (HNTs) sourced from different deposits. Halloysite nanotubes find application in different fields including drug delivery, enzyme immobilization, polymer technology, catalyst design, removal of pollutants and cultural heritage.[1] HNTs are characterized by mineral impurities that influence the physical and chemical properties of this material.[2]

Despite the possibility of using HNTs as support for catalytic purposes, HNTs could have an intrinsic catalytic activity that alter the final experimental results. The purpose of this research is to highlight this aspect through the degradation of ascorbic acid and the photocatalysis of ibuprofen employing four different types of halloysite, as shown in the figure. In particular, we observed a correlation between the presence of impurities in the chemical composition and the efficiency of a catalyst. Specifically, we examined how the presence of zinc and manganese in the composition could influence the degradation.

This investigation opens up new perspectives of research for accurately selecting halloysite over other nanoclays options.

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**Presenter name: Chiara Ferlito** (*chiara.ferlito01@unipa.it*).

My name is Chiara Ferlito, I'm 26 years old, and I'm currently pursuing a Ph.D. in Physical Chemistry at the University of Palermo. Despite having a background in classical studies for my high school leaving qualification, I decided to redirect my academic focus towards science. I hold a degree in Pharmaceutical Chemistry and Technology. Currently, my research focuses on investigating catalytic systems through both experimental and computational approaches, with a specific focus on their application in addressing water pollution. For this purpose, I am particularly interested in utilizing environmentally friendly and non-toxic materials.

# Studying the formation of non-conventional morphologies on PBLG nanoprecipitation

Silvia Argelia PERAZA KU,[1] Fabienne GAUFFRE[1], Lourdes Mónica BRAVO ANAYA[1], Colin BONDUELLE[2]
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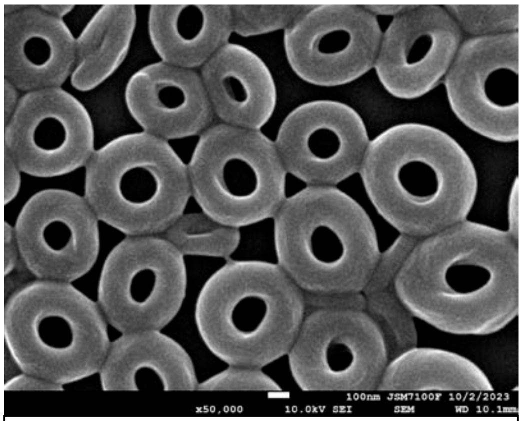
2) CNRS, Bordeaux INP, LCPO UMR5629, Univ. Bordeaux, 33600 Pessac (France)



Doughnut-shaped PBLG nanoparticles

Poly(γ-benzyl-l-glutamate) (PBLG) is a synthetic homo(peptide) that can adopt different conformations depending on molecular weight, temperature, and solvent.

The $\alpha$-helical conformation results from the intramolecular hydrogen bonds between the CO ($i$)and NH groups of the below fourth peptide ($i$ + 4), leading to a rod-like configuration; while the $\beta$-sheet conformation consists of extended polypeptide strands connected by a network of hydrogen bonds[1,2].

On the other hand, nanoprecipitation of PBLG can lead to the formation of different structures, from small spherical particles to doughnut-shaped structures called toroids. Despite several hypothesis in the reported literature[3,4], the mechanism, and the relationship between PBLG conformations and the resultant nanoprecipitations has yet to be fully understood. In this work, we studied the nanoprecipitation of PBLG in a tetrahydrofuran (THF)/water system at different conditions, such as different THF content, additives and mixing speeds. Also, the nanoprecipitation kinetics were analyzed at short time (using a Stopped-Flow device coupled to light scattering) and at long times using Dynamic Light Scattering (DLS). Depending on the mixing speed, the toroid structures appeared in different ranges of THF mass fraction. The kinetics of PBLG nanoprecipitation showed a steady behavior when there is a formation of spheroids, while the formation of doughnut-shaped particles showed an increase and decrease in light intensity over time.

Comprehending the construction of these non-conventional and complex nanostructures is important because of their potential in different fields such as template chemistry, biomedical research and nanomaterials[5].

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**Silvia Argelia PERAZA KU** (*silvia.perazaku@univ-rennes.fr*). I'm a Mexican PhD student at the University of Rennes, in the Institute of Sciences Chimiques de Rennes (ISCR). I am a chemical engineer by formation with a master's in polymeric materials. The main topic of my PhD is to better understand the mechanics behind the nanoprecipitation of big and small molecules, with two principal objectives in mind: to arrive at the formation of core-shell particles for drug encapsulation and drug delivery purposes and to study the formation of non-conventional structures in polymer nanoprecipitation.

# Improving the anti-corrosion properties of titanium materials by applying the poly(*N*-ethyl-4-vinylpyridine) coating

*Tin Klačić*,[1] *Jozefina Katić*,[2] *Tea Juračić*,[1] *Juraj Nikolić*,[1] *Danijel Namjesnik*,[1] *Tajana Begović*[1]

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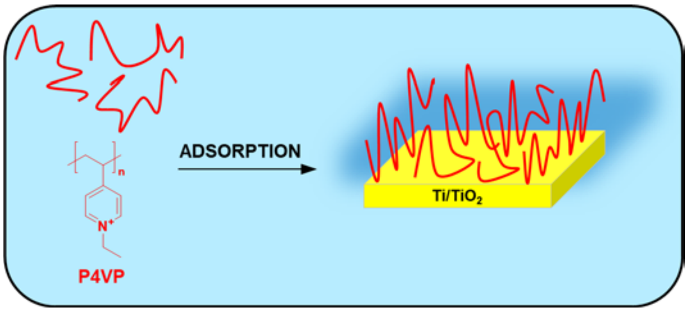

Titanium is a widely employed material in biomedicine, dentistry, and aerospace industries [1]. The main reasons for the extensive application of titanium are its excellent mechanical properties, good biocompatibility, and favorable corrosion resistance. Introducing polymer coating on a titanium surface can improve some of its properties. For instance, the deposition of polyelectrolyte coatings on a titanium surface can provide improved corrosion protection [2].

In this study, the surface and corrosion properties of titanium, modified by an electrochemically formed $TiO_2$ layer and subsequently coated by strongly charged polycation poly(N-ethyl-4-vinylpyridine) (P4VP), were investigated. Different methods such as ellipsometry, tensiometry, atomic force microscopy, single crystal electrodes, and electrochemical impedance spectroscopy were used. It was found that the electrochemically modified titanium surface was moderately hydrophilic and very flat with an average roughness of 4 nm and an oxide layer thickness of 16 nm. Deposition of P4VP on that kind of surface produced a 2 nm thick monolayer with only slightly increased surface roughness and hydrophobicity. Electrochemical measurements revealed a good corrosion resistance of the Ti/$TiO_2$ surface, and even further enhanced anticorrosion characteristics were observed for that surface coated by P4VP polyelectrolyte film.

Acknowledgements: Croatian Science Foundation financially supported the research under the project POLYMIN2 (IP-2020-02-9571).

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**Tin Klačić** (*tklacic@chem.pmf.hr*). I am a postdoctoral researcher at the Division of Physical Chemistry, Department of Chemistry, Faculty of Science in Zagreb (Croatia). My teaching activities at the Faculty of Science are related to seminars and laboratory exercises in the several physical chemistry courses for undergraduate and graduate students. The main areas of my scientific work are colloidal and interfacial chemistry, physical chemistry of macromolecules (especially polyelectrolytes), electrochemistry, and chemical kinetics. In my free time, I like to read books that relax me such as *Atkins' Physical Chemistry*, and *Multilayer Thin Films*, edited by G. Decher and J. B. Schlenoff. ☺

# Surfactant free emulsion polymerization using different sulfobetaine-zwitterionic monomers

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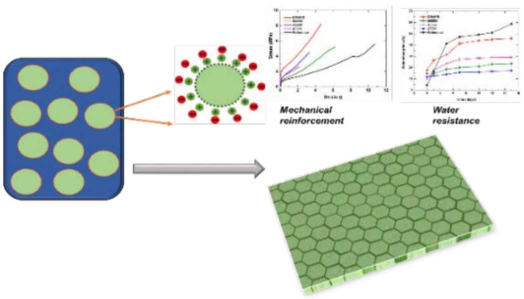
*2) IKERBASQUE, Basque Foundation for Science, , Maria Diaz de Haro 3, 48013 Bilbao, Spain*



Waterborne polymer dispersions are often produced using surfactants through emulsion polymerization [1]. However, surfactant migration during film formation negatively impacts performance and contributes to environmental pollution [2]. Copolymerizing minor amounts of ionic monomers with the main monomers offers a solution, yielding emulsifier-free latexes with excellent colloidal stability and enhanced properties [3].

In this study, making use of this approach, four different sulfobetaine-based zwitterionic monomers with methacrylic, acrylic, or acrylamide functionalities, each with varying chain lengths between two ions were carefully selected and are copolymerized with methyl methacrylate (MMA) and n-butyl acrylate (n-BA) through seeded semi-continuous emulsion polymerization, and their effect on polymer properties were examined. The performance of resulting surfactant-free coatings is also compared with a latex stabilized using conventional surfactant.

As expected, methacrylic and acrylamide zwitterionic monomers demonstrate enhanced copolymerization with MMA/n-BA compared to acrylic ZM, leading to prompt formation of stabilizing units. Consequently, this results in the production of coagulum-free colloidal dispersions characterized by improved salt and freeze-thaw stability. Furthermore, polymer films from emulsifier-free waterborne dispersions showed enhanced mechanical properties, reduced water sensitivity, and improved moisture barrier compared to those stabilized with conventional surfactants, making them promising for widespread integration in the coatings industry.

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[3] S.Bilgin, R. Tomovska, J.M. Asua, European Polymer Journal, 93, 480-494 (2017)

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**Sumi Murali Nair** (*sumi.murali@ehu.eus*).Sumi Murali Nair currently holds a postdoctoral position at the University of Basque Country in Spain. She successfully defended her Ph.D. in December 2023 under the supervision of Prof. Radmila Tomovska and Dr. Amaia Agiree. Her doctoral research focused on the incorporation of zwitterionic monomers into waterborne polymer dispersions.

# 3D-printed gas diffusion electrodes from colloidal nano-inks

Nadia Batool[1,2], Thomas Gaillard[1], Wensen Wang[2], Jiefeng Liu[2], Damien Voiry[2], Tangi Aubert[1,3]

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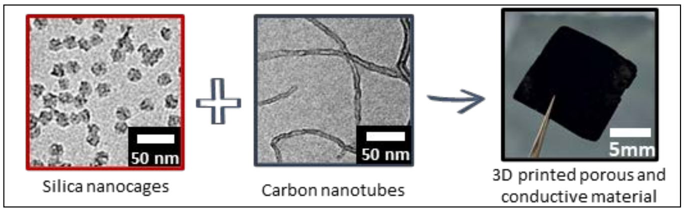
*2) IEM, Univ Montpellier, CNRS, ENSCM, 34000 Montpellier, France*
*3) corresponding author: tangi.aubert@umontpellier.fr*



The advancement of nanomaterials over the past decades has enabled a number of opportunities for the development of innovative fabrication strategies making use of colloidal building blocks for the bottom-up assembly of complex structures with precise architectures. In parallel, 3D printing is emerging as a powerful tool for the processing of advanced materials with complex geometries, intricate internal structures, and customized parts with high precision. We recently demonstrated a new approach for the direct 3D printing of hierarchically porous materials based on silica nanoparticles with cage-like structures [1]. Hierarchically porous materials have remarkable importance across many scientific disciplines owing to their unique structural characteristics, including high surface areas and controlled pore sizes/structures. These features make them valuable for a variety of applications in health, catalysis, or energy.

In this contribution, we will showcase how the integration of colloidal nano-inks with stereolithography 3D printing generates immense potential to fabricate functional devices such as gas diffusion electrodes (GDE) for flow cells. GDE is highly useful for $CO_2$ electrochemical reduction for instance, and would strongly benefit from the 3D printing capability to generate hierarchical structures. Besides porosity, these applications also require the support material to be hydrophobic, to prevent flooding with water, and conductive. To meet these requirements, we developed new 3D printing inks based on silica nanocages with added functionalities. First, we took advantage of the versatile surface chemistry of silica to functionalize the nanocages with hexamethyldisilazane. The materials printed from such modified nanocages showed highly hydrophobic behaviours and prevented water penetration in porous structures. To implement electrical conductivity, we then integrated carbon nanotubes (CNTs) together with the silica nanocages in the ink formulation. The CNTs were dispersed in a mixture of N-methyl-2-pyrrolidone and propylene carbonate, resulting in stable colloidal solutions compatible with commercial printers. These new inks were used to fabricate porous and conductive 3D structures with high potential as gas diffusion layers in innovative GDE designs.

## References:

[1] Aubert T, Huang J Y, Ma K, Hanrath T, Wiesner U, *Nat. Commun*. 11, 4695 (2020).

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**Nadia Batool** (*nadia.batool@etu.umontpellier.fr*). She received her master's degree from Soochow University, China. Currently, she is pursuing a PhD at the University of Montpellier, her research focuses on the 3D printing of porous electrode materials for electrocatalytic applications.

# Drying of silicone oil emulsions on absorbent substrates

Allan Salem-Tabet,[1,2] Kevin Roger[2], Véronique Schmitt[1]
1) CNRS, Centre de Recherche Paul Pascal, UMR 5031, Université de Bordeaux
2) CNRS, Laboratoire de Génie Chimique, UMR 5503, Toulouse INP

Oil-in-water emulsions are used in diverse industries to make coatings on roads, papers or textile in order to cover the substrate and change its surface properties. Hydrophobicity, non-stick or even cosmetic changes are usually targeted. During the film formation process, drying is an important step since it influences the structure and cohesion of the film, to avoid cracks for example.[1] In literature, a well-known three-steps drying process involves a series of physicochemical events that convert diffusing diluted droplets into a coherent solid film (Fig. 1).[2] Initially, water evaporation occurs, inducing droplet-droplet contact and deformation. Subsequently, coalescence ensues followed by chemical crosslinking. However, this process is modified when drying on absorbent substrates since they behave like capillary sponges and the increase of interface creates confined spaces where droplet-droplet contacts are enhanced. Paper was the chosen substrate for its ability to absorb liquids in its porosity and cellulosic fibers.[3]

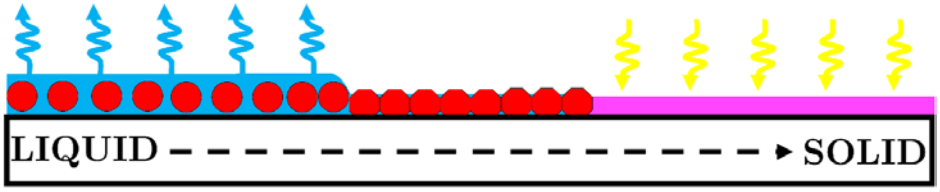

*Fig. 1: Drying process of an emulsion on non-absorbent substrate. From left to right: drying, packing, coalescence and cross-linking.*

The conducted study has the objective to describe the changes in the film formation process. To do so, experiments have been performed to see how absorption plays on water disappearing, surface chemistry, confined space and fibers wetting influence coalescence and film coherence.

The first part of the work was focused on the preparation of silicone oil emulsions stabilized either by polymers, surfactants or both. Prepared at high oil content, we were able to obtain narrow drop size distributions where the mean diameter is controlled by the quantity of surface agent. Then, drying experiments revealed diverse behaviors depending on the substrate and stabilizer. Polymer-stabilized emulsions showed strong resistance to coalescence on non-absorbent substrate in a wide range of temperatures, while breaking on paper at room temperature. Whereas surfactant-stabilized ones inevitably broke on all substrates at all temperatures. Finally, imbibition tests permitted to see the droplets flow inside the paper. After drying no droplets were spotted and the fibers and porosity were filled with oil. An imbibition microfluidic cell coupled with optical microscopy, confocal and Raman confocal permitted to spot coalescence inside the paper.

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[1] H. N. Yow, M. Goikoetxea, L. Goehring, A. F. Routh, *J. Colloid Interface Sci.* 352 (2), 542-548 (2010).

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[3] S. Chang, J. Seo, D.-G. Lee, W. Kim, *J. Fluid Mech.* 845, 36-50 (2018).

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**2017-2022: Materials engineer, Polytech Sorbonne, Paris, France.**

**June to July 2021: Synthesis and characterization of amphiphilic block copolymers, internship in Institut Parisien de Chimie Moléculaire, UMR 8232, Sorbonne Université, Paris, France.**

**February to September 2022: Study of the compatibility of composites PA6GF with de-icing salt, intership in Valeo, La Verrière, France.**

**2022: PhD in physical chemistry.**

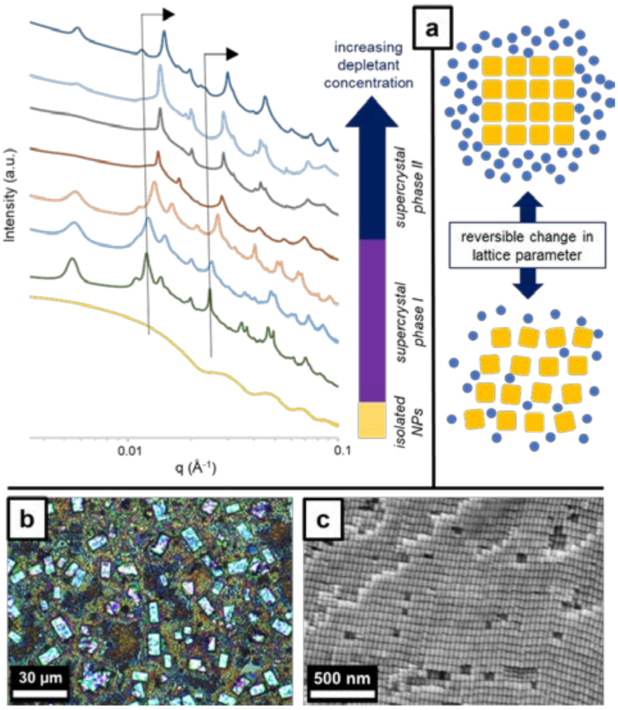
# Day 2

| | | |
|---|---|---|
| June 25th / Tuesday | | |
| | Amphi 1 | |
| 9:00-10:00 | Agustin Mihi | |
| | Amphi 2 | Amphi 3 |
| | Chair: M. Mendes | Chair: G. Lacroix |
| 10:00-10:20 | Jaime Gabriel Trazo | Sribaharani Sekar |
| 10:20-10:40 | Qingyuan Song | Mohammad Mahdi Assaf |
| 10:40-11:00 | Coffee break | |
| | Chair: L.van Hazendonk | Chair: G. Gimenez |
| 11:00-11:20 | Matheus Mendes | Zi Lin |
| 11:20-11:40 | Xiaoyu Qi | Carolina Dari |
| 11:40-12:00 | Margaux Gaillard | Mónika Bak |
| 12:00-13:30 | Lunch | |
| | Amphi 1 | |
| 13:30-14:30 | Katherine Elvira | |
| | Amphi 2 | Amphi 3 |
| | Chair: Z. Lin | Chair: R. Ramanujam |
| 14:30-14:50 | Giulia Gabbricci | Sofia Rogers Ruiz |
| 14:50-15:10 | Anyi Ropero Barrera | Antoine Castagnède |
| 15:10-15:30 | Ilaria De Cristofaro | Matteo Farci |
| 15:30-16:00 | Coffee break | |
| | Chair: I. Jalisse | Chair: X. Yin |
| 16:00-16:20 | Loic Jouan | Laura van Hazendonk |
| 16:20-16:40 | Sebastian Höhne | Antoine Simon |
| 16:40-17:00 | Usue Aspiazu Iturbe | Mariafrancesca Coccimiglio |
| 17:00-17:20 | Theo Duarte | Matthieu Soula |

# Tunable Lattice Parameters and Symmetry in Plasmonic Metasurfaces

*Jaime Gabriel Trazo,*[1] *Jules Marcone*[1]*, Cyrille Hamon*[1]*, Marianne Impéror-Clerc*[1]
*1) Laboratoire de Physique des Solides, Université Paris-Saclay*

The self-assembly of metal nanoparticles (NPs) into crystalline structures opens up novel and collective functional properties not found in conventional materials [1, 2]. However, current methods of self-assembly generally yield static 3D assemblies, and their dimensionality and lattice parameters are not tunable [1].



***(a)*** *SAXS | Plasmonic Au@Ag cuboid nanorods self-assembled by depletion exhibit tunable inter-NP distance and a change in lattice symmetry;* ***(b)*** *Faceted supercrystals of Au@Ag nanocuboids seen by optical microscopy;* ***(c)*** *Stacked layers of the tetragonal lattice of the same Au@Ag nanorods seen by SEM.*

Herein, we assembled Au@Ag nanorods (NRs) of varying aspect ratio and cross-section by depletion induced self-assembly, wherein CTAC surfactant micelles act as depletants. A reversible self-assembly in solution of metal NRs into 2D colloidal plasmonic SCs with tunable crystal lattice symmetries is achieved.

By varying the micelle concentration, we show that this method enables one to change the lattice parameter, the lattice symmetry, and the dimensionality of the SCs formed by one given NR (Figure 1a).

First, higher depletant concentration reduces the inter-NP distances in the colloidal SCs. Second, a change in lattice symmetry is observed from an orthorhombic to a tetragonal lattice, while increasing depletant concentration in assembling square NRs (Figure 1a, 1b). Finally, at equivalent depletion conditions, high aspect ratio NRs prefer self-assembling into 2D SCs while low aspect ratio NRs prefer forming 3D SCs (Figure 1b, 1c).

This result is a new advancement in understanding the self-assembly of anisotropic NPs by balancing nanoscale forces [1, 3], as well as the possibility of switching between different lattice symmetries [4, Figure 1a]. Our results also highlight the key interplay between NP shape, aspect ratio, and depletion forces that drive NP auto-organization into different structures [1]. We propose depletion induced self-assembly as a new method for creating reconfigurable plasmonic metasurfaces.

References:

[1] C. Goldmann, et al., Confinement Effects on the Structure of Entropy-Induced Supercrystals. *Small*, 2303380 (2023).
[2] T.O. Otomalo et al. Spectral Variations of the Ultrafast Transient Light Extinction by Bimetallic Nanoparticles in the Near-UV, *Adv. Opt. Mater.*, 9(8) 2001778 (2021).
[3] K.L. Young, et al. Assembly of Reconfigurable One-Dimensional Colloidal Superlattices Due to a Synergy of Fundamental Nanoscale Forces. *Proc. Natl. Acad. Sci. U.S.A,* 109(7), 2240-45 (2012).
[4] J. Marcone, et al. Polymorphous Packing of Pentagonal Nanoprisms. *Nano Lett.* 23(4), 1337-42 (2023).

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**Jaime Gabriel TRAZO** (*jaime-gabriel.trazo@universite-paris-saclay.fr*). Specializing in nanomaterials and plasmonics, Jaime Trazo is a PhD student researcher at Université Paris-Saclay, and a member of the MATRIX Team of the Laboratoire de Physique des Solides (LPS). Trained in chemistry and materials science, he earned his undergraduate degree at the Ateneo de Manila University, and completed his masters under the SERP+ Erasmus Mundus Program. Apart from his doctoral research, he loves to talk about languages, mathematics, and coffee.

# Short-time formation kinetics of OUZO droplets as possible scaffolds for the assembly of nanoparticles into submicron shells. Towards optical resonators.

**S.Sekar**,[1] M. Nour Mahamoud,[2] J. Giermanska,[1] A. Baron,[1] F. Gauffre,[2] J.-P. Chapel,[1] V. Ponsinet.[1]

1) Centre de Recherche Paul Pascal (CRPP), UMR CNRS 5031, University of Bordeaux, 33600 Pessac
2) Institut des Sciences Chimiques de Rennes (ISCR), UMR CNRS 6226, University of Rennes, 35042 Rennes

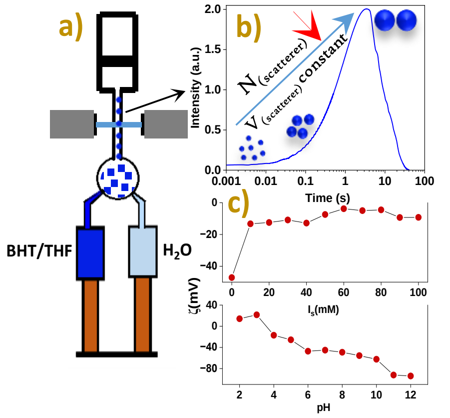

*Figure 1: a) Schematic representation of stopped flow (SF), b) Characteristic bell-shaped curve of the scattered Intensity as a function of time, c) Zeta potential of Ouzo droplets Vs pH and salt.*

Spontaneous emulsification is of great interest as it is one of the most efficient formulation routes used in the food, paint and cosmetics industries. A good example is the Ouzo effect, which results from liquid-liquid phase separation of hydrophobic solutes in a ternary system by the addition of a non-solvent.[1] In this work, we used a model system, in which, when water is added to a clear, homogeneous solution of butylated hydroxytoluene (BHT) in THF, droplet nucleation results from super-saturation of the solution, and further coalescence leads to the formation of metastable “ouzo” droplets. These nanoprecipitated droplets are responsible for the bluish appearance of the solution.

Here, we tackle the difficult issue of monitoring the kinetics and mechanism of emulsion droplet formation at an early stage (4 ms to 100 s), which was still lacking in the literature, using a stopped-flow light scattering[2] (SF) device, as illustrated in Fig. 1. The scattered intensity versus time presents a distinct bell-shaped curve, in the domain of the ternary diagram BHT/THF/$H_2O$[3], where ouzo droplets are generated. This is a distinctive signature that we have recently observed in other systems involving liquid-liquid phase separations (complex coacervation, Aqueous Two Phase System). In addition, we have systematically probed the size of the droplets by dynamic light scattering (DLS) coupled with the SF. The effect of ionic strength and pH were also characterized by Zeta potential, DLS and optical microscopy, to explain the high stability of the ouzo droplets with time. These droplets are further used as scaffolds to elaborate shells of metallic nanoparticles for the fabrication of plasmonic resonators with specific optical resonance modes in the visible light wavelength range[4].

References:

[1] K. Roger et al, *Journal of Colloid and Interface Science*. 650, 2049-2055 (2023).
[2] X. Liu et al, Soft Matter.12, 9030-9038 (2016)
[3] D. Iglicki et al, *Journal of Colloid and Interface Science*. 633, 72-81 (2023).
[4] M. Lafitte et al, Langmuir, 40, 2601-2615 (2024)

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***Google Scholar citation:***
https://scholar.google.se/citations?user=YJOs59EAAAAJ&hl=en

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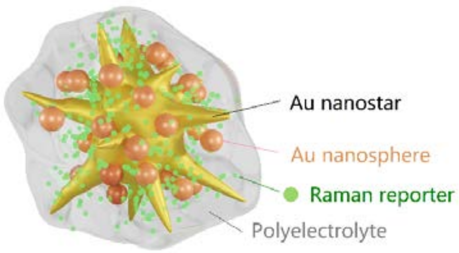
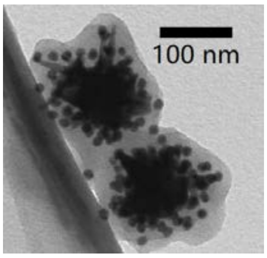
|---|---|---|
| Feb’23 – Present | ***Post-Doctoral Researcher***<br>(Mentors: Dr. V. Ponsinet & Dr. J.-P. Chapel) | Centre de Recherche Paul Pascal<br>Pessac, France |
| Feb’16 – Apr’16 | ***Visiting Researcher***<br>(Mentor: Dr. A. Fery) | Leibniz institute for polymer research<br>Dresden, Germany |
| Sep’13 – Jan’16 | ***Post-Doctoral Researcher***<br>(Mentors : Dr. M. Pauly & Dr. G. Decher) | Institute Charles Sadron<br>Strasbourg, France |
| Jan’10 – Jul’13 | ***Ph.D***<br>(Mentor : Dr. J.-P. Chapel) | Centre de Recherche Paul Pascal<br>Pessac, France |
| Aug’08 – Dec’09 | ***Project Assistant***<br>(Mentor : Dr. S. Patil) | IISc, Bangalore, India |

# Gold Nanostar–satellite Nanoprobes for Surface Enhanced Raman Spectroscopy

*Qingyuan Song,[1] Florian Wieduwilt[2], Yingying Cai[1,*], Philipp Vana[1,*]*
*1) Institut für physikalische Chemie, Georg-August-Universität Göttingen Tammannstr. 6, Göttingen 37077, Germany*
*2) Institut für Nanophotonik Göttingen e.V., Hans-Adolf-Krebs-Weg 1, Göttingen 37077, Germany*

The design and fabrication of plasmonic nanostructures to sustain high electromagnetic enhancement is of key importance for the analytical and biomedical applications of surface-enhanced Raman spectroscopy (SERS) nanotags. Due to their unique optical properties, anisotropic nanoparticles with sharp spikes, such as triangles, (bi)pyramids, flowers or stars, often provide more outstanding near-field enhancement compared to their spherical counterparts. Besides the "tip effect" enhancement provided in the proximity of the sharp spikes, a further enhancement can be achieved in so-called hot spot in interparticle junctions, which is also referred as "gap effect".[1] These hot spots can be generated by building small clusters, aggregates, or core-satellite structures. Other parameters of the nanotag, including the fine-tuning of the spectral position of the plasmonic core, the choice of Raman reporter with suitable electronic resonance as well as the method for the surface coating should be meticulously designed and tailored for specific analytic condition.[2]





In this work, we proposed an assembly method for SERS-nanotag based on gold nanostar-satellite cluster, with diffusion-incorporated Raman probe molecules encapsulated by polyelectrolyte coating. With the nanostar-satellite cluster structure, we demonstrate the possibility of combining both tip effect and gap effect and maximizing the enhancement in one single SERS nanotag. Meanwhile, with the encapsulation strategy, no covalent anchoring group on the Raman reporter is required and more than a monolayer of surface density can be achieved, thus increasing the SERS signal intensity.

References:

[1] A. Shiohara, S. M. Novikov, D. M. Solís, J. M. Taboada, F. Obelleiro, and L. M. Liz-Marzán: J. Phys. Chem. C, 119 (2015), no. 20, p. 10836–10843.
[2] B. Andreiuk et al: Nanotheranostics, 6(2022) 6, no. 1, p. 10–30.

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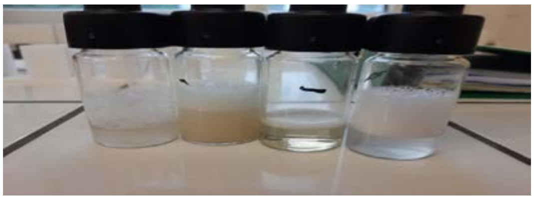
**Qingyuan Song** (*qingyuan.song@stud.uni-goettingen.de*). Qingyuan Song received her B. Sc. in Chemistry in 2019 before completing her M. Sc. in 2022 from the University of Göttingen. Currently, she is a doctoral student in the group of Prof. Philipp Vana at the University of Göttingen. Her research interest focuses on developing polymer-nanoparticle hybrid materials for surface-enhanced Raman spectroscopy applications.

# Foaming properties of aqueous solutions of natural plant proteins in relation with their interfacial rheological properties at the air/water interface

*M. Assaf[1,2], P. Marchal[1], V. Sadtler[1], O. Mesieres[1], S. Beaubier[1], R. Kapel[1], T. Hamieh [2,3], T. Roques-Carmes[1]*
*[1]LRGP, Université de Lorraine-CNRS, UMR 7274, 1 rue Grandville, Nancy F-54000, France*
*[2]Université Libanaise (UL), Beirut, Liban*
*[3]Maastricht University, Maastricht, Netherlands*



*Proteins have been a significant part of human nutrition. The majority of protein in our diet comes from whole foods (raw, cooked, or processed) or formulated food products that include components of fractionated protein that come from plants or animals.*

*Plant-based proteins have gained more attention. Consumers are searching more and more for plant-based eating options, due to their health benefits and environmental advantages. Furthermore, plant proteins align with ethical and environmental concerns because in general, they leave fewer ecological traces than protein sources originating from animals [1].*

*Moreover, its technological functionality, such as gelling, emulsification, and foaming, provides food with attractive qualities in terms of texture and sense.*

*The aim of this study is to examine how the interface changes in response to a compression/expansion deformation named dilatational rheology, and to investigate the link with, or its impact on the foamability, (foam stability and foam quality) of various proteins. Three plant protein were tested as green surfactant sunflower, rapeseed, and linseed, where BSA an animal protein, have been used as a reference.*

*First, a comparison study of the interfacial properties (in terms of surface tension, elasticity, and viscosity of the interface) for different interfacial layers formed by the different proteins at the air/water interface was carried out using a drop tensiometer. Followed by a foam study using ultra turrax mixer to probe their foam stability and foamability at different concentrations. Foam stability was studied by following the evolution of the foam by measuring the height of foam as a function of time.*

*The two methods allowed us to better identify the link between the interfacial rheological properties and foamability of these natural proteins. Interfacial rheology can be view as a predictive tool for studying the functional properties, such as foams stabilization, for adding value to bio-based materials and for developing new products.*

References:

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- ✓ 2nd Year PhD at LRGP, University of Lorraine Nancy F-54000, France.
- ✓ Internship at L2Cmp, University Poitiers2022 France.
- ✓ Master degree in Materials and catalysis, Lebanese University 2021 Lebanon.

# Template-assisted chirality induction to magnetic nanoparticles using silica nanohelices. Towards new magneto chiral responsive nanocomposites.

*Matheus de Souza Lima Mendes*[1], *Gautier Duroux*[1], *Iryna Makarchuk*[2], *Sylvain Nlate*[1], *Reiko Oda*[1], *Benoit Pichon*[2], *Elizabeth Hillard*[3], *Emilie Pouget*[1]
*1) CNRS, Univ. Bordeaux, Bordeaux INP, CBMN, Pessac, France.*
*2) CNRS, Univ. Strasbourg, IPCMS, Strasbourg, France.*
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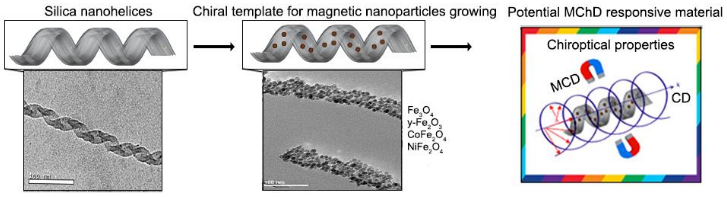

Grafting of magneto-optically active nanoparticles into silica nano helices with controlled chirality.

The MagnetoChiral Dichroism (MChD) is a fascinating phenomenon used to enrich one of the two enantiomers of a racemic mixture without circularly polarized light and is considered a plausible explanation for homochirality in life[1]. The MChD is a cross effect between the Natural Circular Dichroism (NCD) phenomenon observed in chiral materials, and the Magnetic Circular Dichroism (MCD) observed in magnetic achiral materials. The development of materials to study MChD is a huge challenge and just a few examples are available in the literature due to the big effort necessary to obtain materials that can be both NCD and MCD active[2]. In the present work, we develop different strategies aiming to assembly and inducing chirality to magneto-optically active magnetite ($Fe_3O_4$), maghemite (y-$Fe_2O_3$), and cobalt ferrite ($CoFe_2O_4$) colloidal particles using a helical silica nano-template that is intrinsically chiral by its morphology[3] to obtain potential new MChD responsive materials (see figure). Finally, those systems can be used as model systems for a first step toward the first nanocomposite systems to possibly detect the MChD phenomenon.

References:
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[2] C. Train, M. Gruselle, M. Verdaguer, Chem. Soc. Rev., 2011, 40, 3297
[3] T. Delclos, C. Aimé, E. Pouget, A. Brizard, I. Huc, M.-H. Delville, R. Oda, Nano Lett., 2008, 8, 1929

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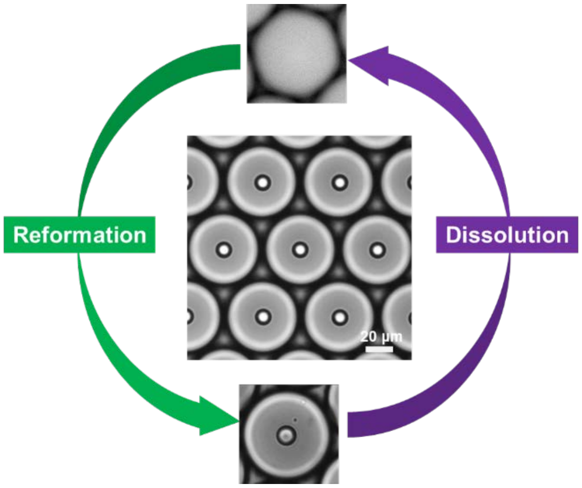
Graduated with a Bachelor's degree in Chemistry with Technological Attributions from the Federal Institute of Education, Science and Technology of Rio de Janeiro (IFRJ) (2015-2019) and a Master's degree in Polymer Science and Technology from Federal University of Rio de Janeiro (IMA-UFRJ) (2021) where he developed skills on research projects in the area of science teaching, polymer technology, advanced oil recovery, magnetic nanocomposites for environmental recovery and environmental management. He is currently a Ph.D. student in Physical Chemistry at the Université de Bordeaux (UB) and is particularly interested in the synthesis of new magnetochiral materials.

# Dynamic behavior of light-responsive coacervates in microfluidics droplets

Zi Lin[1], Thomas Beneyton[1], Jean-Christophe Baret[1], Nicolas Martin[1]

1. Univ. Bordeaux, CNRS, Centre de Recherche Paul Pascal, UMR 5031, 33600 Pessac, France

**Abstract:** Liquid-liquid phase separation is ubiquitous in biology since it is the underlying mechanism to form membraneless organelles.[1] Coacervate droplets produced in vitro with oppositely charged polyelectrolytes are promising models of membraneless organelles. These droplets are highly-crowded and open compartments, easily respond to environmental stimuli and recapitulate essential processes occurring inside living cells.[2] To mimic the dynamic behavior of membraneless organelles, we recently designed light-responsive coacervate droplets capable of dissolution and reformation under light stimuli.[3] Here, we use droplet-based microfluidics to encapsulate these photoswitchable coacervates within water-in-oil emulsion droplets , providing a stable observational platform to extract and rationalize the kinetics of light-induced phase behaviors. Ultimately, complex non-equilibrium behaviors, such as budding and self-division, are achieved under optimal co-illumination conditions. These light-responsive systems could open perspectives for the reversible control of biocatalytic reactions in synthetic cells, and serve as dynamic artificial membraneless models for prebiotic protocells.

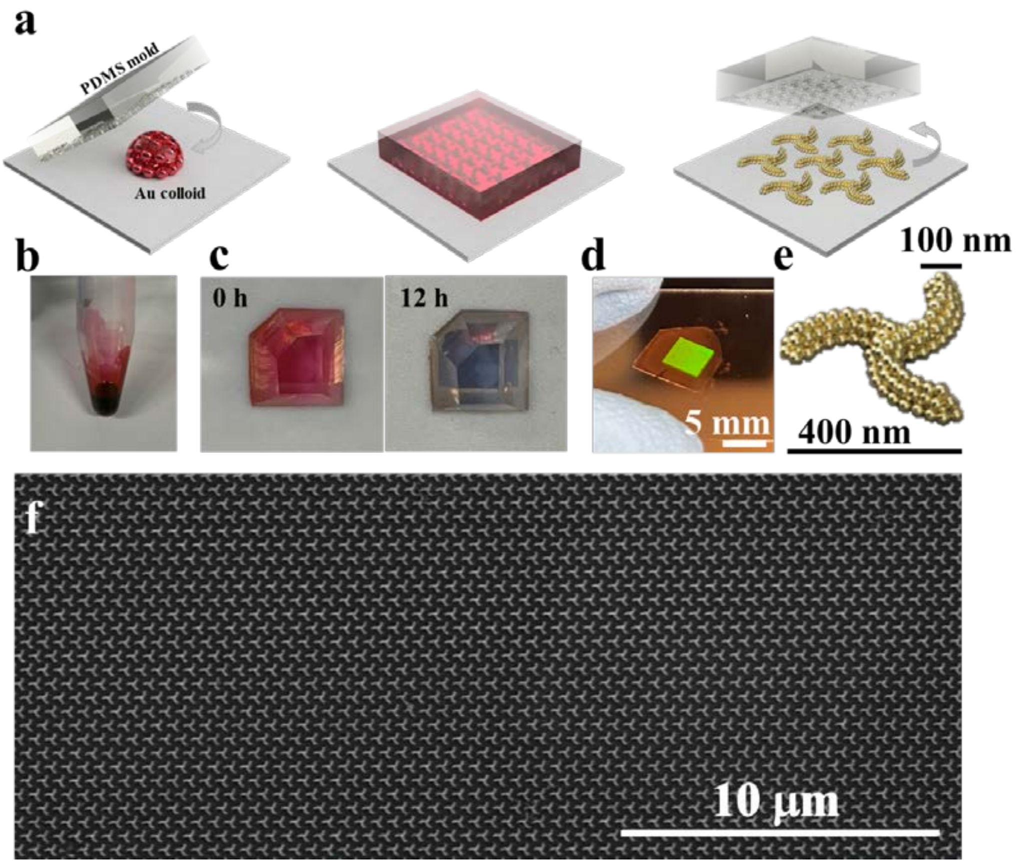


[1] N. A. Yewdall, A. A. M. André, T. Lu, E. Spruijt, *Current Opinion in Colloid & Interface Science* **2021**, *52*, 101416.
[2] Z. Lin, T. Beneyton, J.-C. Baret, N. Martin, *Small Methods* **2023**, *7*, 2300496.
[3] N. Martin, L. Tian, D. Spencer, A. Coutable-Pennarun, J. L. R. Anderson, S. Mann, *Angew. Chem. Int. Ed.* **2019**, *58*, 14594.

# Template-assisted assembly of metal colloids for tunable chiral plasmonic lattices

*Xiaoyu Qi[1], Luis Alberto Pérez[1]*, Jose Mendoza-Carreño[1], Miquel Garriga[1], Maria Isabel Alonso[1], Agustín Mihi[1]**

*1）Institute of Materials Science of Barcelona ICMAB-CSIC; Bellaterra, 08193, Spain.*



A universal, straightforward, scalable method is demonstrated for crafting chiral metasurfaces using a variety of Ag and Au metal colloids. Here elastomeric molds pre-patterned with arrays of chiral shapes guide the assembly of the metal colloids on the substrate. The resulting chiral lattices exhibit a blend of intrinsic and extrinsic chiroptical responses, resulting in metasurfaces with a g-factor of 0.4 at normal incidence, tunable up to a g-factor of 1.55 at oblique incidence. The programmable optical response of the nanoparticle arrays is demonstrated to impart chirality to a fluorophore deposited on top resulting in a strong and tunable circularly polarized photoluminescence.

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Xiaoyu Qi is a PhD student of Materials Science (ICMAB-CSIC) now. During PhD, she is working at fabrication and characterization of plasmonic metasurfaces under the supervision of Dr. Agustín Mihi.

# Lamellar gel network stabilizing water-in-water emulsions

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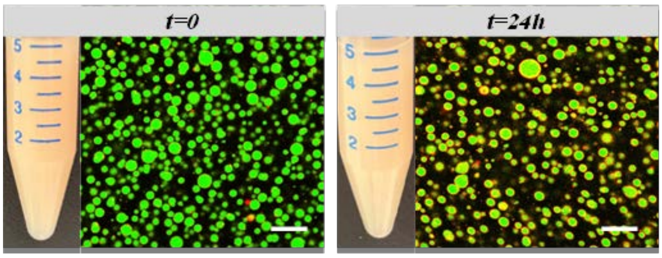

Water-in-water (W/W) emulsions refer to the dispersion of an aqueous phase in another aqueous solution. This can occur when two hydrophilic polymers in a mixture at certain concentration exhibit phase separation. W/W emulsions have found diverse applications across various domains such as food, biomedical, drug delivery, etc. Stabilizing W/W emulsions is a challenge due to their low surface tension and a larger interface when compared to conventional oil-in-water emulsions. The mixture of surfactant and fatty alcohols is known to form Lamellar Gel Networks (LGNs), which can be described as a multi-phase colloidal structure mainly composed of a lamellar phase and bulk water. LGNs are widely used to stabilize oil-in-water emulsions. In the current context of growing concern for the environment, bio-based surfactants are an alternative to synthetics for the production of LGNs. Alkyl polyglucosides (APGs) is a recognized group of natural surfactants, based on glucose and fatty alcohol. Here, we report the use of LGNs based on APGs and fatty alcohols to stabilize model W/W emulsions based on dextran-in-poly(ethylene glycol) [1].

In the first step, we studied the influence of the concentrations of two different APGs: decyl glucoside (DG) and lauryl glucoside (LG), and the molar ratio between the APGs and decanol as model fatty alcohol on the stability and droplets size of the W/W emulsions. Combining observations with the naked eye and confocal microscopy (Figure 1), we determined the best concentration of APGs and the best ratios to obtain emulsions with high stability. The self-assembled structure formed by decanol:APGs was characterized by Small Angle X-ray Scattering and confocal microscopy. The results indicate a LGNs both in the bulk phase and likely at the surface of dextran-rich droplets.

Then we demonstrated the versatility of our system, extending our approach to other APG and to other fatty alcohols. We demonstrated that the self-assembled structure of coco-glucoside and decanol also led to dextran-in-PEG emulsions with no phase separation and no change in droplet size after 24h. In addition, the stabilization of such aqueous emulsions was also achieved with the combination of dodecanol or myristyl alcohol with DG or LG, with no significantly changes for at least 24h. All these systems forming LGNs stabilizing the W/W emulsions

Finally, we took advantage of the stability of these W/W emulsions systems to show for the first time that it is possible to produce a foam using such W/W emulsions as the continuous phase.

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# Self-Assembly-Driven Biosensors: DNA-Guided Gold Nanoparticles for Information coding

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Gold nanoparticles (GNP) are nanometer-sized particles of gold with unique properties that make them highly promising for numerous applications in diverse fields, such as medicine, biotechnology, chemistry, catalysis and photonics. In particular, GNP are used to develop biosensors[1], which are devices capable of detecting specific molecules in biological samples. GNP-based biosensors offer a number of advantages over traditional biosensors, such as greater sensitivity, selectivity and ease of use. In addition, GNP can be combined with DNA to encode information[2]. This can be used to create even more sensitive and selective biosensors, or to develop new methods for diagnosing and treating diseases[3].

The challenge of the project is to develop a technique to encode information in a nanoparticle-based ink and to be able to collect and read the coded information once deposited on a surface. We use DNA hybridization to ensure the selectivity of the recognition technique. In fact, by hybridizing nanoparticles on a surface using DNA coding (Figure 1) and by collecting the spectral response of the nanoparticles, it is possible to detect and recognize the code.

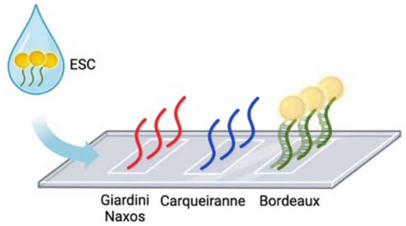

*Figure 1: Principle of information coding using DNA*

First, we verified our hybridization protocol by hybridizing DNA strands with fluorophores at their ends. Then, we immobilized GNP and Qdots on a glass substrate by DNA hybridization. Finally, we optimized the immobilization protocol using Surface Plasmon Resonance (SPR).

**Acknowledgments**

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After being graduated in material sciences, I began my doctoral studies in nanoscience at the Lumière, nanomatériaux et nanotechnologies laboratory. The aim of my doctoral studies is centered on the way to fight the trafficking of cultural goods through the use of nano-labeling.

# Structuring liquids through solvent-assisted interfacial association of oppositely charged polyelectrolytes and amphiphiles

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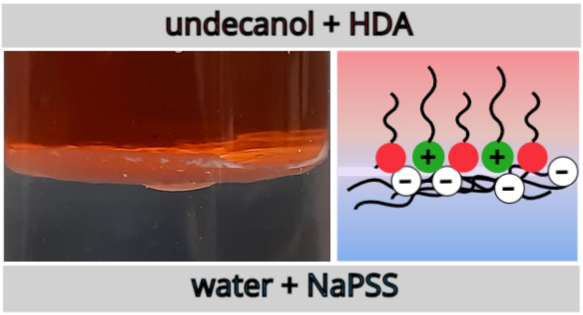

Exciting novel instances of liquid/liquid two-phase systems are structured liquids, where the shape of the liquid phases is locked. These systems have been recieving an intense interest especially when produced from simple compounds with versatile application potentials. Structured liquids are based on their solidified interface, which can be created through jamming of the adsorbed compounds.

In this work an anionic polyelectrolyte and a cationic traditional surfactant were utilized to contribute in arresting the interfacial layer, which is suitable for separating liquid phases, and which is formed from the spontaneous association of components with opposite charges dissolved in two different phases [1]. This phenomenon is made possible by the use of an organic solvent with the special property of „surface freezing", which can integrate into the association created on the surface and thus solidifies the resulting layer. The incorporation of the organic solvent molecules into the film as a co-surfactant is unique, and the formed layer are promising in the fields of membranes and two-phase catalysis, as well as in all-liquid structural applications.

We studied the resulting interfacial film using various experimental techniques, for example ATR-IR spectroscopy, SAXS, WAXS and 3D printing. Taking steps towards its practical application aspects it was mapped how the membrane behaves if after the formation both surrounding phases are replaced by an aqueous solution, thus the permeability to various components, e.g. dyes could be examined. It was also studied whether the layer is suitable for permanent stabilization of emulsion droplets. The temperature-responsiveness of the resulting system was examined as well.

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She began her studies in 2014 at Eötvös Loránd University in Hungary, and obtained a teacher's degree in Chemistry and German language. After that she started her doctoral studies in Chemistry in 2020. Her major research topics are gold nanoparticles and structured liquids. Meanwhile she also teaches at a secondary school and believes that - since she is not always able to talk down children - motivation should be created through loving attention and leading by example.

# Microfluidic synthesis of Solid Lipid Nanoparticles and Nanostructured Lipid Carriers for enhanced dermal delivery: characterization, optimization, and structural comparative analysis

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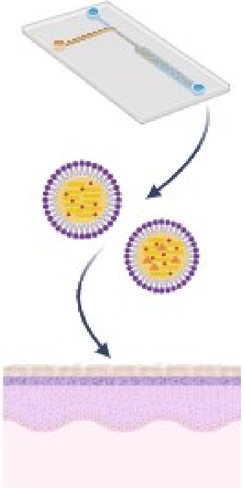

The main challenge in topical delivery is to overcome the skin protective barriers, the outermost being the *stratum corneum* (SC) which prevents trans-epidermal water loss and the penetration of chemical agents, microorganisms, and drugs into the skin. One promising approach for overcoming skin barrier and enhancing the delivery of actives is the use of lipid nanoparticles[1]. Among the lipid nanocarrier, solid lipid nanoparticles (SLNs) and nanostructured lipid carriers (NLCs) are suitable for dermal delivery. Their high affinity for the SC allows a higher bioavailability and penetration of the encapsulated molecules, and their strong adhesion on skin produces an occlusive effect enhancing skin hydration[2]. Moreover, SLNs and NLCs allow to modulate the release behavior of both hydrophobic and hydrophilic active substances. While a quicker release can improve penetration, a sustained release is crucial for either active ingredients that may cause irritation or prolonged delivery. Despite the benefits offered by SLNs, their application remains restricted due to the long preparation times, high concentrations of reagents and significant variability in nanoparticle size and PDI across different batches that characterize the current bulk production methods. Innovative microfluidic techniques ensure reproducibility, scalability, and control over the chemical-physical properties of the synthetized SLNs. Moreover, smaller nanoparticles with narrower size distribution can be obtained, highly desirable for an effectively delivery through biological barriers[3]. However, despite recent studies demonstrated the use of microfluidics for liposome and lipid nanoparticles synthesis, there are still few works on the SLNs production using this technique.

In this work, different formulations of SLNs and NLCs were synthetized with a microfluidic apparatus and size, PDI, and encapsulation efficiency of two model molecules were optimized using an experimental design approach. The obtained nanoparticles were all below 200nm, monodisperse and with high encapsulation efficiency. The investigation was focused on the impact of the composition (presence of liquid lipid, type of solid lipid and surfactants) on the crystalline and supramolecular arrangement. The nanoparticles size was measured with Dynamic Light Scattering, the supramolecular and crystalline structure was performed by SAXS/WAXS measurements. Calorimetry was performed to assess the transition of the lattice core and cargo quantification was done with HPLC.

This work has been cofounded by Procter and Gamble.

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27/10/2023 Master’s degree in chemistry with a thesis entitled “Optimization of thymol loaded Solid Lipid Nanoparticles for home-care applications”

02/01/2023-30/09/2023 Research assistant entitled “Solid Lipid Nanoparticles for the encapsulation of perfumes and natural actives and their stability in surfactants”

# Surface modification of cotton for sustainable antimicrobial cellulose-based products

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Developing sustainable antibacterial properties for formulated products is critically important. Cellulose-derived fibres and fabrics (e.g. cotton) are potential candidates for replacing polymer products. To explore strategies to functionalise cellulose-based substrates, we have used cotton and also silica wafers as proxies for cellulose -OH groups to evaluate different surface treatments. To this end, Zeolitic imidazolate framework 8 (ZIF-8) was grown *in situ* on silica and non-woven cotton fabrics in a facile process.[1] Then, curcumin, a naturally occurring antimicrobial agent derived from turmeric, was coordinated into the surface-grown ZIF-8 layer. Using synchrotron X-ray Reflectivity (XRR) we analyzed the structure of the modified surfaces, comparing pristine silica with silica coated with ZIF-8, Curcumin, and both ZIF-8 and curcumin.

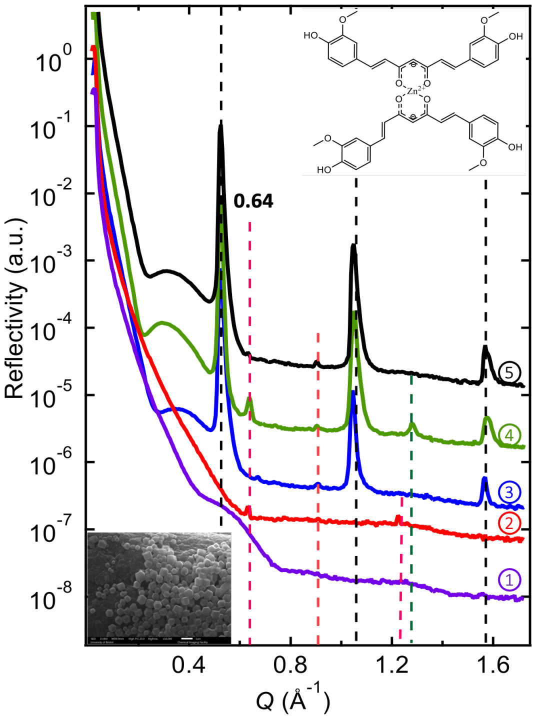

***Figure 1.*** XRR curves of 1) bare silica, and silica with 2) Curcumin (Curc) 0.4%, 3) ZIF-8, 4) ZIF-8-Curc-0.4% (Spin-coated), 5) ZIF-8-Curc-0.4% (In situ grown). Inset top right: Zinc-Curcumin complex; Bottom left: SEM of ZIF-8-Curc-0.4% on a cotton

Wide-angle X-ray Scattering (WAXS) measurements on cotton also confirmed unequivocally the success of the ZIF-8 modification, revealing Bragg peaks that could be assigned to ZIF-8 and curcumin.

Curcumin deposition is usually highly dependent on it hydrogen bonding with the available surface -OH groups. The use of ZIF-8 overcomes this restriction, as curcumin acts as a ligand and forms a metal complex with the $Zn^{2+}$ in ZIF-8. However, the notable absence of the peak characteristic of curcumin at Q ~ 0.64 Å$^{-1}$ in the XRR curve (Fig.1) when curcumin is grown *in situ* on the ZIF-8 coated silica compared to when it is spin-coated, demonstrates that varying deposition methods influences the structural arrangement of curcumin molecules on the ZIF-8 layer.

These results pave the way for our future work on single cotton-fibre nano-XRD[2] and tensile test studies, as well as further antimicrobial tests to correlate how ZIF-8 functionalization would affect cotton-fibre softness and antimicrobial efficacy.

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# Nanostructure of polymer-surfactant complex films with long-lasting antimicrobial efficacy

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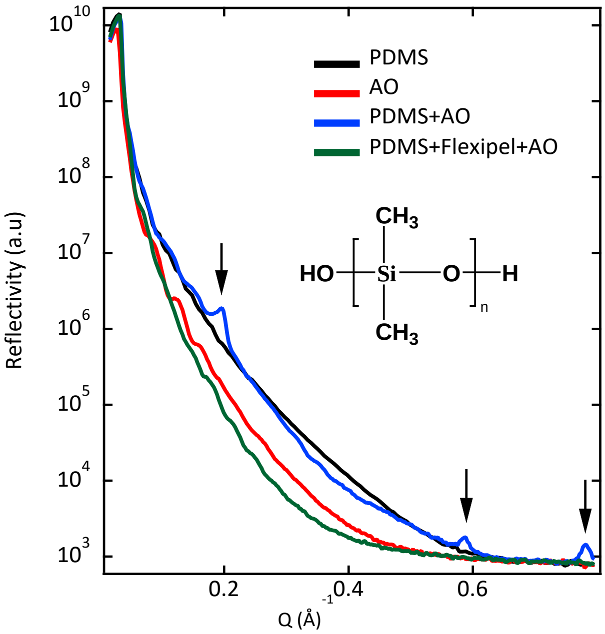

*Fig. 1. XRR curve of different nanofilms on silica, showing Kiessig fringes. The arrows point to the Bragg peaks, indicative of a multilayer structure.*

Development of Long-lasting antimicrobial surfaces is crucial for reducing chemical usage and promoting environmental sustainability. Furthermore, surfaces with long-term effectiveness are critically important in public health in the post-COVID era. Jointly with Wessex Chemical Factors Ltd, we are evaluating a polymeric formulation containing polydimethylsiloxane (PDMS), amine oxide (AO; a surfactant), and Flexipel (a water-based silane emulsion), as main ingredients, which has unexpectedly exhibited long-lasting antimicrobial activity.

Some advantages of PDMS include low surface energy, high chemical and thermal stability [1, 2] and in Wessex formulation, it leaves polymeric films that impart a smooth shiny surface. In order to understand the surface structure of PDMS films in the formulation, different polymeric films on silica substrates (PDMS, PDMS + surfactant) have been studied initially. The films were prepared using dip coating and measured by X-ray reflectivity (XRR) at beam line B28 of the European Synchrotron Radiation Facility (ESRF). Interestingly, experimental XRR profiles showed Kiessing fringes and Bragg peaks (Fig. 1), which indicate differences in the nanofilm structure. Such structural information will help to understand their long-lasting antimicrobial efficacy and inform on formulation optimization.

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# Fast event-driven simulations for soft spheres: from dynamics to Laves phase nucleation

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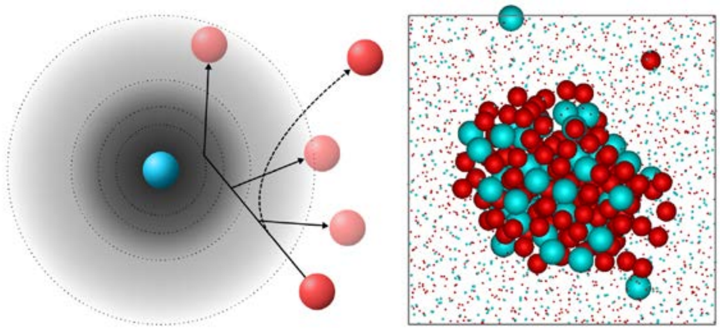

**TOC FIG:** (left) Schematic view of a collision process between two particles as handled in EDMC (solid lines) compared to time-driven MD (dashed). (right) Snapshot of a crystalline cluster for a binary

Hard spheres remain one of the most fundamental objects in colloid science: despite their simplicity, they exhibit a wide array of fascinating physical properties, among which the capacity to self-assemble into a crystal, and have stimulated the development of a plethora of simulation techniques to study their behavior. However, in practice, hard sphere colloids in the real world are never perfectly hard, prompting the need for simulations of nearly-hard sphere systems. Unfortunately, conventional molecular dynamics (MD) simulations struggle with sharply repulsive interactions, due to the need for a small integration time step.

Here, we present a novel implementation of an event-driven Monte Carlo (EDMC) scheme first introduced by Peters and de With [1], and show that it accurately reproduces both the static and dynamic properties of a steeply repulsive Weeks-Chandler-Andersen model system [2]. Impressively, the EDMC approach achieves over a 10-fold performance increase over conventional MD by circumventing the time step issue. This allows us to investigate the phase behavior of the monodisperse and binary WCA models at temperatures significantly lower than were previously accessible.

In particular, we extend past predictions of the phase behavior of monodisperse WCA particles to extremely low temperatures. Additionally, we report the spontaneous crystallization of a binary WCA system into a mixture of the three Laves phases, via a clear nucleation and growth mechanism. This spontaneous nucleation process occurs even at temperatures where this was previously predicted to be preempted by dynamical arrest.

As such, for model systems with e.g. steep interaction potentials, or interactions with continuous and discontinuous components, EDMC provides an extremely efficient new route to study the dynamics of many-body systems in the canonical ensemble.

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# Lipid nanocarriers for inhalation therapy: design and physicochemical characterization

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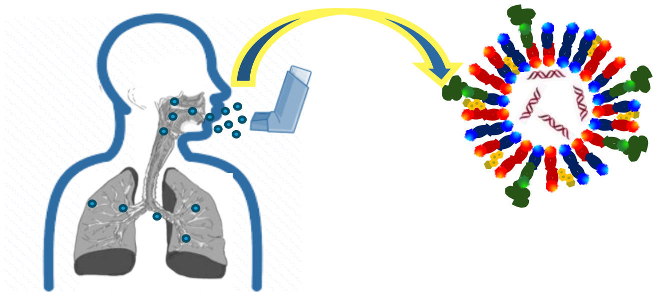

With their ability to encapsulate therapeutics and release their content at the desired time, liposomes provide a valuable platform for the treatment of a variety of diseases. Notwithstanding their impressive advantages, the administration modality plays a not less important role in targeting efficiency and side effect reduction, as well as patient comfort.

In this regard, a promising alternative to intravenous administration is represented by pulmonary administration by inhalation. We developed liposomes using the main component of pulmonary surfactant (DPPC) as a major substituent to improve the biocompatibility of the entire system and ensure better interaction with the lung surfactant membrane, which is the main barrier that liposomes need to overcome while being pulmonary administrated. Liposomes with different compositions have been designed to understand how each lipid (DPPC, DOTAP, and cholesterol) affects the physicochemical properties of the system itself. This was done by combining several techniques, such as DSC, DLS and SAXS. The results obtained revealed that DOTAP and cholesterol addition affect liposome size, as well as lipid system transition temperature. Preliminary tests have been performed to encapsulate a CSC-targeting DNA aptamer (AP-9R) that suppresses tumorigenesis, cancer progression and angiogenesis in lung cancer. Understanding how the different lipids affected the physicochemical properties of LNCs, can benefit the development of new strategies for the delivery of oligonucleotide therapeutics, providing a scientific platform for future clinical approaches.

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# Modeling the Impact of Steric Forces and Charge Regulation in Cyclic Voltammetry Curves

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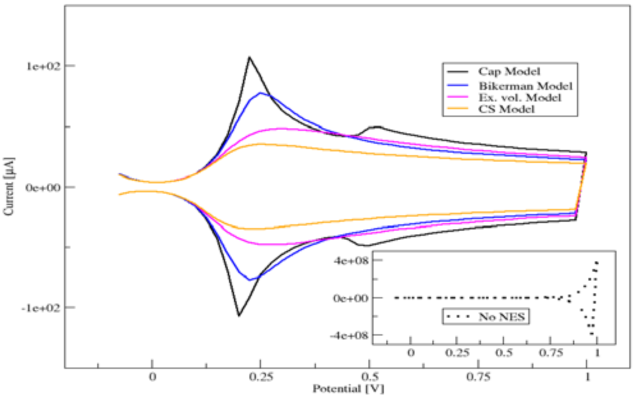

Our study analyzes the phenomena of ion adsorption on charged surfaces immersed in an electrolyte solution. Understanding these processes is crucial for advancing the development of devices such as biosensors and batteries. Furthermore, it helps to simulate the outcomes of electrochemical techniques like cyclic voltammetry, which are widely used in the study of these devices.

Under equilibrium conditions, the Poisson-Boltzmann (PB) model is typically employed. However, this model is inadequate at high voltages or ion concentrations due to the omission of non-electrostatic (NES) effects. We refer to these effects as NES since they are independent of the electric field generated by the charged surface. Notably, steric effects, resulting from the finite size of ions [1], are among the most significant NES factors. To address these NES effects, more sophisticated theories than the classical PB model are necessary. However, these models cannot be resolved analytically. Therefore, we are developing a Python library to numerically solve modified PB models using finite element methods [2].

Our aim with this research is to outline modified PB models that incorporate steric effects. Various steric models are under consideration, including the Carnahan-Starling (CS) model derived from the viral equation of state, and the excluded volume model (and its derivations) originating from the ideal entropic free energy of the solvent. As our results demonstrate, the CS model produces a smoother concentration profile and a lower maximum concentration of counterions, resulting in reduced current, as depicted in the TOC Figure. This model appears to provides results that are more closely aligned with experimental data.

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Matteo obtained his bachelor's and master's degrees in chemistry and chemical science, respectively, from the University of Cagliari. During both his bachelor's and master's theses, he focused on molecular modeling within the supervision of Prof. P. Ruggerone at the Department of Physics in Cagliari. His work aimed to evaluate various open-source software for protein-ligand and protein-protein docking, utilizing them to explore biological systems. For his master's thesis titled "Protein-protein interactions in synaptic junctions," Matteo investigated the interaction between Shank3 and Homer1, two proteins implicated in various neurological and neurodevelopmental disorders. Additionally, he collaborated with Prof.ssa F. Mocci at the Department of Chemistry in Cagliari to examine the stability of DNA G-quadruplexes with different ligands, employing molecular dynamics simulations. In November 2022, Matteo secured a PhD scholarship in Chemical Sciences and Technologies at the University of Cagliari under the guidance of Prof. D. F. Parsons. His doctoral research focuses on developing Python codes and mathematical models to analyze electrochemical systems under both equilibrium and non-equilibrium conditions. Starting with the Poisson-Boltzmann model for equilibrium systems and the Poisson-Nernst-Plank model for non-equilibrium systems, Matteo aims to apply these models in the study and advancement of biosensors using simple electrochemical techniques such as cyclic voltammetry.

# Massive production of micrometer-sized emulsion droplets with microfluidics

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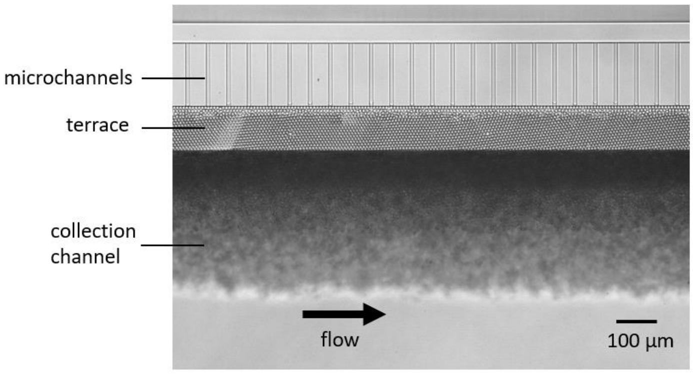

Emulsions have numerous applications, notably in cosmetics or food processing. They are traditionally created by applying shear to the two liquids, allowing destabilization of the dispersed phase and hence the creation of droplets. More recently, advances in microfluidics have made it possible to obtain emulsions in a more controlled way and to tune emulsion features much more precisely [1].

One of the main challenges is to produce such tailored emulsions in a large amount as required for applications. Here, we study the massive parallelization [2] of an emulsification process named step-emulsification [3]. During that process, droplets are formed at the end of a microchannel emerging in a deeper one. Such confinement release induces a capillary driven flow that triggers droplet pinch-off.

The massive parallelization of drop generators (or microchannels) is made possible by the introduction of an intermediate-height zone called the terrace, which allows for decorrelation between drop production and recovery by a water flow perpendicular to the oil flow.

We were able to characterize this system by measuring observables such as droplet production frequency and droplet size. These may vary as a function of different geometric parameters, such as the number of parallelized microchannels or the length of the terrace, but also flow conditions controlled by the pressures applied to the different fluids. This study has enabled us to find the optimal flow conditions for producing droplets that are less than 10 µm at a high throughput.

This massive emulsification is limited by mass transport of surfactants from the collecting channel to microchannel array. Indeed, we notice that coalescence occurs above a critical frequency of droplet production. This critical frequency is shown to be limited to the diffusion of surfactants molecules in the compact emulsion located in the terrace. It is a function of the terrace length and surfactant concentration. We also notice a remarkable phenomenon where coalescence events propagate along the microchannel array prior to a complete destabilization of the emulsification process.

This study opens the way to the creation of large amount of emulsion with controlled size that can be used to make valuable products but also as model systems to investigate phenomenon occurring at concentrated emulsion.

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**Loïc Jouan** (*loic.jouan@espci.fr*). I'm a second year PhD student at ESPCI, in the LCMD team from the CBI lab. My work focuses on concentrated emulsions, and a new microfluidic technology capable of generating a very monodisperse emulsion at a high throughput. I speak French, English, and I will gladly talk to you about my work! :-)

# Morphological analysis of polydisperse nanoplatelets using SAXS

*Laura S. van Hazendonk*,[1] *Remco Tuinier*,[1] *Eleonora Foschino*[1], *Lauren Matthews*[2], *Heiner Friedrich*[1], *Mark Vis*[1]

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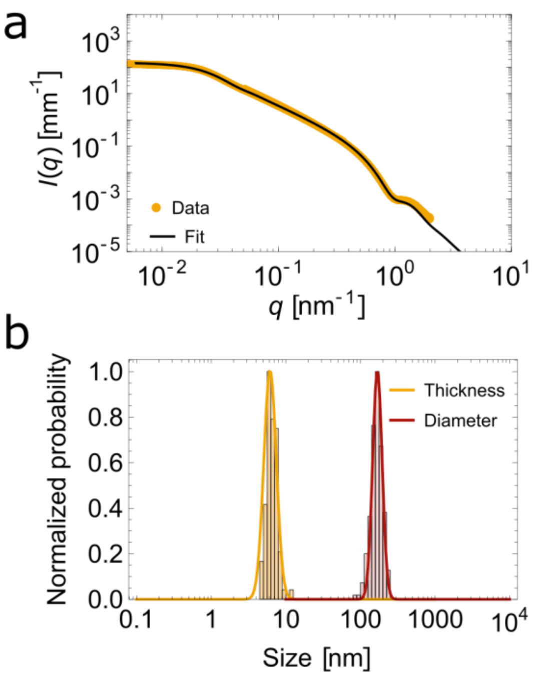

Figure 1 : Gibbsite platelets ; a) SAXS data and fit of a polydisperse form factor ; b) Size distributions for thickness and diameter measured with AFM/TEM (bars) and SAXS (solid lines).

Nanoplatelets like graphene, transition metal dichalcogenides, boron nitride and MXenes are increasingly popular for their high specific surface area and unusual electrical, thermal and optical properties [1]. A cheap way to produce these materials in bulk is through liquid-phase exfoliation, which yields polydisperse platelets [2]. However, many applications require nanoplatelets with well-defined dimensions. For instance, many physical properties are defined by the number of monolayers, and the phase behavior of plate-like colloids depends on the particle dimensions and polydispersity. Size selection methods like centrifugation suffer from limited predictability, making reliable size characterization essential [2]. Unfortunately, size characterization methods which can probe both the thickness and lateral dimensions of polydisperse plate-like colloids in dispersion are still lacking.

In this contribution, we present a fast and quantitative method for the *in situ* characterization of polydisperse nanoplatelets using synchrotron small-angle X-ray scattering (SAXS), simultaneously probing the platelet diameter and thickness. The synchrotron SAXS data were fitted with a polydisperse form factor for platelets. The method was benchmarked with a well-defined gibbsite clay model system, showing excellent agreement between the SAXS results and microscopy data (Figure 1). Finally, the SAXS procedure was used to characterize highly polydisperse graphene nanoplatelets of 1-60 layers in thickness and 20-2000 nm in diameter.

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# Influence of process and formulation parameters on powder characteristics of spray dried, oily powders and their influence on powder flowability

*Sebastian Höhne,*[1] *Jan Maruna,*[1] *Volker Gaukel*[1]
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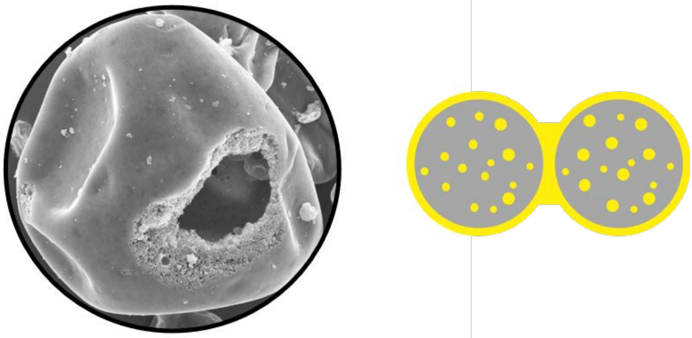

Spray drying of emulsions is a common encapsulation technique for the production of powders containing oil. During the drying of an emulsion droplet, an undesired redistribution of the oil droplets to the surface can occur, which can have a negative effect on the flow properties. Previous studies have investigated either the influence of process and formulation parameters or certain powder structure parameters such as encapsulation efficiency and residual moisture on flowability. The aim of this work is to deepen the understanding of the influence of spray drying on the flowability of spray-dried powders and to mechanistically link the flowability (ffc value determined using a ring shear cell) with relevant structural parameters. A reduction in the oil concentration and a lower drying temperature led to an increase in flowability, which could be linked to analyses of encapsulation efficiency and residual moisture of spray dried particles.

**Sebastian Höhne** (*s.hoehne@kit.edu*) is working as a PhD student in the research group of Dr. Volker Gaukel since 2021 at the Karlsruhe Institute of Technology on the spray drying of emulsions in a project from AiF (Pre-competitive Industrial Collective Research). The focus is on the impact of the drying step on critical product parameters, studied in both spray drying experimental setups as well as single droplet drying setups.

# Advanced Control Mechanisms in True Catanionic Surfactant Systems: Tri-Component Strategies and Charge Dynamics

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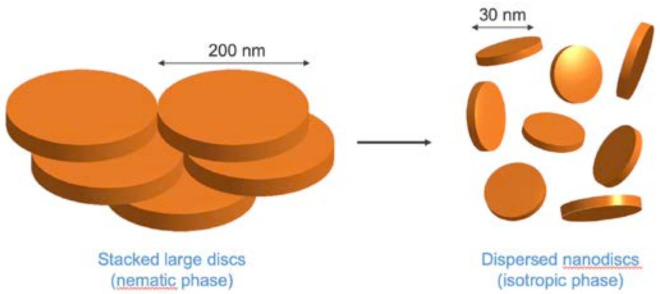

In the field of colloidal science, the precise control of catanionic surfactant structures is essential for their application in drug delivery, nanotechnology, and beyond [1]. This study presents breakthrough strategies in the controlled assembly of catanionic nanodiscs, with a particular focus on the analysis of nanodisc structure and thickness, the regulation of nanodisc size through charge mismatch, and the implementation of a tri-component strategy for controlling crystalline nanodisc size.

Building on a new three-component strategy has successfully led to the control of the size of nanodiscs, yielding tailored morphologies suited for specific functions. Our investigation into the control of catanionic nanodisc size illuminates the crucial role of charge excess in dictating the overall charge of the aggregates. This excess charge profoundly influences the morphological diversity of catanionic assemblies, resulting in a variety of structures such as vesicles, discs, lamellar phases, and micelles [2]. Incorporating nanoarchitectonics, our approach manipulates the assembly of catanionic surfactants, exploiting their charge characteristics to shape nanoscale architectures. An essential aspect of our findings is the role of surfactant tail interdigitation within the nanodiscs, which has a substantial impact on their phase behavior and thermal properties. Our research unravels the complexities associated with variations in melting point temperatures of these nanodiscs, providing deeper insights into the mechanisms behind phase transitions [3].

This interplay of charge excess, structural form, and surfactant tail interdigitation advances our understanding of colloidal science and establishes foundational knowledge for the synthesis of complex nanostructures with precise control over their physicochemical properties.

**Keywords**: Catanionic surfactants, nanodiscs, molecular segregation, zeta potential, phase transitions

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# OptoFluidic Force Induction (OF2i) to Monitor the Particle Size in Emulsion Polymerization Reactions

*Usue Olatz Aspiazu,*[1] *Michael Schnur*[2], *Doris Auer*[2,3], *Christian Hill*[2,3], *Maria Paulis*[1], *Jose Ramon Leiza*[1]
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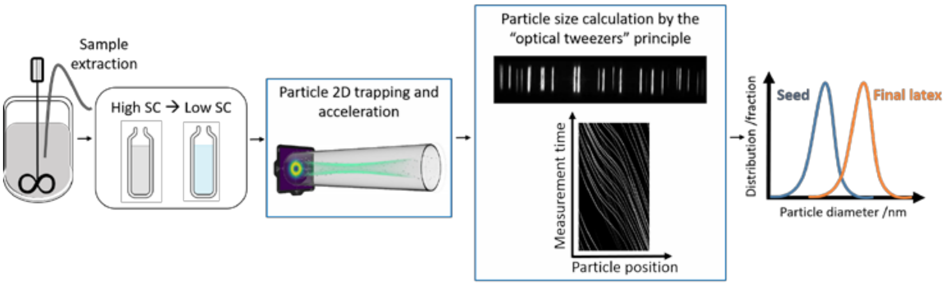

Nano-scaled materials are present in different stages of industrial manufacturing and increasingly used in many applications from biomedical to packaging, automotive or energy. Physical and chemical properties of these materials are strongly dependent on their size, making the characterization of mean size, size distribution, and shape of nano-scaled particles a critical aspect for the quality and efficiency of manufacturing processes [1], [2]. Currently, conventional particle size characterization technologies display several shortcomings, which represent a big innovation obstacle for manufacturers of nanoparticles. In most cases, they still have to perform the analysis via offline testing of sampled materials, which results in delayed characterization and impossibility of controlling product quality and reliability during the process. Consequently, the development of new technologies capable of improving the speed and reliability of nanoparticle characterization in real-time industrial applications is one of the main demands of nano-scaled materials producers [2].

OptoFluidic Force Induction (OF2i) is an online Process Analytical Technology (PAT) to measure the particle size and the particle size distribution of nano- and micron- size materials in real-time [3], [4]. A laser applies forces over the particles that are flowing through a microfluidic cell. These forces are applied in different directions, due to the angular momentum of the laser, and will make the particles to be trapped in the cross-section (2D trapping) and accelerated in the third direction, following the Newton's equation of motion. From this acceleration particle size is calculated.

In the present work, the OF2i technology will be assessed to online monitor semibatch emulsion polymerization processes, which are commonly used to produce waterborne polymeric dispersions with applications in the paint&coatings and adhesive sectors.

Acknowledgements:

The authors would like to acknowledge the NanoPAT European Project (grant agreement nº 862583) and the Austrian Research Promotion Agency (FFG) through the project AoDiSys 891714 for the funding and the help of the BRAVE Analytics team during the entire process.

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**Usue Olatz Aspiazu Iturbe** (*usue.aspiazu@polymat.eu*). Predoctoral researcher at POLYMAT with a background in materials engineering by the University of the Basque Country. PhD carried out under the NanoPAT European Project testing different particle size real time monitoring techniques to monitor industrially relevant emulsion polymerization processes.

# Photo-active carbon nanoparticles colloidal solutions from coffee-waste: a dive in the chemical environment interaction of a multicomponent system

*Mariafrancesca Coccimiglio,[1,2] Simona Bettini,[2] Michela Ottolini,[2] Rosanna Pagano,[2]*
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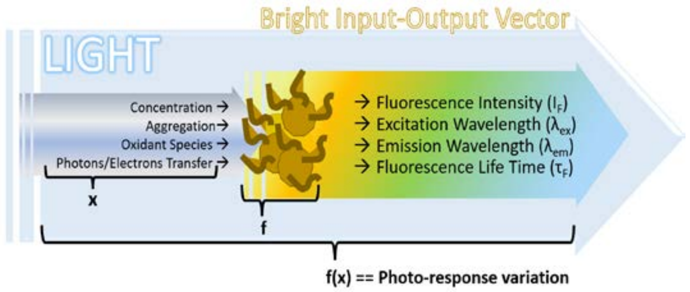

The synthesis-properties correlation studies on carbon nanosystems obtained from bio-waste are increasing in a sight of cutting-edge and follow-up research, to achieve functional and innovative systems through sustainable procedures. The physical-chemical properties of carbon nanoparticles, related to the carbon-chemistry and to the nano-structure and its surface functionalization and composition, prompt the investigation of these nanosystems in different application fields, from technological to biological ones. [1] The main aim is the understanding of the system complexity to take advantage for the tuning of their photochemical and photophysical features, so to better address photo-induced applications. [2] Carbon nanoparticles colloidal solutions have obtained from coffee factory waste, such as coffee silver-skin and spent coffee ground, using mild hydrothermal protocol, with the purpose to exploit elemental, molecular and bio-polymeric composition of the selected waste to confer specific and tuneable properties. The colloidal solutions have been characterized during the synthesis and purification steps using morphological (AFM, TEM) and spectroscopic (ATR FT-IR, XPS, UV-vis absorption and emission in steady state and time resolved) methods. The deep spectroscopic probing on the interaction effects of the multicomponent system points toward the implementation of a bright input-output vector, that harvest and carried information on chemical environment it-around (concentration, inter-system aggregation, oxidants, electrons/photons transfers). The whole to highlight huge potentiality in the detection of different possible targets, that can influence spectral response of this versatile platform upon light stimulation. [3,4]

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Loss myself in the Nature wonders, enjoy to evaluate connections in knowledge network to try to understand the whole in its constituents by exploiting light-matter interaction like as a communication input-output vector.

# Advanced study of photoluminescent carbon quantum dots photophysical behavior

*Theo Duarte[1]*, Roy Konnoth-Ancel[1], Christophe Couteau[1], Jérôme Plain[1], Julien Proust[1]*
*1) Light, Nanomaterials, Nanotechnology (L2n) - CNRS UMR 7076*

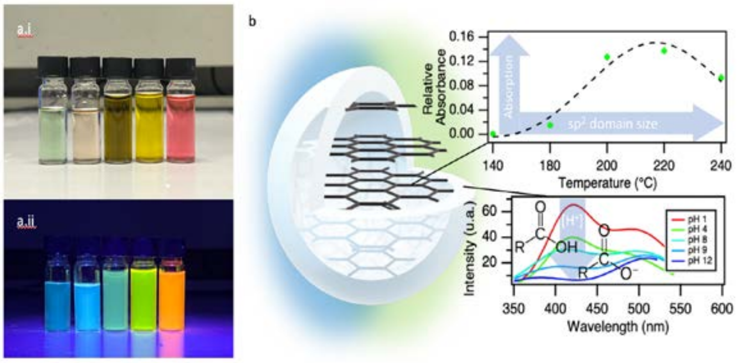

Fig1: (a.i) Synthezied sample under daylight (a.ii) and under UV light; b) Illustration of emission from the core and from the surface of the carbon dots

In 2004, Xu et al. [1] made a breakthrough discovery regarding nanoparticles comprised of carbon that exhibit blue photoluminescence. These nanoparticles, known as carbon dots, are characterized by a 0D hybrid structure featuring clusters of $sp^2$ carbon akin to graphene, enclosed within a shell of amorphous $sp^3$ carbon exhibiting organic functional groups on its surface [2].

Carbon dots constitute a new and promising category of nanomaterials capable of bright fluorescence, biocompatibility and photostability [3]. However, the mechanisms governing their photoluminescent properties are still misunderstood [4]. Because of the challenges present in purification [5] and multi-components fluorescent behavior, the use of advanced spectroscopy techniques is required to pave the way toward new efficient synthesis and applications.

We synthesize diverse carbon dot structures through bottom-up high-pressure methods using organic molecules as precursors. Optimal synthesis conditions such as pressure, temperature, and precursor selection, are determined from subsequent characterizations. Purification is either performed through thorough dialysis or silica column chromatography to separate nanoparticles from fluorescent precursors or molecular by-products and their structure is then determined through FTIR, Raman, XPS, and TEM imaging.
Then, saturation fluorescence correlation spectroscopy (FCS) is used as a performant tool enabling us to determine the origin of fluorescence, i.e. the carbon dot or free molecular fluorophores.
Using low-temperature (<10K) photoluminescence measurements on single carbon dots, we were also able to determine whether the fluorescence originated from the graphene core, functional groups, and surface defects, or from a molecular fluorophore trapped in the nanoparticles.

The aim of the work presented here is to understand as precisely as possible the photophysical process of these new fluorescent nanoparticles, which could one day replace traditional semiconductor quantum dots.

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PhD student in nanosciences at the University of Technology of Troyes, focused on nanomaterials synthesis and optical properties. Currently researching nanophotonics of carbon nanoparticles for secure anti-counterfeiting archaeological artefact marking, with prior experience in nanoparticle assembly and surface analysis.

# SELF-ASSEMBLY OF TRIPLEX FORMING DNA COATED COLLOIDAL MICROPARTICLES

*Matthieu SOULA, Etienne DUCROT, Serge RAVAINE*
*Centre de Recherche Paul Pascal, UMR5031, CNRS, Université de Bordeaux, Pessac, France*

Self-assembly pathways have proven to be a valuable strategy for accessing material structures at the nano/micron scale with rich optical and electronic properties. The starting point is the pre-encoding of colloidal building blocks, by grafting short single strand DNA segments at their surface, that will then form specific inter-particles interactions and autonomously arrange in the desired structure. They generate an attractive interaction based on the formation of duplexes with their complementary strands anchored at the surface of other building blocks. The temperature is often the control parameter that modulates the reversible DNA hybridization, as it can be weakened or strengthened around the so-called melting temperature. Using this strategy, multiple DNA-coated colloids have been successfully assembled into colloidal clusters, chains, gels and crystals paving the way for the creation of valuable functional materials [1]. Up to now, the assembly of DNA coated colloids has mainly relied on the formation of DNA duplexes between particles even though they are only one on the possible supramolecular assemblies that DNA strands can form [2]. Indeed, a particular ternary interaction based on the DNA triplex (*i.e*. forming supramolecular assemblies involving three strands) has been the focus of recent work [3][4]. While the formation of a DNA duplex relies on Watson-Crick base pairing, a triplex requires also Hoogsteen hydrogen bonds with a third strand. The presence of this third strand should have a signature on the dynamic of the assembly and allow additional orthogonal control knobs.

Here we explore the possibility to program the assembly of colloidal building blocks into colloidal crystals thanks to the formation of DNA triplexes. To form this supramolecular assembly, DNA-grafted particles and an additional third strand present in solution are required. As a testing platform, we functionalize 800 nm fluorescent polystyrene colloidal particles thanks to a swelling/deswelling process in the presence of a functional copolymer PS-*b*-PEO-$N_3$ [5], and decorate them with designer-DNA strands by click chemistry (SPAAC). The influence of temperature, buffer conditions, interaction between particles and their crystallisation are studied. A special consideration is given to the influence of pH on the formation of parallel triplex as this is an additional parameter brought by the nature of DNA triplex [6].

We acknowledge funding from IdEx Bordeaux (ANR-10-IDEX-03-02), and from Région Nouvelle-Aquitaine (AAPR 2020-2019-8330510).

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**Matthieu SOULA** (*matthieu.soula@u-bordeaux.fr*). I received my dual *M.Sc.* degree in 2022 in Chemistry from the University of Bordeaux (France) with a specialty in Physical Chemistry & Chemical Physics and in Material Sciences from the Colorado School of Mines (USA). I started my PhD right after in Centre de Recherche Paul Pascal in the Colloids, Interfaces, Assemblies group.

# Day 3

**June 26th / Wednesday**

| | | |
|---|---|---|
| 9:00-10:00 | Debora Berti | |
| | Chair: S. Sekar | Chair: M. Mendes |
| 10:00-10:20 | Danni Luo | Matthew Terkel |
| 10:20-10:40 | Francesca Porpora | Auriane Bagur |
| 10:40-11:00 | Coffee break | |
| | Chair: R. Medeiros | Chair: A. Brézault |
| 11:00-11:20 | Helena Bach-Rojecky | Mouktar Nour Mahamoud |
| 11:20-11:40 | Aleksandar Sladojevic | Yinong Feng |
| 11:40-12:00 | Camille Courtine | Marion Le Guevel |
| 12:00-13:30 | Lunch | |
| 13:30-14:30 | Frank Smallenburg | |
| | Chair: A. Bagur | Chair: J. Bassetti |
| 14:30-14:50 | Stefano Onofri | Jenni Koskinen Engstedt |
| 14:50-15:10 | Natalie Blot | Antoine Brézault |
| 15:10-15:30 | | Ralitsa Uzunova |
| 15:30-16:00 | Coffee break | |
| | Chair: A.Brézault | Chair: K. Ballu |
| 16:00-16:20 | Joanne Zimmer | Yupei Ma |
| 16:20-16:40 | Elodie Layan | Nur Syazaliyana Azali |
| 16:40-17:00 | Yuri Fernandes | Megan Parker |
| 20:00-23:00 | Gala Diner | |

# Improving flotation of fine valuable lithium minerals through the formation of small hydrophobic aggregates

*Danni Luo*,[1,2], *Wei Sung Ng*[1,2,3], *George V. Franks*[1,2,3]
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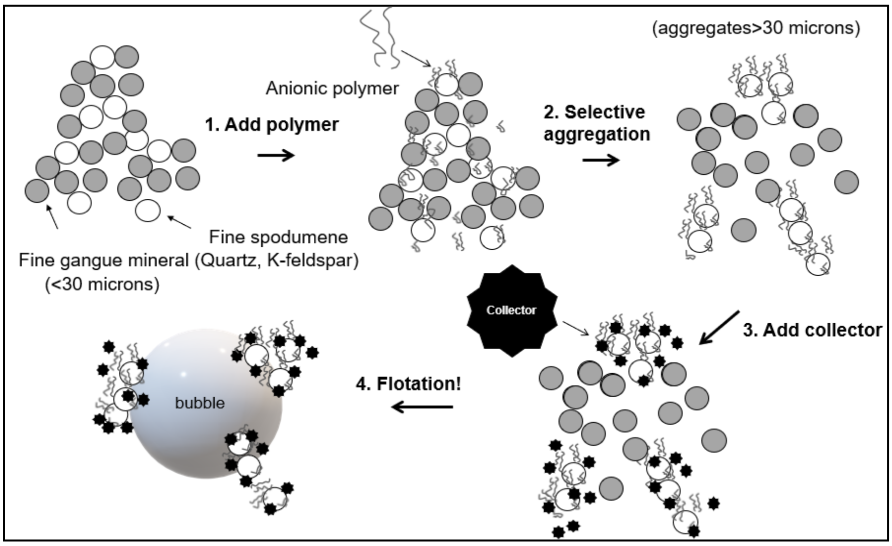

The surge in lithium demand for energy generation and storage systems necessitates efficient recovery methods from primary sources such as spodumene ores. Froth flotation is one of the primary methods used in minerals processing for the treatment and separation of spodumene prior to downstream lithium extraction. However, conventional flotation techniques face challenges in recovering fine particles, primarily due to suboptimal bubble-particle interactions. This study introduces an innovative approach to enhance the flotation efficiency of fine spodumene particles via selective flocculation. Our research objective is to selectively aggregate fine spodumene particles (approximately 20 µm) into larger clusters (approximately 100 µm) using commercially available polymers, thereby enabling more effective recovery in froth flotation processes. The first part of the study focuses on the selective aggregation of fine spodumene over other gangue minerals, such as feldspar and quartz, via specific chemical interactions with the functional groups of these polymers. This approach leverages the principles of interface science to control the aggregation process. Here, we present our results on how the aggregation behaviour of spodumene and quartz varies with different metal ion concentrations, polymer dosages, pH levels and shear conditions. Zeta potential and adsorption isotherms are used to understand how the polymer adsorbs. Additionally, we monitor aggregate formation in-situ using a particle imaging and sizing probe under mechanical flotation cell conditions. This real-time analysis provides critical insights into the flocculation process. Under the correct conditions, spodumene can be aggregated without aggregating quartz. The findings from the aggregation measurement studies will be combined with flotation studies to present new fundamental insights into the flocculation-flotation process for enhancing the processing of complex lithium deposits.

**Danni Luo** (*dluo2@student.unimelb.edu.au*): Danni Luo began her academic journey at the University of Melbourne, where she obtained her Bachelor's degree in Science in 2019. She furthered her studies at the same institution, earning her Master's degree in Chemistry in 2022. As a significant part of her master's program, she spent a year at the Institute of High Energy Physics, Chinese Academy of Science in Beijing. During this time, she collaborated on various projects, expanding her research horizons and deepening her knowledge base. Upon her return, and before joining the Future Battery Industries Cooperative Research Centre (FBICRC) as a PhD candidate, Danni played an integral role at the ARC Centre of Excellence in Exciton Science. Within this capacity, she immersed herself in nanoparticle synthesis and the exploration of Surface-Enhanced Raman Scattering (SERS) substrates, particularly for their application in point-of-care analyte sensing. Now at the FBICRC, her focus is sharply on the domain of mineral processing. Specifically, she is pioneering methods aimed at improving the flotation of fine valuable lithium minerals. Central to her approach is the formation of small hydrophobic flocs, a promising technique with vast implications for the industry. https://www.linkedin.com/in/danni-luo-601266170/

# Branching transition of driven magnetic colloids through a microfluidic Y-junction

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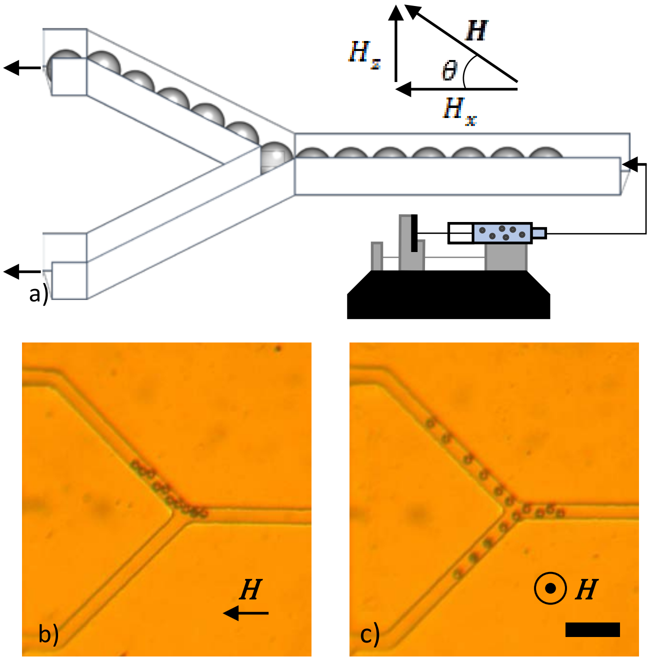

Figure 1: a) Schematic showing a microfluidic Y-junction filled by colloidal particles and the magnetic field orientation at the top. (b,c) Optical microscope images showing a flowing chain of paramagnetic colloidal particles with induced attractive (b) and repulsive (c) dipolar interactions. Scale bar = 100 µm.

Investigating the collective dynamics of microscopic particles moving through narrow channels is of great importance from both a scientific and a technological point of view. In the first case, driven particles across thin channels display fascinating many-body effects resulting from the interplay between pair-interaction, forcing and confinement. On the other hand, related technological applications include the control of particulate matter through porous media, the flow of red blood cells within vein networks or water molecules across biological nanopores.

In this talk, I will discuss recent results related with the collective transition of a single file of interacting magnetic colloids when flowing from a straight channel to a Y-shaped bifurcation. Our colloids are paramagnetic particles dispersed in a fluid medium that can be manipulated via an external magnetic field. Depending on the field orientation field, we tune the pair interactions from net attractive to repulsive, leading respectively to the formation of condensed chains or separate particles. We observe a sharp transition induced by the Y-junction from a single file to separated particles and characterize this effect in terms of a magnetization-like order parameter. Our results are complemented via Brownian dynamics simulations including the dipolar interactions.

The control of colloidal flow through confined channels and across a Y-junction could potentially provide insight into the complex yet rich dynamics of many fluidic systems across different length scales.

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**Matthew Terkel** (*mbterkel@ub.edu*). Matthew recently received his PhD on the topic of magnetorheological fluids from the University of Granada (Spain), and is now a postdoc at the University of Barcelona in the research group of Pietro Tierno and currently continues to research magnetic colloids. He is fluent in Spanish and is learning Catalan – slowly.

# Proposal for a remediation method for the “vinegar syndrome” in cellulose acetate-based motion picture films

*F. Porpora*[1], *A. Maiano*[1], *C. Forcellini*[1], *C. D’Aleo*[1], *L. Lisi*[1], *E. Carretti*[1,2], *L. Dei*[1], *M. De Sanctis*[3]
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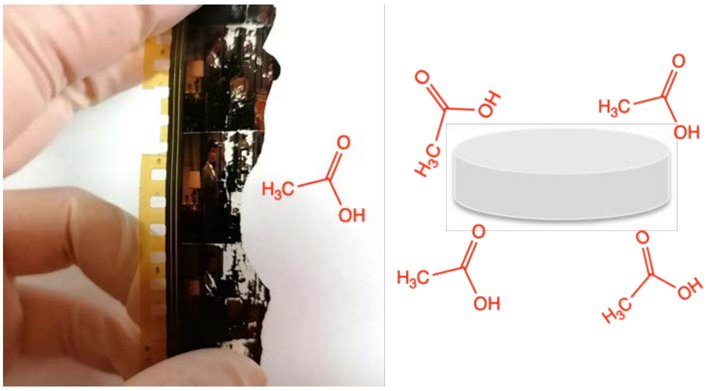

Motion picture films made of cellulose acetate (CA) are subjected to chemical degradation mainly due to the “vinegar syndrome”. It concerns the cleavage of the ester bonds between the acetate group and the cellulose chain through ester hydrolysis (deacetylation), with the formation of hydroxyl groups and the release of acetic acid. It is strictly influenced by temperature, moisture and acidity: the released acetic acid acts as a catalyst for the reaction. By-products of deacetylation can promote, also, the hydrolysis of the glycosidic bonds of the cellulosic backbone. The consequent deformation and embrittlement of the films can strictly compromise their usability [1,2].

The most important goal of this project is to set up innovative, cheap, easy-to-produce and handle and possibly reusable chemical inhibitors. We proposed and characterized several systems based on two strategies: the use of sponge-like systems (1) made of polyethyleneimine (PEI) and/or (2) uploaded with metal oxide nanoparticles. The intent was to use free amino groups, in the first case, and inorganic nanoparticles, in the second case, to convert acetic acid into ammonium carboxylate and acetate salt, respectively, through an acid/base reaction. The evaluation of the efficacy of the above-mentioned systems in inhibiting the vinegar syndrome was performed both on real motion picture films on which the deacetylation process has been artificially induced with an innovative degradation protocol and on films naturally affected by the “vinegar syndrome”. The different behaviors of untreated and treated films have been evaluated through an innovative multi-analytical protocol able to monitor the chemical alterations of the supports connected with the occurrence and the evolution of the “vinegar syndrome”.

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**Francesca Porpora** (*francesca.porpora@unifi.it*). I am a PhD candidate in Chemical Science (curriculum Science for the Conservation of Cultural Heritage) at the University of Florence (Italy). During my academic career, I had the opportunity to merge two great passions: chemistry and art. In particular, I have expertise in:

- synthesis and characterization of sponge-like and gel-like systems for cleaning works of art and/or absorption of VOCs;
- synthesis and characterization of nanoparticles;
- consolidation of archaeological bones;
- conservation of motion picture films and photographic material.

Currently, I am involved in a fellowship on the development of reversible adsorbent smart materials for molecular archaeology to disclose paleolithic stone tools as bio archives (SMarT4BioArCH).

In my free time, I am an enthusiastic nerd who draws ugly doodles, plays theater improvs and likes Star Wars stuff.

# Programmable self-assembly of DNA-coated patchy nanoparticles into colloidal polymers

*Auriane Bagur*[1,2], *Etienne Ducrot*[2], *Serge Ravaine*[2], *Etienne Duguet*[1]

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Building materials through colloidal self-assembly, a powerful bottom-up approach, has recently seen remarkable innovations starting with isotropic colloids like monodisperse spherical particles as building blocks. These particles can efficiently self-assemble into thermodynamically favored structures such as fcc and hcp lattices [1]. However, patchy particles have received significant interest for their ability to exhibit directional and selective interactions, forming building blocks that encode the target materials' structural information [2].

Here we report the synthesis of patchy nanoparticles, consisting of a silica core of ~50 nm diameter and two polystyrene patches, obtained using a seeded-growth emulsion polymerization and a subsequent dissolution step. The synthesis takes place using monodisperse silica nanoparticles previously surface-modified allowing a fine control of the number and location of patches with a morphological yield of 97% [3]. To reach precise self-assembled structures, we rely on DNA coatings as a tool to program the interactions between particles. An azide terminated block copolymer is anchored at the patches surface through a selective swelling-deswelling process [4]. DBCO-terminated DNA strands are coupled to these azidated patches thanks to click-chemistry. We conducted a comprehensive analysis of the morphological evolution of the particles using TEM and AFM to compare the particle morphology before and after the patches' selective coating. We show that the thermo-reversibility and specificity of DNA hybridization between patches leads to the assembly of one-dimensional structures at the nanoscale, called 'colloidal polymers' [5]. We highlight the modulation of the chain length based on incubation time and the formation of hetero-sequences according to the patches coatings [6].

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[5] C.R. Laramy *et al*, *Nat. Rev.* 4, 201-224 (2019).
[6] M. He *et al*, *Nature*. 585, 524-529 (2020).

**Auriane Bagur** (*auriane.bagur@u-bordeaux.fr*).

Coming from Royan, France, I pursed a Master's degree of chemistry at the University of Bordeaux, focusing on nanoscience and polymer chemistry. During this period, I conducted my master's thesis in Bordeaux, working on the synthesis of nanoparticles for on-demand drug delivery. Currently a 3rd year Ph.D. student working at ICMCB and CRPP (CNRS, Bordeaux), my project focuses on the self-assembly of patchy colloids driven by DNA-hybridization. Additionally, I serve as a representative for Ph.D. students at the doctoral school of chemistry.

# Enhancing hydrophobicity through radiation crosslinking of stearic acid monolayers on calcium carbonate

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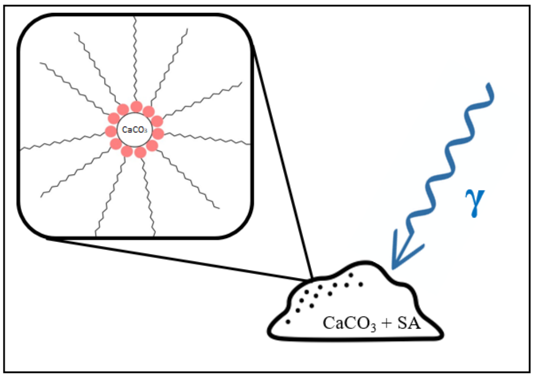

Calcium carbonate ($CaCO_3$) is widely used as a filler in the polymer industry, where its addition boosts stiffness, stability and impact resistance, thereby enhancing the durability and longevity of the polymer. However, its hydrophilic nature makes it incompatible with hydrophobic polymers. While larger particles can be incorporated into the polymer, smaller particles tend to agglomerate due to heightened particle-particle interactions. To overcome this issue, the surface of $CaCO_3$ has to be treated. This treatment reduces the particle-particle interaction and improves the adhesion between the matrix and filler, resulting in enhanced composite properties [1].

Fatty acids have the ability to adsorb to the surface of $CaCO_3$ in the form of an organized, densely packed monolayer. Exposing the monolayer of fatty acid to high-energy ionizing radiation leads to crosslinking of adjacent aliphatic chains, resulting in the formation of a polymer nanocoating (PNC) that is only a single molecule thick. This crosslinking, known as radiation-induced crosslinking, is characterized by its speed, uniformity and simplicity. It occurs at room temperature, does not require the use of toxic solvents and initiators, and sterilizes the entire material at the same time.

In this study, the conditions for the formation of a monolayer of stearic acid (SA) on the surface of $CaCO_3$ and its radiation crosslinking as well as the properties of the resulting materials were investigated. Crosslinking was initiated by two sources of ionizing radiation: gamma irradiation and electron beam (e-beam) radiation. $CaCO_3$ was synthesized by precipitation from the $Na_2CO_3$-$CaCl_2$ system and subsequently exposed to a SA solution, resulting in adsorption and self-assembly of molecules on the surface to form a monolayer. The obtained system was exposed to γ-irradiation and e-beam irradiation in the presence and absence of oxygen, at a constant rate of adsorbed dose and different adsorbed doses of irradiation. The morphological, structural and topographical properties were monitored. The hydrophobicity of the system was measured by contact angle measurements and the color change was determined by colorimetry.

The obtained results show that irradiation in the presence of oxygen led to material degradation, while in the oxygen-free system an increase in hydrophobicity was observed, indicating that crosslinking of SA occurred.

Acknowledgements: This work was supported by the Croatian Science Foundation (HRZZ IP-2020-02-4344), and the European Union's Horizon Europe Research and Innovation programme (EURO-LABS-RAPID-2023-1).

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# Emulsion processing of gold nanoparticle shells: towards plasmonic nanoresonators

*Mouktar Nour Mahamoud[1], Sribharani Sekar[2], Déborah Iglicki[1], Clément Goubault[2]Alexandre Baron[2], Jean-Paul Chapel[2], Joanna Giermanska[2], Virginie Ponsinet[2] et Fabienne Gauffre[1]*
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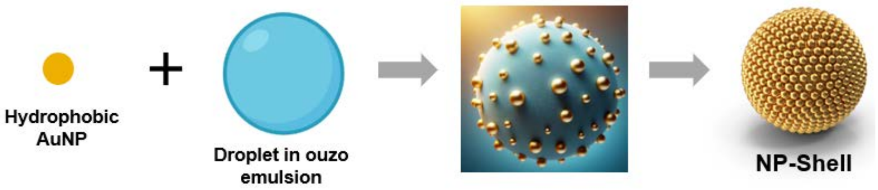

The chemistry of metallic nanoparticles, and more specifically that of noble metals, is a rapidly expanding field (1). The elaboration of well-ordered assemblies of nanoparticles by solution routes remains an experimental challenge, with a wide potential of applications.

In the case of metallic gold or silver nanoparticles, electromagnetic effects resulting from plasmonic coupling between the nanoparticles are expected. In particular, "hollow" spherical assemblies of such nanoparticles can constitute plasmonic nanoresonators capable of interacting with the magnetic component of light, a phenomenon that does not exist in natural materials. Such nanoresonators are being considered as the building blocks for the development of metamaterials

Our team has developed a process for the formulation of nanoparticle shells, based on an unconventional emulsification (spontaneous and without surfactant): The Ouzo effect.(2) This strategy allows the assembly of nanoparticles around droplets of about 100nm in diameter, with excellent size homogeneity. However, this has not been achieved with gold yet.

The objective of this work is to elaborate gold NP shells and to understand the physico-chemical mechanisms involved in order to develop metamaterials and explore their applications.
The first part is devoted to the study of the ternary ouzo system "water/THF/BHT" allowing the formation of NP-shells.(3) In addition, we look at the effect of NP on the drops. Furthermore, the idea is not only to assemble the gold nanoparticles around the ouzo drops but also to control the distance between them by substitutions in situ with shorter ligands in order to have plasmonic coupling, which is necessary to obtain the desired optical properties.

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-Cycle préparatoire

- Licence : Chimie de l’environnement
- Mastère 1 : Chimie Matériaux Séparatives et Procédés
- Mastère 1 : Didactique en Science Physique et Chimie
- Mastère 2 : Chimie Matériaux Inorganique

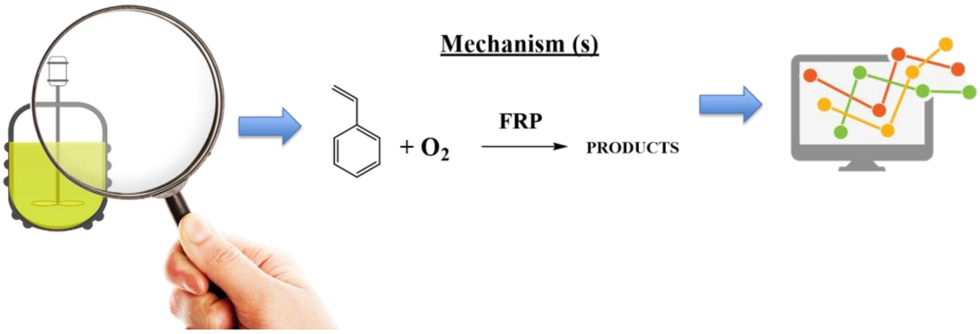
# Exploring Oxygen's Effects on Styrene Free Radical Polymerization: A Revised Study

*A. Sladojevic, Dr. N. Ballard, Dr. S. Hamzehlou, Prof. J.R. Leiza*

*POLYMAT, Kimika Aplikatua Saila, Kimika Falkultatea, University of the Basque Country, UPV/EHU, Joxe Mari Korta Zentroa, Tolosa Hiribidea 72, 20018 Donostia/San Sebastián, Spain*

The role of oxygen in free radical polymerization processes is of paramount importance, as it significantly influences polymerization kinetics and final polymer properties. [1] In contrast to the typical scenario observed with most other vinyl monomers, where polymerization is either entirely inhibited or significantly retarded, styrene exhibits unique behavior. Instead of complete inhibition, the polymerization of styrene leads to the formation of formaldehyde, benzaldehyde, together with other organic side products. Despite over eighty years of academic and industrial research into the influence of oxygen in free radical polymerization (FRP) of styrene, a pivotal question remains unanswered: How does oxygen impact this polymerization process? [2, 3, 4]

This work looks into the mechanism underlying the solution polymerization of styrene in the presence of oxygen. By elucidating the reactions governing polymerization kinetics, we provide insights into the production of VOCs, notably benzaldehyde and formaldehyde, as well the evolution of molar mass and conversion. Through mathematical modeling, our work allows for a better understanding of the kinetics involved, particularly in the context of oxygen-mediated reactions.



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I was born and raised in Serbia where I finished the bachelor studies in chemistry in the University of Novi Sad. After finishing, I moved to Germany where I conducted my master studies in the field of advanced synthesis and catalysis at the University of Regensburg. After finishing my masters thesis, which was performed under the supervision of Prof. B. König and Prof. W. Kunz, I moved to sunny San Sebastian where I am now carrying out my PhD in the field of Polymer Science and Engineering under the supervision of Dr. N. Ballard and Professor J.R. Leiza.

# Starch–Lauric Acid Complexes Retard Gastrointestinal Release and Absorption of Lipids in Diacylglycerol Structured Emulsions

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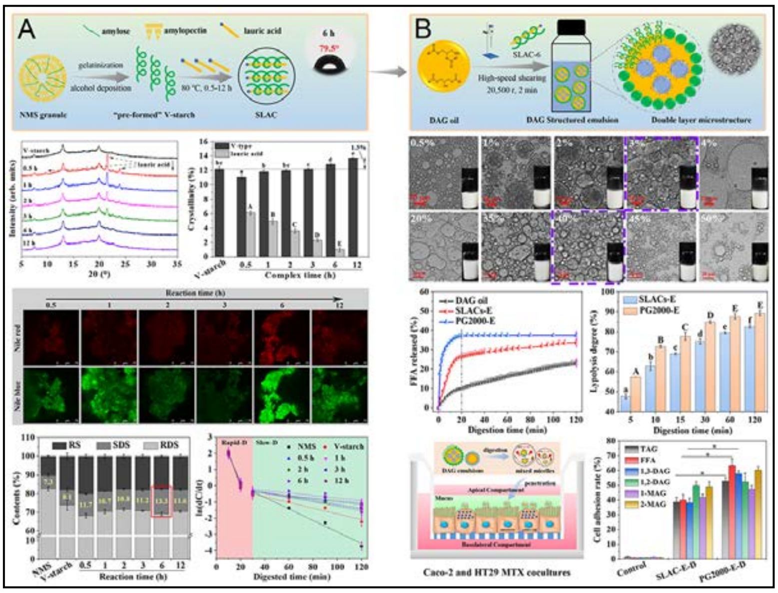

Starch–lipid complexes are considered as the fifth type of resistant starch and exhibit potential in constructing functional delivery systems and delaying oil gastrointestinal digestion. Here, V-type starch–lauric acid complexes (SLACs) were fabricated via solid encapsulation (Figure A) and applied in diacylglycerol (DAG) structured emulsions (Figure B). X-ray diffraction patterns and confocal laser scanning microscopy images revealed an enhanced complexation degree between V-type starch and lauric acid by tracking the signal intensity of free/bound lauric acid and the V-type ordered structure of starch as time processed, resulting in an increased slowly digestible starch content and gradually reduced starch digestion rate. SLACs-6 (3wt%) presented an excellent emulsifying performance to stabilize a maximum of 40% DAG oil phase fraction, further forming a gel-like network. Simulated gastrointestinal digestion indicated that SLACs-stabilised emulsions possessed a slower release rate and a lower maximum release of free fatty acids, thus pointing towards a reduced lipolysis degree of DAG oil, as compared to PG2000 (commercial chemically modified starch). A Caco-2 and HT29 MTX cell coculture experiment displayed that SLACs delayed the absorption of DAG oil digestion products, suggesting a more sustainable cell adhesion than PG2000. Our study provides an effective scheme for better regulation of functional lipid digestion in the targeted intestinal tract.

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**Yinong Feng** (*yinong.feng@ugent.be*) is a joint-PhD candidate at South China University of Technology and Ghent University. His research focuses on the construction of starch-based diacylglycerol structured emulsions and the regulation of their lipid digestion and metabolism. At present, more than 10 SCI papers have been published in journals such as Journal of Agricultural and Food Chemistry, Carbohydrate Polymers, and Food Hydrocolloids.

# Water in silicone emulsions towards super soft, biomimetic materials

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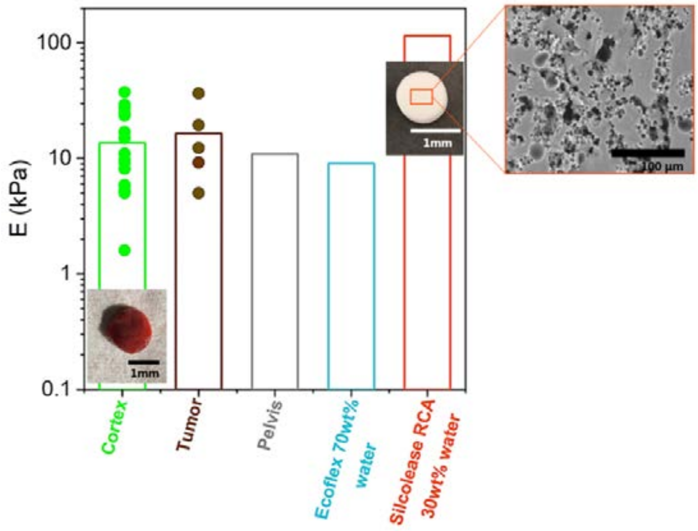
Over the past decade, 3D-printing has attracted a lot of attention in the medical field. Currently, this technology has been used to prepare organ phantoms for the pre-operative training of surgeons. In the case of kidney's surgery, the complex nature of the renal organs makes it difficult to design phantoms that mimic accurately their nonlinear mechanical properties. Yet, those are crucial parameters during an operative process.

This work is focused on the understanding of the mechanical properties of kidneys and the development of biomimetic materials. Mechanical data are recorded from fresh human renal samples collected inside an operating room. The results are used as a target for making materials with adapted mechanical properties. These materials are prepared through a water in oil (W/O) emulsion pathway whether in thermal-curable or UV-curable polymers[1,2]. The selected silicone matrices are shown to give different types of emulsions, which influence the final properties of the crosslinked materials. On the one hand, soft thermal-curable silicone enables the formation of well-defined single droplets. On the other, UV-curable polymers gives sticky droplets that partially merge with one another. After curing of the polymer network, we successfully obtain water-containing silicones with tunable mechanical properties depending on their microstructure. With thermal-curable silicones, the drops are homogeneously distributed in the crosslinked polymer while with UV-curable silicones, the material exhibits both areas with connected droplets and areas of pure matrix. Two water-containing formulations are selected as promising candidates to mimic linear mechanical properties and properties at break of the kidneys. They are being tested simultaneously by medical staff, to evaluate their behavior during surgery trainings and by our partners, to investigate their 3D-printability inside a hydrophilic gel support via freeform reversible embedding (FRE).



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[2] Kovalenko, A.; Zimny, K.; Mascaro, B.; Brunet, T.; Mondain-Monval, O. *Soft Matter* **2016**, *12* (23), 5154–5163.

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**Camille Courtine** (*camille.courtine@crpp.cnrs.fr*).

I am a post-doc student at CRPP in Bordeaux working on soft water-containing silicones.

I have pursued my PhD at the University Paul Sabatier of Toulouse working on photosensitive hydrogels.

I am very interested in soft matter and materials science for applications in medical or environmental field.

# Oil removal by flowing of surfactant solution: a two scale approach

*Marion Le Guével [1], Michael Levant [1], Nicolas Passade-Boupat [1], Valérie Molinier [2], Laurence Talini[3],
François Lequeux [1], Emilie Verneuil [1]*

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*2) TotalEnergies, PERL, Lacq, France*
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In industrial processes, oil droplets often clog porous media, prompting the use of surfactant solutions to unclog it. However, the mechanisms governing oil droplet detachment remain poorly understood. We investigate this phenomenon using a model system mimicking pore-scale interactions.

Our system, employing a simple chemical setup forming microemulsions, exhibits large variations of interfacial tension due to changes in water salinity (from $10^{-2}$mN/m to 10mN/m).

The experiments can be divided into two categories based on mechanisms which occurs.

Below the critical micellar concentration (CMC), droplet detachment is governed by hydrodynamics. We observe droplet detachment occurring above a critical shear rate, as observed in the literature in surfactant-free systems [1]. The presence of surfactant impacts the interfacial tension but also the droplet wetting because surfactant adsorb on solid walls. We find that these effects can be accounted for by a critical capillary number, at which detachment occurs in all the investigated conditions.

Above the CMC, oil solubilization into micelles at the droplet interface occurs. This solubilization is independent of flow velocity but dependent on surfactant concentration.

These systematic microfluidic studies offer fresh insights into detergency mechanisms under dynamic conditions.

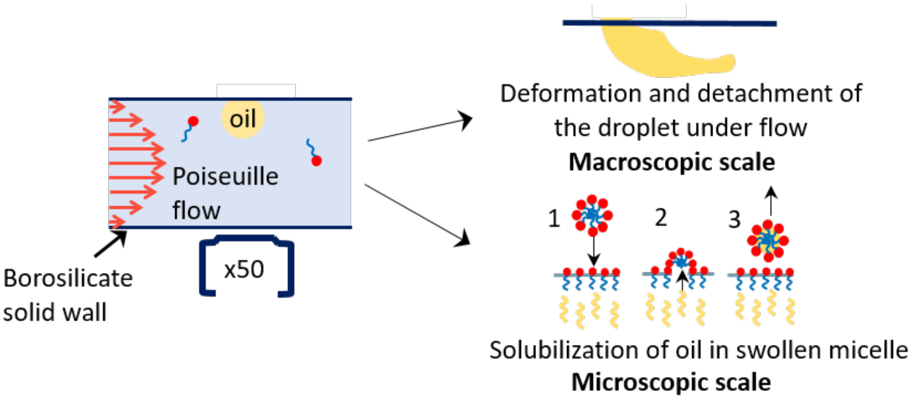

***Figure1.*** *Schematization of our experiment and results*

### References

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**LE GUEVEL Marion** (*marion.le-guevel@espci.fr*). I completed a Bachelor's degree in Physics and Chemistry, followed by specialization in Physics through a Master's program. For the past three years, I have been pursuing a doctoral degree at ESPCI in Paris.

# Numerical simulations of liquid bridges between colloids

Stefano Onofri,[1*] Thejas Hulikal Chakrapani,[1,2] Stefan Luding,[1] Elke Scholten,[3] Ahmed Jarray,[1,3] and Wouter K. den Otter [1]

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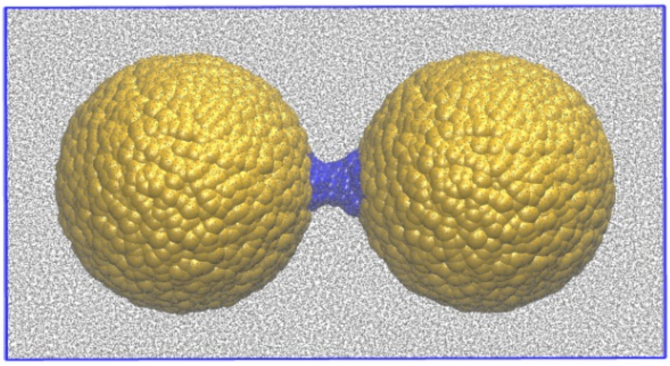

*Snapshot of a liquid bridge connecting two colloids.*

Colloids suspended in a primary fluid can be made to aggregate by adding a small amount of an immiscible secondary liquid: the three types of interfacial tension in this system conspire to form liquid bridges between the colloids that bind the colloids together, see as illustrated. The resulting mixtures vary from viscous fluids to elastic gels, with various promising applications, e.g. in the food industry, porous filter manufacturing and battery slurries production. We use Multibody Dissipative Particle Dynamics (mDPD) to simulate two equally sized colloids connected by a liquid bridge suspended in a bulk fluid. The force exerted on the solid particles by the liquid bridge is measured by constraining the distance between the colloids in the simulations. We compare the force versus elongation curves with fitted expressions in the literature and numerical solutions of a phenomenological macroscopic theory. We propose an improved fit function of the force valid over a much wider range of contact angles and droplet volumes.

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**Stefano Onofri** completed his Master's (2020) and Bachelor's (2017) degrees at the University of Rome "La Sapienza" and is currently working as Ph.D. at the university of Twente, Enschede, the Netherlands (looking for a postdoc).

If you have any additional questions, please feel free to contact me via email at s.onofri@utwente.nl.

# Investigating the swelling behavior of Soybean Phosphatidylcholine and Glycerol Dioleate mixtures.

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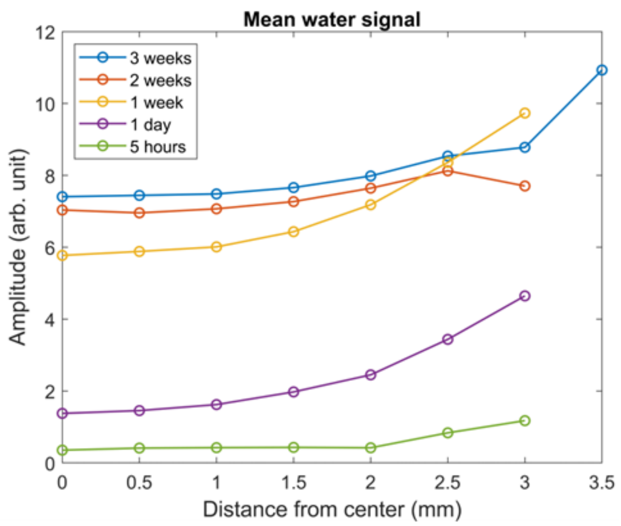
*[c] Biofilms – Research Center for Biointerfaces, Malmö University, SE-205 06 Malmö, Sweden*
*[d] Lund University Bioimaging Center, Lund University, SE-221 84 Lund, Sweden*



Lipid-based drug delivery systems show promise in improving bioavailability, reducing dosing frequency, and enhancing patient adherence. When exposing amphiphilic lipids to an aqueous environment, initially dry lipid mixtures form liquid crystalline phases. Depending on the composition of the lipid mixture the range of potential structures includes lamellar bilayers, hexagonally arranged channels, complex reverse bicontinuous structures and micellar arrangements. [1] Differences in lipid composition, depot size, and hydration-induced phase transitions are expected to influence the diffusion processes within and outside the depot.

Depots composed of soybean phosphatidylcholine (SPC) and glycerol dioleate (GDO) mixtures underwent hydration for different time intervals in a phosphate-buffered saline (PBS) buffer, followed by analysis using Karl Fischer titration, magnetic resonance imaging (MRI) (see TOC figure), and gravimetric techniques. Mathematical modeling, employing diffusion equations, was utilized to estimate diffusion parameters characterizing the swelling process.

The swelling kinetics were influenced by the lipid composition and depot size. The diffusion parameters acquired from Karl Fischer titration and MRI, which offered temporal and spatial resolutions, respectively, exhibited good concordance. Notably, MRI data revealed a water content gradient within the depot even when the system was in equilibrium. While seemingly contradictory to the classical form of the first Fick's law, these findings are explained by the generalized Fick's law, which attributes diffusion to the gradient of chemical potential rather than concentration.

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*Currently working with my PhD project titled "Nanostructured lipid composites for long-acting parenteral drug delivery".*

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*MSc in Technical Nanoscience with specialization in Nanobiomedicine*

***Fun fact**: I have 3 horses, 2 cats and 2 dogs.*

# Limits to Design in Colloidal Self Assembly

*Natalie Blot[1], Lucas Sixdenier[2], Rabeya Hussaini[2], Maitane Munoz-Basagoiti[3], Angus McMullen[2], Jasna Brujic[2] and Zorana Zeravcic*

*1) Ecole Superieure de Physique et Chimie Industrielle*
*2) New York University Center for Soft Matter Research*
*3) IST Austria*

Recent work has provided many paradigms to design and control the self-assembly of colloidal building blocks to obtain desired geometries [1-3]. In the case of DNA coated colloids, McMullen et al demonstrate in [1] that temperature protocols can be used to hierarchically fold a chain of colloids of particular types, eg a “colloidomer” into a desired rigid conformation. Since this process happens out of equilibrium, a well chosen assembly protocol can select a series of metastable states, and can therefore reliably construct clusters with high free energies. Extending this work in two and three dimensions, we discover that not all geometries are equally easy to design- in fact, given a limited alphabet of building blocks, the majority are impossible to design! Among the designable few, there are again strongly preferred structures, in that many more protocols assemble some than others. Using exhaustive enumeration of potential assembly protocols, we can investigate what makes these clusters so special. Conversely, we can also ask what makes their undesignable counterparts “hard.” Our results show that assembly is indeed biased towards symmetry, similar to claims about biological evolution of proteins in [4], as well as showing that larger designable clusters typically contain smaller designable clusters within them.

We also discuss more complex assembly strategies to access “hard” structures, which use 2 dimensional restriction to assemble clusters not otherwise attainable with small alphabets. For example, the hollow icosahedron is impossible to design directly from a chain, but by first building two dimensional nets and controlling their subsequent folding, we can identify methods to assemble it.

References:

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[2] Zhu et al. Forthcoming. https://arxiv.org/pdf/2312.08619.pdf. (2023)
[3] Curatolo et al. *Nature Communications.* Vol 14, Issue 1, page 8328. (2023)
[4] Johnston et al. *PNAS.* Vol 119, Issue 11, page e2113883119. (2022)

**Natalie Blot** (*natalie.blot@espci.fr*).

Currently a Phd Candidate at ESPCI under the supervision of Zorana Zeravcic, I completed my Masters Degree from the ICFP Soft Matter and Biophysics track in 2022. Before that, I received by Bachelors degree in Physics and Mathematics from the Ecole Polytechnique in 2020. In my free time, I enjoy poetry, rock climbing, and watching movies.

# Multi-responsive Supramolecular Core-shell PNIPAM microgels

Antoine BREZAULT,[1,2,3] Véronique Schmitt [1], Valérie Ravaine[2], Patrick Perrin[3], Nicolas Sanson[3]
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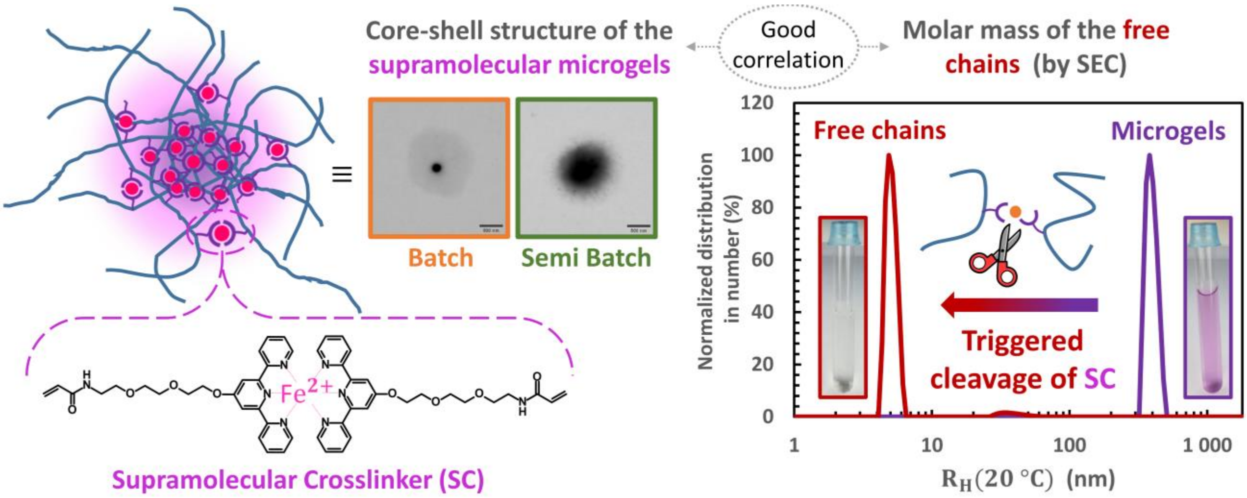

Stimuli-responsive microgels with a well-controlled structure are of great interest not only in fundamental research but also in a broad range of applications [1]. Here, we study the structure-properties relationships of new multi-responsive supramolecular PNIPAM microgels originally synthesized by incorporating a home-made metallosupramolecular crosslinker during the precipitation polymerization (TOC figure).

On a first hand, this supramolecular crosslinker endows the microgels with interesting responsive properties [2]. The microgels exhibit salt responsiveness benefiting from the crosslinker charges, in addition to temperature responsive properties as expected from PNIPAM-based objects. Besides, microgels can be degraded on demand since the crosslinking points are cleavable by oxidation. We describe the mechanisms of degradation and the reasons why the kinetics or the salt and temperature responsiveness are highly affected by the structure of these microgels.

On the other hand, the supramolecular crosslinker proves to be a powerful tool to investigate the core-shell structure of the microgels with laboratory techniques instead of SANS or SAXS techniques. The supramolecular crosslinker content can be easily quantified using UV-vis spectroscopy thanks to the specific UV band of the terpyridine/metal complex. Besides, TEM pictures permit to easily characterize the core-shell-like structure of the microgels since the crosslinker contains iron ions which increases the electronic contrast of the crosslinked core. Most interestingly, size exclusion chromatography proves that the mass distribution of the polymer chains coming from the triggered degradation of the microgels is closely correlated to the core-shell-like structure of these microgels.

References:
[1] M. Karg *et al*, *Langmuir.* 35, 6231 (2019)
[2] A. Brézault, P. Perrin, N. Sanson, *Macromolecules*. (2024) https://doi.org/10.1021/acs.macromol.3c02550

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**Research:** PhD at the CRPP and at the ISM in Bordeaux in collaboration with the SIMM laboratory at ESPCI in Paris (2022-2025).

# Adsorption properties of volatile amphiphiles at solution/vapor interfaces

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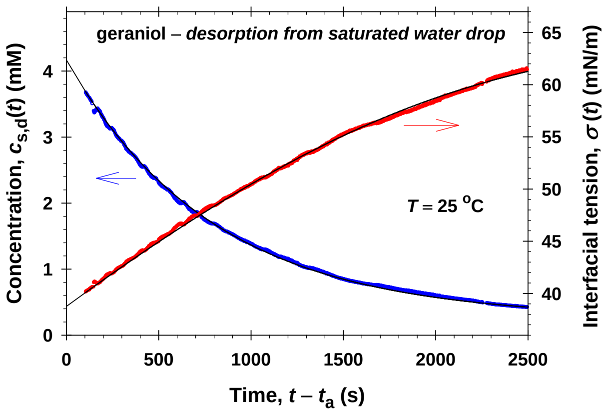

Volatile amphiphiles are commonly found in perfume formulations, cosmetics, household cleaning, and pharmaceutical products. They are partially soluble in water, have relatively low vapor pressure, and adsorb at the solution/vapor interfaces, changing the surface rheology. The aim of our study is to investigate the adsorption properties of a series of volatile amphiphiles - linalool, citronellol, benzyl acetate [1], menthol, and geraniol.

To characterize the adsorption parameters in the isotherms and 2D equations of state, the equilibrium surface tensions are measured using the maximum bubble pressure method. The surface tension isotherms are excellently described by the van der Waals type of equation of state and the most probable equilibrium parameters are estimated.

The kinetics of adsorptions of the volatile amphiphiles from their vapors to water drops are measured using the pendant drop method. The obtained experimental data suggest the application of the mixed barrier-diffusion controlled adsorption mechanism. From the respective theoretical data interpretation, the adsorption and desorption rate constants are calculated.

After the saturation of the adsorption layer, the experimental cell is opened to the atmosphere to quantify the evaporation of the volatile amphiphiles from the saturated solution drop into the air. The process of evaporation is modeled both with the determined barrier-diffusion controlled approach and with a new semi-empirical method. The simple semi-empirical model is suitable for the quantitative comparison of evaporation rates of the studied volatile amphiphiles, which can be beneficial for practical applications.

During the evaporation process, the interfacial dynamic rheological properties of the adsorption layers are investigated using the oscillating drop technique. The measured dilatational elastic moduli are greater than the loss moduli and increase with the rise of dynamic surface tension. An appropriate theoretical interpretation of the rheological data is proposed based on the determined physicochemical parameters of the respective volatile amphiphile.

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Acknowledgments: The authors are grateful to the National Science Fund of Bulgaria, Grant No. KP-06-N 79/4/2023.

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- **Master's degree in Medical Chemistry, Sofia University, Bulgaria;**
- **First-year Ph.D. Student in "Physical chemistry and macrokinetics", Sofia University, Department of Chemical and Pharmaceutical Engineering;**
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# PNIPAM microgel-stabilized aqueous Pickering foams

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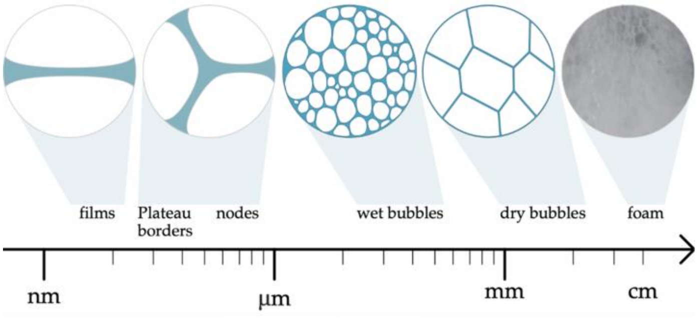
*1) Soft Matter at Interfaces, Institute for Condensed Matter Physics, TU Darmstadt, Hochschulstraße 8, D-64289 Darmstadt, Germany*



*Length scales of "foams"*

Particle-stabilized foams, so-called Pickering foams, are gaining increasing attention due to their high long-term stability and possible stimuli-responsiveness. Suitable stabilizers for generation of these foams are PNIPAM microgels (MG) as they possess a high adsorption energy at the water-air interface compared to classical surfactants. In addition, they exhibit a temperature-dependent reversible volume phase transition which allows for the generation of switchable foams, that can be destroyed on demand.

The aim of this work is to generate MG-stabilized Pickering foams by sparging gas ($N_2$) through a PNIPAM MG dispersion. For this purpose, the Teclis Foam Scan® device is used, which measures foam properties such as foam volume over time, liquid fraction as well as bubble size and bubble size distribution. In this work, a special focus is set on identifying device and sample parameters for generation of foams with a homogenous bubble size distribution. This is essential for a quantitative comparison of the foam properties and the investigation of foam destabilization processes. In addition, single foam films are investigated by intensity measurements recording spatially resolved disjoining pressure isotherms with a Thin Film Pressure Balance (TFPB). In this respect, MG with increased crosslinking density generate more homogenous, thinner, and stable foam films, which we aim to better understand.

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I am a PhD student in the group of Regine von Klitzing. My work focuses on untangling stabilizing effects of thermo-responsive PNIPAM microgels on foams and foam films. I therefore investigate foams on different length scales and strive to find answers to the question "How is foam and foam film stability related to MG structure, swelling and mechanical properties?".

# SELF-ASSEMBLED POLYPEPTIDES: TOWARDS BIOMIMETIC PIEZOELECTRIC MATERIALS

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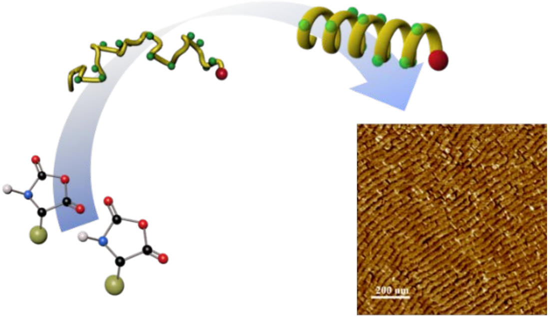
**Keywords:** Piezoelectricity, dipolar arrangement, block copolymer, self-assembly

Piezoelectric polymers are organic macromolecules capable of generating electrical polarization in response to mechanical stress. Among these, polyvinylidene fluoride (PVDF) is widely known for its high piezoelectric properties.[1] In its β-phase crystallized form, PVDF exhibits a parallel arrangement of dipoles, resulting in superior piezoelectricity. However, PVDF lacks (bio)degradability for advanced applications in biolectronics.[2] Interestingly, natural proteins like collagen also demonstrate strong macroscopic dipoles that respond to external electric fields and shear force due to the directionally aligned hydrogen bonds within their triple-helix structure.[34] This macrodipole alignment can also occur in other secondary structures, such as α-helices, by aligning all the peptide bond dipoles of the polypeptide.



Our objective in this study is to replicate the piezoelectric performance of electroactive fluorinated polymers using synthetic, protein-like backbones. To achieve this, we utilized N-carboxyanhydrides (NCAs) ring-opening polymerization to produce fluorinated polypeptides with a block copolymer (BCP) structure. Incorporating highly dipolar C-F bonds into α-helical polypeptides offers an optimal balance for biomimetic piezoelectricity, combining strong macrodipoles, amino acid building blocks, and biodegradability. To precisely align the macroscopic dipoles, we studied the self-assembly of these materials in thin films and evaluated their dielectric properties using dielectric spectroscopy. Our study aims to pave the way for biomimetic and piezoelectric materials, potentially contributing to the development of innovative biomedical applications.

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# Light trapping within 3D macrocellular ceramics towards environmental remediation

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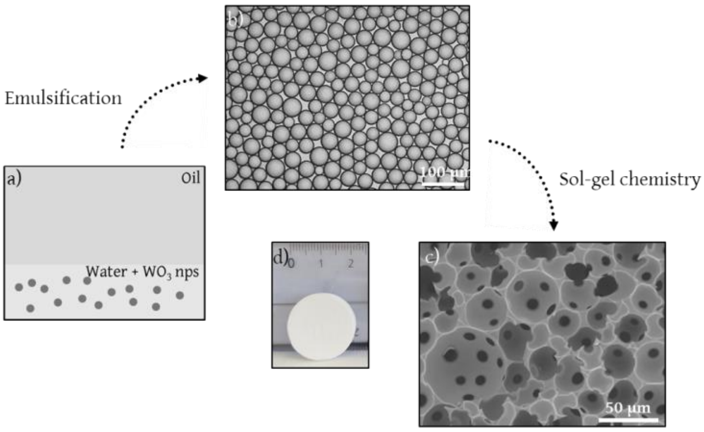

**Figure:** a) Starting oil-in-water emulsion, b) Optical microscopy image of the resulting Pickering emulsion, c) Scanning electron microscopy image of the ceramic after sol-gel, drying and sintering steps, d) Macroscopic aspect of the monolithic catalyst.

Hierarchical porous architectures have attracted a great deal of attention because of their unique characteristics. Facilitated mass transport, enhanced light harvesting, high surface area and open porosity are among their properties. When employed as catalyst' supports, they allow increased catalytic activity compared to their analogues with monomodal porosity. In particular, combining open macropores (pores with a size above 50 nm) and mesopores (2 nm < pore size < 50 nm) could be one of the most interesting association according to some authors. [1] Therefore, we aim to design novel hierarchical inorganic architectures by combining sol-gel chemistry and emulsion templating, bearing all three levels of porosity (micro/meso/macro). [2] By introducing $TiO_2$ nanoparticles into the silica matrix through a colloid approach, catalysts exhibiting good photo-oxidative properties towards acetone degradation were obtained. These self-standing materials showed activity and light trapping in volume where the majority of photocatalysts are only active on their top surface. [3,4] By using photoactive nanoparticles as emulsion stabilizers even better properties are expected. In this vein, Pickering emulsions (*i.e.* emulsions stabilized by particles or colloids) stabilized by $WO_3$ nanoparticles were designed. $WO_3$ nanoparticles are indeed expected to act as Mie scatterers when exposed to light irradiation and would consequently enable light diffusion towards the bulk of the material, reaching even more active sites. Using Pickering emulsions as templates also provide control over both pore size and pore connectivity by varying the amount of particles. Addressing such control is regarded as a mean to enhance catalytic activity through enhanced photonic and mass transport. Aside, these hierarchical porous architectures can be easily tuned to address different applications, going from photocatalysis [3,4], to biocatalysis [5] when associated with enzymes or for liquid phase catalysis [2].

References:

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[5] A. Roucher *et al, Enzyme Microb. Technol.,* 120, 77-83 (2019)

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After graduating from the National Graduate School of Chemistry of Montpellier with a specialization in materials science, I joined the University of Bordeaux as a PhD student. Here I am working at Paul Pascal Research Center on 3D macrocellular ceramics for environmental remediation, especially air purification by photocatalysis, supervised by Pr. Rénal Backov and Pr. Thierry Toupance.

# Active-Passive Colloid Crystallization

*Nur Syazaliyana Azali*,[1] *Dr Stephen Ebbens*[1]
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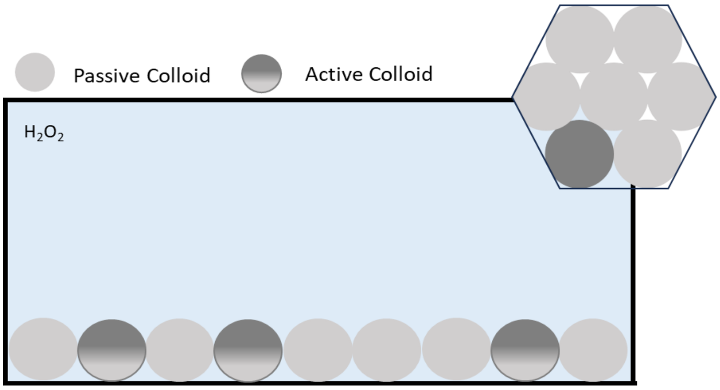

**Figure: Schematic representation of the active-passive colloidal complex crystallization. The image of active colloids represents Janus colloids half-coated (dark region) with platinum metal, which enables them to catalytically decompose hydrogen peroxide fuel. This causes enhanced motion at low volume fractions, but this work investigates the effect of activity on local and global crystal order.**

Colloidal crystallization provides a route to make hierarchically ordered materials through self-assembly. Self-assembled regular colloidal structures have a wide range of applications including photonic materials, lithography and porous separators in energy materials. Active colloids, specifically catalytic Janus colloids, have the capability of decomposing dissolved fuel to provide rapid motion in fluids. The kinetics of colloidal crystallization involves three phases[3]: diffusion, penetration, and rearrangement. However, in this highly sensitive system, the colloidal interactions play a vital role during crystal formation. Consequently, combining active and passive colloids to enable complex crystallization processes, where both the hindered active colloid motion and catalytically induced interactions alter the overall order, has new potential to synthesize responsive smart materials and overcome common issues in passive colloid self-assembly such as polycrystallinity and glass arrest[1,2].

Here, the formation of mixed active-passive colloidal crystals from Polymethyl Methacrylate (PMMA) spheres is reported. This system has been shown to self-organize into close-packed hexagonally ordered monocrystalline arrangements. The influence of active colloids activity on crystallization formation was analyzed through a series of static optical microscopy images. This allowed the effect of active colloids on local and global order to be quantified. Various factors, including catalytically induced interactions and shear effects[4], have significant effects on colloidal crystallization. The presence of active colloids in active-passive complex crystallization can also has considerable influence on crystal defects.

These findings indicate the ability of colloidal systems to form crystal arrangements with a small doping of catalytically active colloids into the system. The study consequently reports a new insight into the crystallization of colloids, thus optimizing the use of colloidal systems for research advancement.

References:

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3 S. Yang, Z. Chen and X. Liu, *Arab. J. Chem.*, 2021, **14**, 103387.
4 K. T. Saud and M. J. Solomon, *J. Colloid Interface Sci.*, 2023, **641**, 950–960.

**Nur Syazaliyana Azali** (*NSAzali1@sheffield.ac.uk*). Nur is currently a PHD student with Dr. Stephen Ebbens in Department of Chemical and Biological Engineering at University of Sheffield, United Kingdom. She received her Master's Degree (Research) in Science of Engineering and Built Environment at Universiti Kebangsaan Malaysia in 2021. Her research interests include controlled released of drug delivery (e.g., Mesoporous Silica Nanoparticles), microfluidic transport system and self-assembly of micromaterials. She is particularly interested in self-assembly colloidal crystallization for engineering applications.

# Novel high internal phase emulsion binders stabilized by amphiphilic RAFT polymers for minerals beneficiation

[1,2]Yuri Fernandes, [1,2]Negin Amini, [1,3]Alisha Debas, [1,4]Erica Wanless, [1,3]San H. Thang, [1,2]Ellen Moon
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[2]School of Engineering, Deakin University
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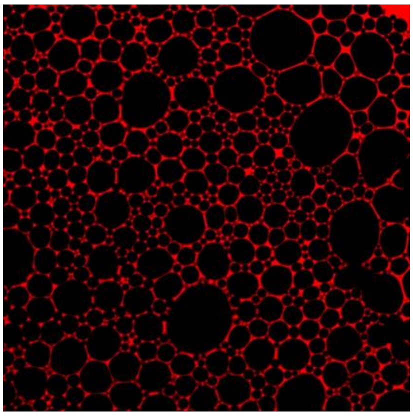

The liberation of critical minerals from complex ores produces a challenging but valuable source of material: fine particles. Well-known industrial techniques for minerals recovery struggle when it comes to fine particles, losing most of them to tailings. Oil agglomeration is a process that stands out in this category, however, has never been considered industrially applicable due to its high costs [1].

High internal phase (HIP) water in oil (w/o) emulsions are a dispersed system in which at least 74% of water is dispersed in a continuous oil phase, stabilized by the reduction of interfacial tension. A lower proportion of the continuous phase allows the reduction of the oil and stabilizer requirements, while keeping the oil surface properties dominant for the emulsion binder. Hence, the feasibility issue of oil agglomeration may be circumvented. Previous work by our wider group was the first to demonstrate the use of emulsions stabilized by tailored amphiphilic macromolecules, obtained by RAFT polymerization, to recover hydrophobic fine particles at an equivalent, or improved quantity as compared to 'traditional' emulsions prepared with commercial surfactants [2].

Here, the most recent outcomes of this project are presented, in which the composition of the RAFT polymer was optimized to increase the sustainability of the reagents used. Agglomeration experiments show improved performance in recovery of hydrophobic fine particles by the novel binders, considering the organic dosage, when compared to the traditional emulsion. A detailed characterization of the RAFT HIP emulsions and the benchmark traditional emulsion is provided, comparing their effectiveness and the agglomerates generated for particle recovery.

References:
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**Yuri Fernandes** (*s223743785@deakin.edu.au*). I have a master's degree in Materials Science and Engineering from UFRN/Brazil, in which I studied the development of ceramic membranes for water treatment. I am currently a PhD candidate in the School of Engineering at Deakin University, Australia, in the research field of minerals beneficiation, and am a member of the ARC Centre of Excellence for Enabling Eco-Efficient Beneficiation of Minerals.

# Redox chemistry in solution toward large silicon particles

*Megan A. Parker[1], Anissa Ghoridi[2], David Portehault[2], Patrick Rosa[1], Mathieu Gonidec[1], Glenna L. Drisko[1]*
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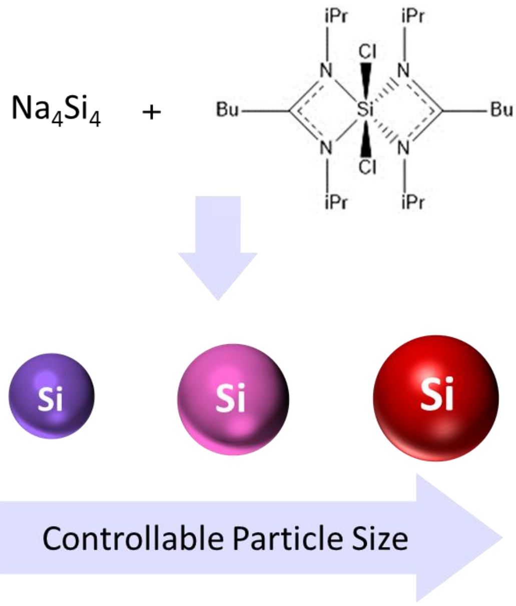
*2) Sorbonne Université, CNRS, Laboratoire de Chimie de la Matière Condensée de Paris (LCMCP), F-75005 Paris, Fr*



The synthesis of nano-silicon has proved to be a difficult challenge for chemists over the past few decades. Small spherical nanoparticles ($d < 20$ nm) can be produced, but larger sizes are difficult to achieve. Here, a solution-phase synthesis provides a pathway toward reaching this goal via a ligand-controlled growth mechanism. The method involves changing the solvent and/or ratio of a silicon Zintl phase with an amidinate-stabilized silicon coordination complex to tune particle size[1]. Upon precursor decomposition, the amidinate ligand simultaneously acts a nanoparticle stabilizer to control growth. Spherical particles are produced from this reaction of controllable size, from 15 to 230 nm in diameter. The particles are characterized by TEM, XRD, ATR-IR, XPS and Raman spectroscopy. The particles are promising candidates for a wide range of Si-based nanomaterials including in optics, batteries, and nanomedicine.

References:

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**Megan Parker** (megan.parker@icmcb.cnrs.fr).

Third-year PhD candidate in nanomaterials chemistry. Focused on developing bottom-up strategies to synthesize silicon nanoparticles for use in a variety of new materials including energy storage devices, sensors, and optical components. Synthetic skills include the synthesis of air-sensitive compounds, organometallic coordination complexes, inorganic nanoparticles, surface functionalization, and the self-assembly of particles into monolayers. Characterization skills include electron microscopy (SEM, TEM), Raman spectroscopy, XPS, NMR, FTIR, TGA, DLS, and cyclic voltammetry.

# Day 4

**June 27th / Thursday**

| | | |
|---|---|---|
| | Amphi 1 | |
| 9:00-10:00 | Jan Vermant | |
| | Amphi 2 | Amphi 3 |
| | Chair: M. Soula | Chair: E. Layan |
| 10:00-10:20 | Regina Medeiros | Jordan Bassetti |
| 10:20-10:40 | Rahma Boughanmi | Gabrielle Lacroix |
| 10:40-11:00 | Coffee break | |
| | Chair: S. Sekar | Chair: M. Parker |
| 11:00-11:20 | Andriani Tsompou | Ilyes Jalisse |
| 11:20-11:40 | Tatiana Slavova | Leila Issoufou Alfari |
| 11:40-12:30 | Closing Ceremony & Prizes | |
| 12:30-14:00 | Lunch | |

# Improving the collection of fine valuable minerals via aggregation using polyacrylamide polymers

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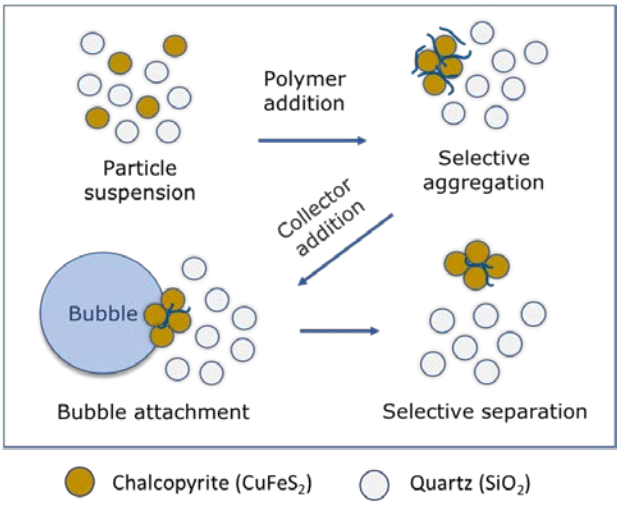

Copper is one of the key elements for a low-carbon future and a global transition into renewable energy, being fundamental for the construction of solar cells, electric vehicles, wind turbines, and energy storage devices[1,2]. Nowadays, copper minerals such as chalcopyrite (CuFeS$_2$) are industrially separated from other waste minerals (e.g. quartz) through flotation processes, where the materials are separated based on their hydrophobicity differences. In this process, the valuable mineral is made hydrophobic and rises to the top of the flotation cell, where it is collected. However, industrial flotation has been limited to collecting particles ranging between 50-150 µm sizes, which results in significant losses of valuables below and above that size[3]. The present work aims to use the flocculation-flotation approach to improve the recovery of fine copper minerals. In this approach, commercial polyacrylamide polymers were used to selectively increase the size of fine valuable minerals via flocculation, to produce aggregates that are in the suitable size for froth flotation. The effect of the polymer characteristics such as charge and molecular weight, as well as the shear input in the cell, was investigated on the aggregate sizing and formation. The results indicated that both cationic (CPAM) and anionic (APAM) polymers can effectively aggregate CuFeS$_2$, however, the cationic polymer is not selective towards the target valuables, as it also aggregates quartz. Furthermore, it was observed that the flocculant's molecular weight and shear intensity also have an important influence on the flocculation performance, with higher MW polymers and lower shear inputs producing bigger and stronger aggregates, that are more likely to survive the hydrodynamic conditions of flotation cells.

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[2] S. S. Jena, et al., *Minerals*. 12, 545 (2022).
[3] S. Farrokhpay, et al., *Mineral Processing and Extractive Metallurgy Review*. 42, 473-483 (2020).

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**Regina de Medeiros** (*rmedeiros@student.unimelb.edu.au*). Regina is PhD student in the Department of Chemical Engineering at The University of Melbourne, in Australia. She is interested in studying colloidal systems and the interaction of powder materials with other reagents, in order to enhance a specific system or product. Currently, she is working on using commercial and novel bio-based reagents to improve the separation of fine copper minerals, to supply the copper demand for clean energy and electronics. In addition to her research, she is interested in gender equity and inclusion initiatives, being an active PhD representative in the Gender, Equity, Diversity and Inclusion Committee (GEDI) at ARC Centre for Excellence for Enabling Eco-Efficient Beneficiation of Minerals.

# Formulation and rheological characterization of Pickering emulsions of organic nuclear waste prior to their immobilization

*Jordan Bassetti*[1]*, Christel Pierlot*[2]*, Arnaud Poulesquen*[2]
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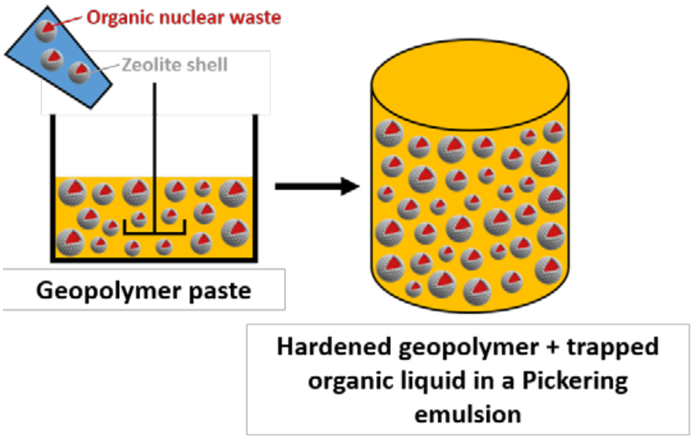
*2) CEA, DES, ISEC, DPME, Univ. Montpellier, Marcoule, France*



The effective immobilization of organic nuclear waste is a critical challenge facing the nuclear industry, due to the complexity and variability of waste streams, the potential for chemical reactions and degradation, and the need to ensure long-term stability and safety. The organic nuclear waste considered in this study are (i) TriButyl Phosphate (TBP), used in the PUREX process (extraction method used for separating uranium and plutonium from spent nuclear fuel for reprocessing); and, (ii) cutting fluids, used in machining operations in nuclear power plants. To avoid hydrolysis reactions [1], one way is first to build a protective shell around the droplets of organic liquid and then to introduce these encapsulated droplets in cementitious or alkali-activated materials.

To achieve this, Pickering emulsions of organic liquids are formulated with zeolites as Pickering agents. The synthesis and characterization of zeolites optimized for emulsion formulation are thoroughly investigated. Attention is paid to the surface chemistry, particle morphology, and interfacial properties of the zeolites to maximise their emulsifying efficiency. Furthermore, the impact of various formulation parameters, including zeolite concentration, emulsification techniques, and surfactants incorporation, on the stability and rheological behaviour of the emulsion is systematically evaluated.

Rheological measurements play a crucial role in assessing the performance of Pickering emulsions [2]. Flow rheology analyses provide insights into the viscosity profiles, shear-thinning behaviour, and flow stability of the emulsions under diverse operational conditions. Additionally, oscillatory rheology studies elucidate the viscoelastic properties and interfacial interactions within the emulsion system, offering information on its structural integrity and mechanical robustness.

Our findings suggest that Pickering emulsions offer a promising avenue for immobilizing organic waste, up to 20 % by volume in a cementitious or an alkali-activated material. These emulsions exhibited stability over a 30-day period, with negligible alterations observed in particle size or zeta potential.

References:
[1] J. Bassetti, C. Pierlot, C. Davy, D. Lambertin, A. Poulesquen, *Science Talks* (6), p. 1-10 (2023).
[2] J. Chen, R. Vogel, S. Werner, G. Heinrich, D. Clausse, V. Dutschk, *Colloids Surf. A: Physicochem. Eng. Asp* (383), p. 238-345 (2011).

**Jordan Bassetti** (*jordan.bassetti@centralelille.fr*) is graduated from the École Nationale Supérieure de Chimie de Lille (ENSCL, France) with a Master's degree in Chemistry and Formulation Engineering. He is currently a PhD student in the Unit of Catalysis and Solid-State Chemistry (UCCS, France) on the containment of potentially radioactive hydrolysable waste in immobilization matrices. His research is partly funded by the French Atomic Energy Commission (CEA, France).

# Preparation of Bio-Hot Melt Adhesives using Biopolymers

*Rahma Boughanmi* [1], *Christine Steinbach* [1], *Norbert Smolka* [1], *Mathias Häschel* [1], *Simona Schwarz* [1]
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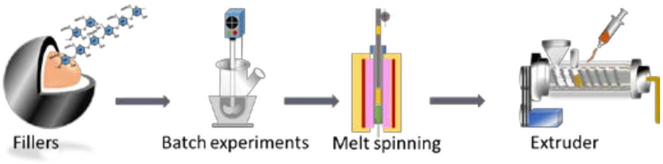

Due to the industrial development of chemical industries, the demand for hot melt adhesives has increased. Most hot melt adhesives are derived from petroleum resources, such as EVA, which are toxic to the environment and contribute to increased $CO_2$ production. This necessitates the development of alternative solutions to replace commercial hot melt adhesives. Bio-based hot melt adhesives serve as a viable alternative, owing to their environmentally friendly attributes, biodegradability, non-toxicity, and low cost [1]. Starch, as a biopolymer, can be utilized as a main component in the alternative after its transformation into thermoplastic starch using plasticizers. Additionally, tackifiers like rosin are used to enhance the adhesive strength. In this study, we prepared various formulations with three different types of rosin and compared them using several characterization methods, such as SEM imaging, FTIR spectroscopy, rheology, TGA, and lap shear strength tests.

References:
[1] X. Yu *et al.*, “Bio-based hotmelt adhesives with well-adhesion in water,” *Polymers*, vol. 13, no. 4, pp. 1–11, 2021, doi: 10.3390/polym13040666.

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**Rahma Boughanmi** (*boughanmi@ipfdd.de*).

During my master's studies from 2018 to 2021 at the Technical University of Dresden, I obtained a Master of Science degree in Chemistry. My research focused on investigating the adsorption properties of heavy metal ions and oxyanions on starch. These studies were conducted at the Leibniz Institute of Polymer Research Dresden, specifically at the Institute for Physical Chemistry and Polymer Physics. Since February 2021, I have been working as a PhD student at the Leibniz Institute of Polymer Research Dresden. In this position, my main areas of focus are the removal of heavy metal ions from water and the modification of biopolymers, particularly chitosan and starch. Also, the development of bio hot melt adhesives using biopolymers such as starch, chitosan, and pectins.

# Formulation of biomimetic silicones for 3D printing of kidney models

Gabrielle Lacroix[1,2], Camille Courtine[1], Marleine Tamer[2], Jacques Leng[2], Olivier Mondain-Monval[1]

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With the aim of continuously improving cancer surgery, surgeons are in need of new materials and techniques that will enable them to train on faithful 3D models instead of biological one. The project we are presenting consists in the development of a 3D printing technique of patient-specific kidney models made of specifically formulated silicone polymers.[1]

The purpose of this research is to formulate the 3D printable "ink", a silicone-based formulation. Some routes are considered in the attempt to match the final material with living kidney characteristics:

- Modification and control of the model mechanical properties (Young's modulus and stress at rupture);
- Establishment of a fluid release mechanism at the cut of the material (pseudo-bleeding)
- Imitate the kidney vascularized structure

To achieve these, water droplets inclusions were suspended in the silicone before its crosslinking. Several ranges of drop sizes (0.1 to 100 µm), water volume fraction (up to 70% vol) and droplets aggregation states can be controlled. The addition of water droplets in the material allows us to, not only make it softer, but also release water at cut.[2] The mechanical properties correspond in part to those of real organs and the pseudo bleeding is sufficiently convincing to emulate the alteration of the micro-vascularisation after cutting.

By controlling the droplets aggregation, we are leaning toward a vessel-like structuration of the colloidal particles. This would also have an influence on some properties of the cross-linked materials, such as the drying kinetics and the fluid quantity released at cut. Finally, the formulated inks stability is tested upon extrusion in thin tubes such as the one used for 3D printing.

Overall, these materials enrich the range of silicone 'inks' that can be used to create a biomimetic phantom kidney.

## References:

[1] Wang, K., Ho, C.-C., Zhang, C. & Wang, B. A Review on the 3D Printing of Functional Structures for Medical Phantoms and Regenerated Tissue and Organ Applications. *Engineering* **3**, 653–662 (2017)

[2] Style, R. W., Boltyanskiy, R., Allen B., Jensen, K. E., Foote, H. P., Wettlaufer, J. S., Dufresne, E. R. Stiffening solids with liquid inclusions. *Nat. Phys.* **11**, 82–87 (2015)

Gabrielle Lacroix (gabrielle.lacroix@crpp.cnrs.fr)

Chemical engineer graduated from the ECPM school of Strasbourg, I work as a second year PhD student in CRPP on the formulation of soft materials.

# A structural investigation on the interactions of cotton fabric with olive oil and water

*Andriani Tsompou*[1,2]*, Ann Terry*[3]*, and Vitaly Kocherbitov*[1,2]

1) *Biomedical Science, Faculty of Health & Society, Malmö University, Sweden*
2) *Biofilms research center for Biointerfaces, Malmö University, Sweden*
3) *Max IV Laboratory, Lund University, Lund, Sweden*

Amid growing concerns about the environmental impact of detergents, there has been a notable shift towards researching eco-friendly washing methods [1, 2]. To understand how water removes oily stains from cotton fabric, we need to look at how cotton, water, and oil interact. This study focuses on exploring how raw cotton fabric is structured and how it interacts with both oil and water.

In the exploration of mechanisms for removing oil from cotton fabric, a combination of scanning electron microscopy (SEM) and a CoSAXS experiment was employed. The analysis of the raw fabric's structure, both before and after the introduction of liquids, extended across multiple length scales—from the fabric itself (>1 mm) to the thread (1 mm), fiber (10 µm), microfibrils (5 nm), and cellulose crystalline structure (sub-nm).

The findings revealed that water permeates raw cotton fabric, influencing its structure at various scales. SEM indicated that, at larger scales, the impact of introducing and removing water on thread structure and fiber appearance is minimal. However, at the nanoscale, water penetration between microfibrils results in a less oriented and looser packing. Similarly, oil interacts with the fabric at mm and µm scales, accumulating between threads and fibers. Post-washing, residual oil concentrates on the surface in patches. Intriguingly, at the nanoscale, oil treatment and subsequent washing have a lesser impact on microfibril packing compared to water treatment. The analysis facilitated the characterization of the distance between microfibrils. 2D scattering maps provide a visual representation of the raw cotton fabric and its structure.

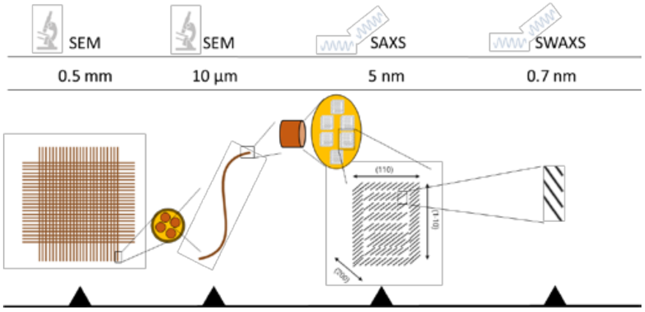


Figure 1: Graphical representation of the 4 different levels of analyses of the fiber. First, SEM is used for analysis of the thread (0.5 mm center to center distance) and fiber structure. SAXS is used for identifying the microfibrils arrangement and their crystalline structure.

References:

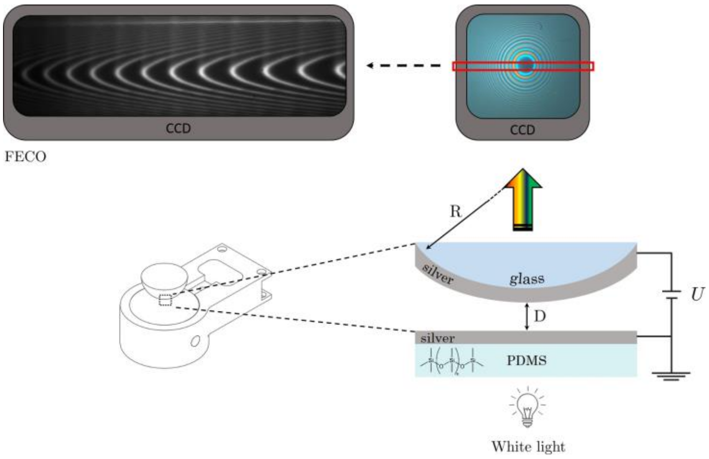
[1] A. Tsompou, V. Kocherbitov, The effects of water purity on removal of hydrophobic substances from solid surfaces without surfactants, Journal of Colloid and Interface Science 608, 1929-1941 (2022).

[2] A. Tsompou, V. Kocherbitov, Surface and bulk mechanisms in repeating treatment of solid surfaces by purified water, Heliyon 9(6) e17163 (2023).

**Andriani Tsompou**(andriani.tsompou@mau.se). 3rd year PhD student in Malmö university. My project aims to investigate how purity of water affects physical interactions relevant for cleaning, washing, solubility, and dispersibility. Moreover, an important part is to develop efficient procedures for the removal of soils from solid with the minimal use of surfactants. My background is biology and surface science.

# Interferometric surface stress sensor

Ilyes Jalisse,[1] Carlos Drummond[2]
1) Centre de Recherche Paul Pascal
Univ.Bordeaux, CNRS, CRPP, UMR 5031, F-33600.Pessac, France



Compliant walls play a significant role in many systems of interest; deformable interfaces abound in systems of biological significance. To understand surface properties of gels (like wetting or adhesion), long-range deformations must be considered. Mammalian synovial joints display remarkable lubrication properties; however, the working mechanisms responsible for that performance, linking charged macromolecules and compliant boundaries, are still not well understood. In that sense, new exploring tools are needed for the precise exploration of the response to external perturbations of compliant boundaries. The main objective of this project is to develop a surface stress sensor (surface membrane sensor, SMS) based on precise determination of the deformation of a compliant membrane exposed to a changing environment, by using multiple beam interferometry. We also aim to build the necessary theoretical/numerical tools to rationalize the novel information gathered. Using this new tool, a combined theoretical-experimental approach will be implemented to investigate important topics in soft matter. First, the electrical double layer[2] at a metal-solution interface and its behavior when it is pushed out of equilibrium, by measuring the compliant membrane deformation[1] to determine the pressure field on the metal-liquid boundary. Then, we will study the elastohydrodynamic[3] (EHD) coupling emerging when a solid object moves near an elastic membrane.

References:

[1] Sajadi B, Goosen H,van Keulen F, International Journal of Mechanical Sciences, (2018), 210-218, 138-139
[2] Richter Ł, Zuk P, Szymczak P, et al., Physical Review Letters, (2020), 125(5)
[3] Vincent Bertin, Yacine Amarouchene, Elie Raphaël and Thomas Salez, J. Fluid Mech. (2022), vol.933,A23

**contact : ilyes.jalisse@crpp.cnrs.fr**

I did my Master 1 at the University of Bordeaux in Fundamental Physics and Applications followed by a Master 2 at the Institut d'Optique d'Aquitaine (I.O.A). I am currently in 3rd year PhD and I study the response of a freestanding membrane when it is pushed out of equilibrium (electrostatics, salt solution, elastohydrodynamic, …).

# Saturated Micellar Networks: Phase Separation and Nanoemulsification Capacity

*Tatiana G. Slavova, Gergana M. Radulova, Krassimir D. Danov*

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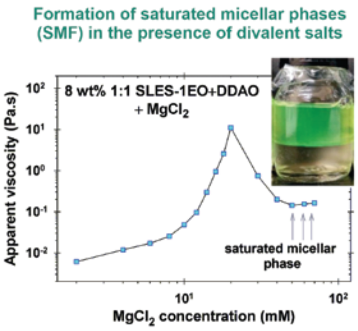
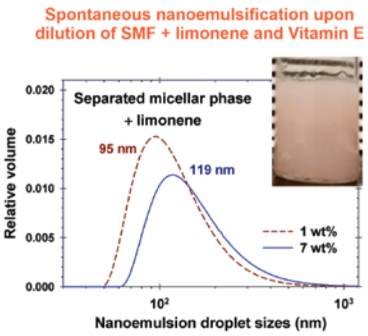

Formation of saturated micellar phases (SMF) in the presence of divalent salts


Spontaneous nanoemulsification upon dilution of SMF + limonene and Vitamin E

Different oils can be homogeneously dispersed in the network junctions of the separated bicontinuous micellar phases [1]. Upon dilution, these dispersions spontaneously form nanoemulsions. The possibility of a micellar sponge phase formation in the case of mixtures with three anionic and two zwitterionic surfactants in the presence of divalent and monovalent salts is studied. The best results are obtained using sodium lauryl ether sulfate with 1 ethylene oxide group (SLES-1EO) and both cocamidopropyl betaine (CAPB) or N,N-dimethyldodecylamine N-oxide (DDAO) in the presence of an appropriate small amount of $MgCl_2$ and $CaCl_2$. Bicontinuous micellar phases can be produced also in high-salinity NaCl solutions. The bulk properties of these phases are independent of the concentration of the initial solutions from which they are separated, and their Newtonian viscosities are in the range from 0.3 Pa.s to 0.8 Pa.s. Both 8 wt% CAPB- and DDAO-containing sponge phases engulf up to 10 wt% limonene and spontaneously form nanoemulsion upon dilution with droplet sizes of 110–120 nm. Vitamin E can be homogeneously dispersed only in CAPB containing saturated micellar network, and upon dilution, these dispersions spontaneously form nanoemulsions with smaller droplet sizes of 66 nm for both 8 diastereomers and 2 diastereomers mixtures of vitamin E.

References:

[1] T.G. Slavova, G.M. Radulova, K.D. Danov, Saturated micellar networks: Phase separation and nanoemulsification capacity, Colloids and Interfaces 8 (2024) Art. No. 11.

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BSc in Chemistry and English
MSc in Cosmetics and Household Chemistry
Currently, I'm a second year PhD student in the Department of Chemical and Pharmaceutical Engineering, Sofia University, Bulgaria
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# Stress imaging at the nanoscale using fluorescent nanocrystals

*Issoufou Alfari Leila,*[1] *Leocmach Mathieu*[1] *Mahler Benoit*[1]
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Pressure sensitive adhesive (PSA) are a class of soft polymeric solids that have the particularity to display an instantaneous adhesion on most surfaces upon application of a light pressure. Designing a high performance PSA requires incompatible mechanical properties such as a good resistance in creep in shear (optimum for hard materials) and an ability to dissipate energy during the peeling process (optimum for very soft materials)[1].
The synthesis of new type of PSA from waterborne acrylic latex of different mechanical properties allows the creation of an adhesive that conciliate these two requirements and exhibit a nanoscale heterogeneous structure.

The aim of the project is the observation of the local mechanical deformation inside the bulk of this PSA adhesive. The study of the mechanical behavior of the polymer is performed by shear test, then to visualize the deformation inside the sample we use confocal microcopy that allow the 3D visualization of a fluorescent sample. Different type of fluorescent dye to label a material exists ether organic molecules or inorganic nanocrystal. The advantage of inorganic nanocrystal is their ability to have a good resistance to the photo bleaching and to heat. They are usually small nanoparticles of a semi conductor material that display a change of fluorescence wavelength with a variation of their size.
To implement this, we use two methods. The first is to label the nanostructured PSA by encapsulation of fluorescent nanocrystals inside the polymer latexes. Then we perform shear test while imaging the sample with confocal microscopy to track the local deformation by image correlation. It allows us to observe if the heterogeneity of the material leads to a heterogeneity of the local deformation of the material.
The second method is to develop a type of new fluorescent stress nanoprobes formed by aggregates of nanoparticles that is inserted inside a polymer matrix. The aggregates have the ability to be coupled by FRET (Froster Resonnance Energy Transfer). The deformation of the polymer matrix induce a displacement of the nanoparticles inside the aggregates and have an effect on the FRET. A quantification of the FRET before and after deformation of the polymer matrix gives us information on the local deformation inside the sample.

References:

[1] Bellamine, A., Degrandi, E., Gerst, M., Stark, R., Beyers, C. and Creton, C. (2011), Design of Nanostructured Waterborne Adhesives with Improved Shear Resistance. Macromol. Mater. Eng., 296: 31-41

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Currently PhD Student at ILM (Institut Lumière Matière Lyon 1) (2022-2025)

Master 2 Degree in material science at university Paul Sabatier Toulouse (Material elaboration characterization and surface treatment ) (2022)

Engeeing School degree in material science at ENSIACET Toulouse (2022)

# ABSTRACTS
# OF
# POSTER PRESENTATIONS

# P 01

## Asymmetric patchy particles from combined colloidal and block copolymer assembly

Alexia Araújo[1,2], Guillaume Fleury[1], Serge Ravaine[2]
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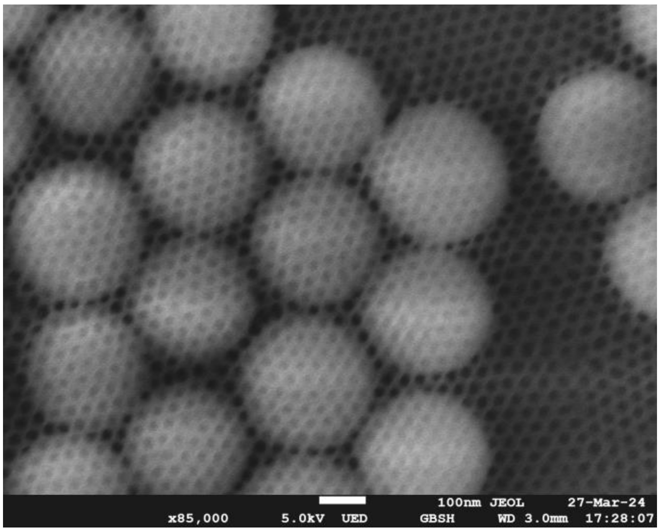
2) Univ. Bordeaux, CNRS, Bordeaux INP, CRPP, UMR 5031, F-33600, Pessac, France



Patchy particles, characterized by surface discontinuities in either chemical composition or topology, hold immense potential for directing assembly processes in specific orientations. These particles, typically equipped with at least two distinct patches, present challenges in fabrication due to the need for precise control over patch characteristics such as size, shape, and interaction properties. Despite these challenges, patchy particles offer promising applications in various fields including the development of photonic crystals, targeted drug delivery systems, and advancements in electronics.[1,2]

Block copolymer thin films are increasingly acknowledged as a cost-effective and versatile nanofabrication technology within self-assembling systems. They have found applications across various technological domains, notably including lithographic masks.[3] Polystyrene-block-polymethyl methacrylate (PS-b-PMMA) was self-assembled, forming three structural patterns with a perpendicular orientation: line & space, hexagonal dot, and honeycomb patterns[4]. Following hybridization, the PMMA domains were selectively infiltrated with $Al_2O_3$ using atomic layer deposition, while the PS domains were etched using reactive ion etching (RIE) plasma.[5] A monolayer of silica nanoparticles (SiNPs) was produced using the Langmuir-Blodgett technique, followed by the deposition of patterned alumina patches onto it, and subsequent sintering in order to fabricate the patchy particles.

References:

[1] Li, W. *et al.* Colloidal molecules and patchy particles: complementary concepts, synthesis and self-assembly. *Chem. Soc. Rev.* 49, 1955–1976 (2020).

[2] Pawar, A. B. & Kretzschmar, I. Fabrication, Assembly, and Application of Patchy Particles. *Macromol. Rapid Commun.* 31, 150–168 (2010).

[3] Ferrarese Lupi, F. *et al.* High Aspect Ratio PS- *b* -PMMA Block Copolymer Masks for Lithographic Applications. *ACS Appl. Mater. Interfaces* 6, 21389–21396 (2014).

[4] Bates, C. M., Maher, M. J., Janes, D. W., Ellison, C. J. & Willson, C. G. Block Copolymer Lithography. *Macromolecules* 47, 2–12 (2014).

[5] Demazy, N. Iterative self-assembly of nanostructured block copolymer thin films, toward the development of functional three-dimensional structures with nanometric periodicity. (Université de Bordeaux, 2022)

**Alexia Araújo** (alexia.freire-de-araujo@u-bordeaux.fr).

Graduated in Materials Engineering from the Federal University of Rio Grande do Norte (Brazil). I participated in a one-year exchange program to study and intern in France, and ended up staying for a PhD.

# P 02

## Value-added bio-based emulsifiers from dairy waste valorization

G. Ballabio,[1] S. Sangiorgio,[1] E. Pargoletti,[1] R. Gelli,[2] M. Rabuffetti,[1] L. Raimondi,[1] M. Bonini,[2] G. Speranza,[1] G. Cappelletti.[1]
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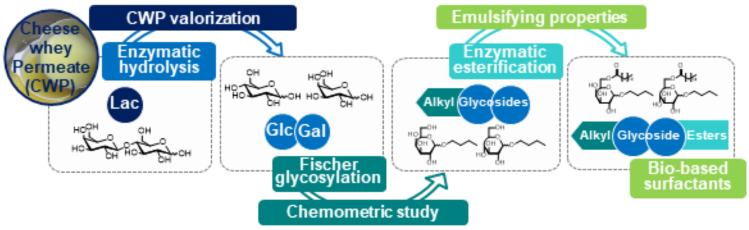
2) Università degli Studi di Firenze-dipartimento di Chimica 'Ugo Schiff' e CSGI, via della Lastruccia 3, Sesto Fiorentino.



Sugar fatty acid esters (SFAEs) are non-ionic surfactants characterized by excellent interfacial tension reduction capability, low toxicity, and biodegradability. These properties make SFAEs extremely promising for their use in cosmetic and food applications. Moreover, this class of surface-active molecules can be obtained from renewable sources, thus answering the need for sustainable and circular chemistry [1]. Herein, cheese whey permeate (CWP), the main waste stream of dairy industry, was used as raw material in the production of bio-based surfactants. Specifically, CWP was enzymatically hydrolysed into a glucose and galactose mixture which was then submitted to a two-step chemoenzymatic synthetic approach [2]. The first step, namely Fischer glycosylation, was not straightforward since several parameters influenced both yield and isomeric ratio. Therefore, a chemometric study was conducted to optimize the reaction conditions. In the second step a solvent-free enzymatic esterification reaction was performed to obtain *n*-butyl 6-*O*-palmitoyl-D-glycosides isomeric mixture. The surfactancy of the synthesized bio-based surfactants was deeply evaluated in terms of static/dynamic interfacial tensions. Turbidimetric and confocal microscopy analysis were used to study their water-in-sunflower oil (W/O) emulsion stabilization capacity over time. Finally, computational studies were performed to investigate the role of the ring size on the final emulsifying properties of the isomeric mixture.

This work has been supported by Fondazione Cariplo, grant n°2020-1094.

References:

[1] B. Estrine, S. Marinkovic, J. François, *Biobased surfactants*, 1, 365 - 385 (2019).
[2] S. Sangiorgio, E. Pargoletti, M. Rabuffetti, M. S. Robescu, R. Semproli, D. Ubiali, G. Cappelletti, G. Speranza, *Colloids and Interface Sci. Commun*. 48, 100630 (2022).

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**Giorgia Ballabio** (*giorgia.ballabio@unimi.it*)
October 2017 – April 2021: **Bachelor degree in Chimica Industriale** at Università degli Studi di Milano with a thesis entitled "Nanocomposite hydrogels with fibrous filler"; final vote: 104/110.
October 2021 – September 2023: **Master degree in Industrial Chemistry** at Università degli Studi di Milano with a thesis entitled "From dairy waste stream to sugar fatty acid esters: synthesis and physico-chemical characterization of biosurfactants for emulsions stabilization"; final vote: 110/110 cum laude.
October 2023 – Present: **PhD in Industrial Chemistry** at Università degli Studi di Milano.
My work has been presented in:
M. Rabuffetti, S. Sangiorgio, E. Pargoletti, G. Ballabio, L. Gelati, M. S. Robescu, R. Semproli, D. Ubiali, G. Cappelletti, G. Speranza, *Lipase-catalyzed synthesis and physico-chemical characterization of alkyl glycoside fatty acid esters from cheese whey permeate*; **Biotrans 2023**, La Rochelle – France, 25-29 June 2023.

# P 03

## Growing larger gold bipyramids from pentatwinned nanorods

*Francisco Bevilacqua*,[1] *Luis Liz Marzán*[1,2,3]
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*2) Ikerbasque, 43009 Bilbao, Spain*
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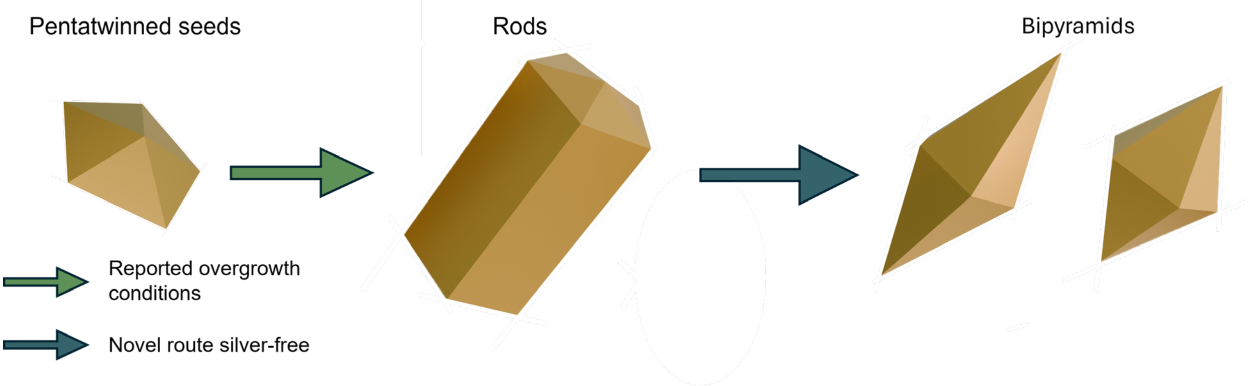
The preparation of anisotropic gold nanoparticles has been thoroughly studied over the last decades due to their high stability, low toxicity, and plasmonic properties. The tunability in the visible and near-infrared (NIR) of the plasmon resonance has made gold nanorods a widely studied material. Seeded growth methods constitute the most used protocol to prepare anisotropic nanomaterials, where nucleation and growth are performed in two distinct steps.[1–4] Such methods show a wide tunability in the final dimensions and a high yield. Two distinct kinds of seeds are typically used to grow Au nanorods: single-crystal and pentatwinned seeds. The nanorods produced by different seeds exhibit different crystallographic surface facets, and both approaches are sensitive to the quality of the seeds.[2,3,5] Pentatwinned seeds allow access to other geometries, such as bipyramids, decahedrons, stars, or more complex geometries.[3,5] For instance, bipyramids display improved near-field enhancement and sharper extinction bands than nanorods, but seed preparation requires optimization. We report the production of large gold bipyramids using pentatwinned rods as seeds. Interestingly, the produced bipyramids exhibit a unique belt structure, different to bipyramids prepared via other methods. These bipyramids exhibit high index lateral facets, despite the absence of additives, whereas the central belt has lower index facets. Regarding optical properties, the samples show a higher intensity transverse plasmon resonance, which may be related to the thicker belt.



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Graduated from the University of Bordeaux, with a Bachelor of Chemistry in 2020. Graduated from the University of Bordeaux and the TU Darmstadt following a master's degree in Advanced Material and Innovative Recycling in 2023. As master thesis work at the ICMCB in group 5 under the supervision of Glenna Drisko, on the preparation of functional silica particles by the co-condensation of Tetraethyl orthosilicate and organo-silicate derived molecules.
Currently pursuing a PhD on the synthesis of gold nanoparticles under the supervision of Luis Liz-Marzán.

# Size scaling of membrane-less compartments by phase separation

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Although constant proportionalities or size scaling between cells and their intracellular organelles have been observed in various organisms and cell types for over a century, the fundamental mechanism and physical descriptions of such size scaling phenomena remain unclear[1, 2]. Recent studies indicate that the membrane-bound organelles-to-cell volume ratio is determined by osmotic pressure balance[3, 4]. However, it is unknown how size scaling is maintained within membrane-less organelles. To address this question, we recapitulate the size scaling of membrane-less organelles using a complex coacervate model consisting of poly-l-lysine (PLL) and adenosine triphosphate (ATP) encapsulated within microfluidic-generated microdroplets. Through in vitro experiments and theoretical analysis, we demonstrate that the size scaling of membrane-less organelles is based on the thermodynamics of phase separation. Moreover, we experimentally investigate the effects of polyelectrolyte and salt concentrations on tuning the coacervate-to-microdroplets size ratio, which can be well captured by a mean-field model. These findings provide insight into the underlying mechanism governing cell and membrane-less intracellular organelle size, as well as associated biological functions.

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# P 05

## Effect of Temperature, Oil Type and Copolymer Concentration on the Long-Term Stability of Oil-in-Water Pickering Nanoemulsions Prepared Using Diblock Copolymer Nanoparticles

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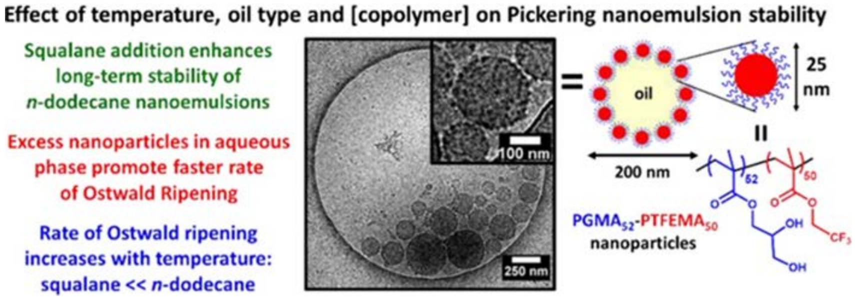

A poly(glycerol monomethacrylate) (PGMA) precursor was chain-extended with 2,2,2-trifluoroethyl methacrylate (TFEMA) via reversible addition–fragmentation chain transfer (RAFT) aqueous emulsion polymerization. Transmission electron microscopy (TEM) studies confirmed the formation of well-defined $PGMA_{52}$–$PTFEMA_{50}$ spherical nanoparticles, while dynamic light scattering (DLS) studies indicated a z-average diameter of 26 ± 6 nm. These sterically stabilized diblock copolymer nanoparticles were used as emulsifiers to prepare oil-in-water Pickering nanoemulsions: either *n*-dodecane or squalane was added to an aqueous dispersion of nanoparticles, followed by high-shear homogenization and high-pressure microfluidization. The Pickering nature of such nanoemulsion droplets was confirmed via cryo-transmission electron microscopy (cryo-TEM). The long-term stability of such Pickering nanoemulsions was evaluated by analytical centrifugation over a four-week period. The *n*-dodecane droplets grew in size significantly faster than squalane droplets: this is attributed to the higher aqueous solubility of the former oil, which promotes Ostwald ripening. The effect of adding various amounts of squalane to the *n*-dodecane droplet phase prior to emulsification was also explored. The nanoparticle adsorption efficiency at the *n*-dodecane–water interface was assessed by gel permeation chromatography when using nanoparticle concentrations of 4.0, 7.0, or 10% w/w. Increasing the nanoparticle concentration not only produced smaller droplets but also reduced the adsorption efficiency, as confirmed by TEM studies. Furthermore, the effect of varying the nanoparticle concentration (2.5, 5.0, or 10% w/w) on the long-term stability of *n*-dodecane-in-water Pickering nanoemulsions was explored over a four-week period. Nanoemulsions prepared at higher nanoparticle concentrations were more unstable and exhibited a faster rate of Ostwald ripening. Finally, the effect of temperature on the stability of Pickering nanoemulsions was examined. Storing these Pickering nanoemulsions at elevated temperatures led to faster rates of Ostwald ripening, as expected.

Reference:

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**Priyanka Chohan** (*pchohan2@sheffield.ac.uk*).

I am a 2nd year PhD student at The University of Sheffield working under the supervision of Prof. Steve Armes. My MChem research project involved the synthesis of bespoke diblock copolymer nanoparticles via PISA for the stabilization of alkane-in-water Pickering nanoemulsions. My current research is focused on preparing hydrophobic diblock copolymer nanoparticles in non-polar media for potential industrial applications.

# P 06

## Chlorogenic acid in zwitterionic liposomes: microfluidic optimization, synthesis and physicochemical characterization

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[2] Center for Colloids and Surface Science (CSGI), University of Florence, Italy
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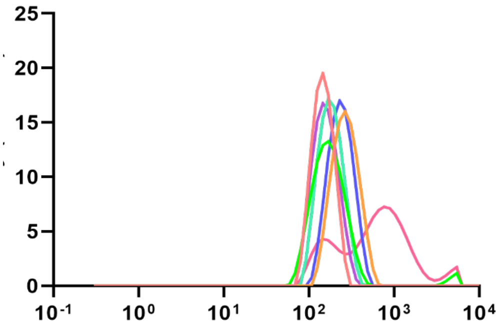

Sperm cryopreservation is an important method of preserving male fertility, but the quality of thawed sperm is often poor. Oxidative stress (OS), resulting from overproduction of reactive oxygen species (ROS), is a mechanism involved in the freeze-thaw process and leads to cellular damage. OS can be mitigated by the addition of antioxidants to the media to reduce cryodamage to sperm [1]. Chlorogenic acid (CGA), a phenolic acid found in various foods, has antioxidant properties and can be encapsulated in liposomes. Liposomes are a controlled release system that forms a protective barrier around the cell membrane, protecting these structures from the damaging effects of oxidative stress.

In this study, we synthesized zwitterionic liposomes loaded with chlorogenic acid using microfluidics and optimized their size and surface properties by experimental design methods. Microfluidic technology enables fine control and manipulation of fluids and provides predictable, defined and controlled environments suitable for the synthesis of nanosystems.

Infrared spectroscopy (FTIR-ATR) was used to obtain experimental information on the functional groups and to evaluate the loading of the bioactive molecule. Nuclear magnetic resonance spectroscopy (NMR) was used to investigate the arrangement of the phospholipid bilayer and to hightlights the interactions with the encapsulated substances, while high performance liquid chromatography (HPLC) was applied to determine the encapsulation efficiency [2].

The zwitterionic liposomes loaded with CGA were used as a supplement for freezing media in human sperm cryopreservation. The results showed that the CGA loaded in the liposomes increased the cryostability and functionality of human spermatozoa.

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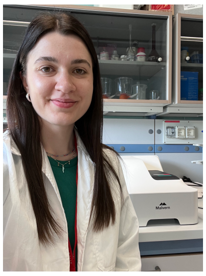

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PhD student in Chemical and Pharmaceutical Sciences at University of Siena |2022

Master's degree in Pharmaceutical Chemistry and Technology, University of Siena | 2016-2022. Experimental thesis in pharmaceutical technologies "Synthesis of novel hyaluronic acid bioconjugates with protein matrices for controlled drug delivery".

# P 07

## Chiral plasmonic nanostructures as enantioselective photocatalysts.

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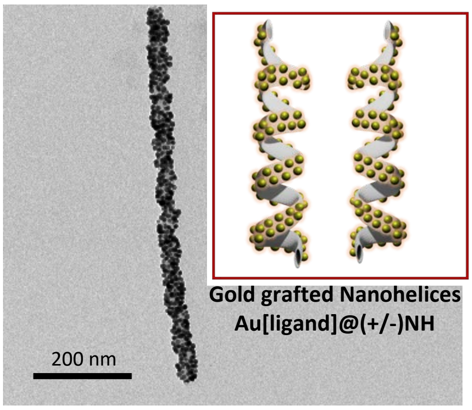
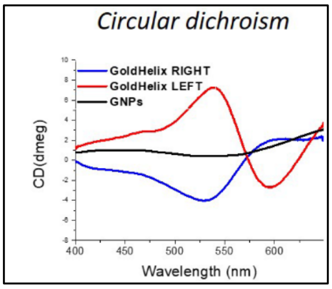


**Gold grafted Nanohelices Au[ligand]@(+/-)NH**



Chirality is a very interesting branch of science as it was proven that different enantiomers don't show the same properties[1]. Nature produces homochirality[2], however synthetizing a single enantiomer in a lab has been a challenge for many years. Numerous advances were made in the field of asymmetric catalysis and particularly asymmetric photocatalysis using photo-redox systems[3]. Photocatalysis is of great interest since it generates efficient and selective chemical transformations thanks to energy or electron transfer process using abundant, inexpensive and greener energy source which is visible light[4]. However, those reactions are mostly carried out in homogenous media which doesn't allow a very effective recycling of the catalyst. Here, we propose new chiral plasmonic nano-objects based on silica nano-helices with finely tunable morphologies covered with gold nanoparticles as potential enantioselective photocatalysts. The heterogeneous character of such samples coupled with the optical activity of the plasmonic helices[5] would allow high efficient catalysis with easy recovering of the systems.

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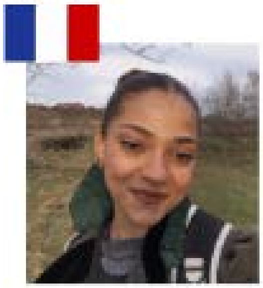


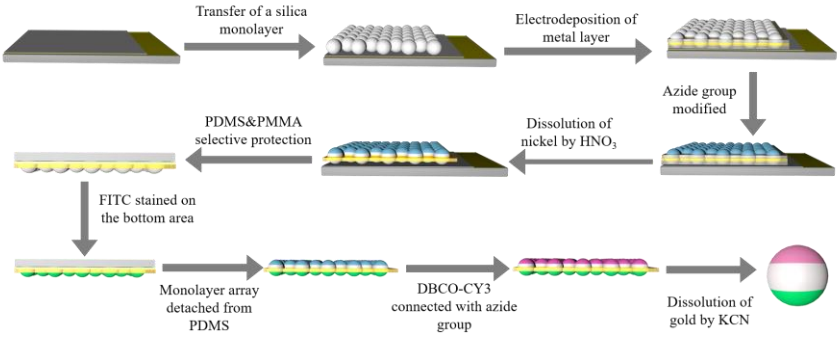
**Paméla DE LA FUENTE** (*p.de-la-fuente@iecb.u-bordeaux.fr*).

I graduated the chemistry degree and the master's degree in functional molecules and macromolecules at the University of Bordeaux. After a five-month Internship at the University of Sheffield working within Steve Armes group, I joined the "Chiral molecular assemblies" group at the IECB, directed by Reiko Oda to start my PhD on November 20203. I am being directed by Emilie Pouget and our research aims to do enantioselective photocatalysis in heterogeneous media using chiral plasmonic object.

# P 08

## A novel pathway for colloidal patchy particles

*Zirui Fan, Serge Ravaine*
*Centre de Recherche Paul Pascal, CNRS, Université de Bordeaux, Pessac, France*



Motivated by the need to fabricate next-generation functional materials without human intervention, intensive research focused on the self-assembly of colloidal building units has been conducted for two decades. This colloidal self-assembly enables easier and cost-effective fabrication compared to standard fabrication methods based on top-down approaches. However, this bottom-up approach is limited by the available building blocks that are mostly spherical and by the interactions between them, which are mostly isotropic. To expand the range of building units, one emerging approach is to engineer the surface of the colloidal particles with “patches” to confer particles predetermined “instructions” for assembly [1].

In this work, we develop a novel templating strategy to prepare patchy particles. Hexagonally ordered monolayers of functionalized silica or polystyrene particles are first formed by self-assembly and deposited on a conductive substrate. This array can be used as template for the infiltration of metallic layers by electrodeposition as previously described [2]. These metal layers act as masks during the further functionalization of the particle surface by fluorescent labels. The selective dissolution of the metal layers leads to the formation of particles with fluorescent patches.

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**Zirui Fan** (zirui.fan@u-bordeaux.fr). Zirui Fan graduated from the Ocean University of China. He did his master degree (2019-2022) working on the hydrogel promoting wound healing of diabetic and polysaccharide related drug delivery. In 2022 he joined the group of Serge Ravaine to focus on the patchy particles by China scholarship council funding.

# P 09

## Phase Re-entrance of Soft-Charged Colloids

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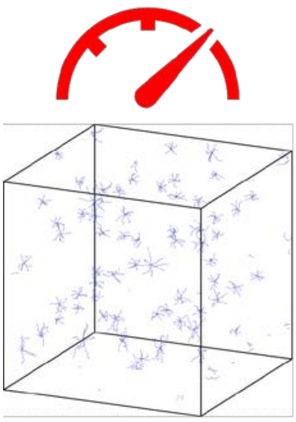
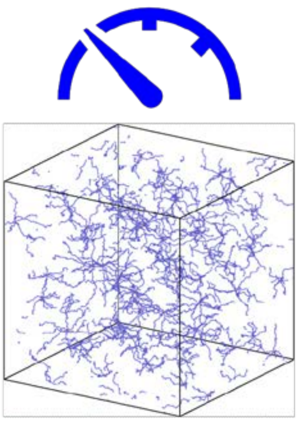
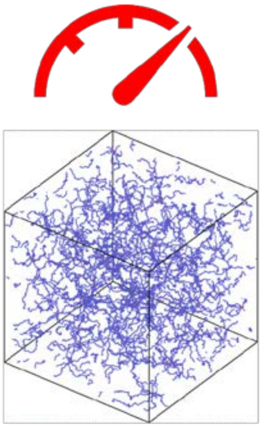


Low concentration: Colloids in a dilute solution correspond to a fluid state with fast dynamics.



Intermediate concentration: Transition state with slower dynamics, indicating the onset of glassiness.



High concentration: Return to fluid state: denser system yet faster dynamics

Colloids are ideal model systems for studying the properties of glass-like materials. They provide insights into the behaviour of disordered materials. Traditionally, studies have focused on colloids that are either hard, soft or a mixture of both, as well as charged ones, such as Wigner glasses formed through long-range interactions. However, the behaviour of soft-charged colloids, which combine softness with an electrical charge, has yet to be as thoroughly examined, especially regarding how they transition into a glassy state. We use coarse-grained molecular dynamics simulations to study soft-charged spherical colloids made from star polymers. We are particularly interested in how these colloids behave as we increase the polymer concentration. Our preliminary findings suggest the existence of phase reentrance, which means that as we add more colloids into the solution, they can transition from a liquid state to a glassier state and potentially back again. This behaviour is crucial for understanding the dynamics of these materials since it shows that their properties can be reversible and dependent on concentration. This insight into the phase reentrance offers a new perspective on designing and applying materials with complex behaviours.

**Utku Gürel** (u.y.gurel@rug.nl) obtained his master's degree from the international program *Physics of Complex Systems* at Université de Paris (2021). For his master's thesis, he conducted research on unsupervised machine learning of structural features in glass-forming liquids under the supervision of Giuseppe Foffi and Frank Smallenburg at Laboratoire de Physique des Solides (LPS) of Université Paris-Saclay. In 2021, Utku began his PhD under the supervision of Andrea Giuntoli at the University of Groningen. His research focuses on exploring out-of-equilibrium emergent phenomena in branched polymers using coarse-grained molecular dynamics simulations.

# P 10

## Light-responsive mononucleotide coacervates as a step towards membrane-free protocells

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**Keywords**: Coacervates, photoswitches, nucleotides, azobenzene, protocells

## Abstract

Coacervate microdroplets, resulting from the associative liquid-liquid phase separation of oppositely charged polyions, offer promising prototypes of membrane-free protocells.[1], [2] Conventionally, the formation of these structures has relied on long polyelectrolytes, given their propensity for multivalent charge interactions.[3] However, advancing toward more prebiotically relevant protocells necessitates the use of low molecular weight species. [4] In this study, we demonstrate the spontaneous generation of coacervate microdroplets in an aqueous environment using mononucleotides and simple cationic organic molecules incorporating azobenzene groups. Our investigation reveals that the formation of these droplets is contingent upon both the charge valency of the anionic nucleotides and the cationic organic molecules, as well as the hydrophobicity of the nucleotides. Notably, we observe distinct phase separation behaviors between purine and pyrimidine nucleotides owing to their varying hydrophobic characteristics. Furthermore, leveraging on the light-switchable isomerization of azobenzene groups enables the induction of dissolution and growth cycles of coacervate droplets, dependent upon the wavelength of light irradiation. Additionally, mixing such photoswitchable coacervates with non-responsive ones yields multiphase coacervates with diverse characteristics, suggesting promising future applications such as encapsulation with controlled release properties or even reaction catalysis. Collectively, our findings highlight the potential of low molecular weight azobenzene-nucleotide systems as viable candidates for the construction of membrane-free protocell models, offering reversible formation and dissolution with precise spatiotemporal control.

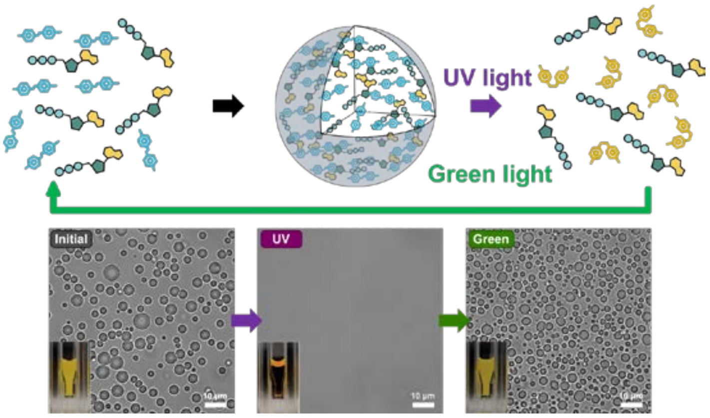

*Fig1. Reversible formation and dissolution of mononucleotide coacervates droplets under green and UV light irradiation*

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## Acknowledgments

We acknowledge the “Agence Nationale de la Recherche” (Grant No. ANR-21-CE06-0022) for funding.

# P 11

# Spatiotemporal control over signaling between artificial micro-compartment with a coacervates 'glue'

Emmanuel Joseph,[1] B.V.V.S Pavan Kumar[2], Nicolas Martin[1]
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2) Department of Chemistry, Indian Institute of Technology, Roorkee, 247667

Living cells are compartmentalized chemical systems that continuously interact with their environment and with each other. Developing artificial cells with the ability to communicate chemically is a potential first step towards creating intelligent colloidal materials with self-organizing properties[1]. Our goal is to create new tools that will allow us to selectively and reversibly cluster giant unilamellar vesicles (GUVs) and regulate their capacity for chemical communication. In order to do this, we investigate the interactions between GUVs and coacervates, membrane-free droplets produced by liquid-liquid phase-separation of oppositely charged polyions. We mainly utilized confocal microscopy to investigate diverse membrane wetting behaviors in response to the polyanion-to-polycation ratio Similar to previous reports[2,3], our findings demonstrate that the surface charge density of coacervates influences their ability to wet membranes. To take things a step further, we are currently focusing on demonstrating that coacervates may interact selectively and reversibly with GUVs using stimuli-responsive systems,. In the future, reversible GUV clustering will be accomplished with the use of coacervates wetting to regulate chemical communication.

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# P 12

## Tuneable Photonic Supercrystals on Mirror by Template-Assisted Self-Assembly technique

A.Koutsogianni,[1] D.B. Amabilino[1], A.Mihi[1]
1) Institute of Materials Science of Barcelona (ICMAB-CSIC)

Metallic nanoparticles exhibit intriguing plasmonic properties, enabling the confinement of electromagnetic fields within nanometric volumes. These properties, intricately tied to the nanoparticles' material, geometry, and environment, offer the possibility of precise manipulation of light-matter interactions. Previous studies have demonstrated that arranging plasmonic nanoparticles into periodic arrays gives rise to collective surface lattice resonances (SLRs), offering tunability in optical properties through adjustments in lattice parameters [1][2].

In this study, we employ the Template-Assisted Self-Assembly technique to fabricate a photonic metasurface comprising a periodic array of nanoparticles spaced above a metallic film by a dielectric layer, following the already known Nanoparticle on a Mirror (NPoM) configuration. Our investigation focuses on two strategies to modulate the resonance of the nanostructure: varying the thickness of the gap between the nanoparticle array and the film, and adjusting the overall geometry of the array.

We utilize angular reflectance spectroscopy to probe the distinctive modes associated with the photonic structure, including the gap mode and the various lattice modes. Our objective is to elucidate and differentiate these resonant modes, attributing each to its underlying mechanism. Additionally, we aim to explore the potential for mode crossing and hybridization, which can facilitate efficient coupling within the system while generating strong local fields beneath the nanoparticles.

This investigation not only advances our comprehension of plasmonic metasurfaces but also offers insights into the fundamental mechanisms governing light manipulation at the nanoscale. Such insights hold promise for the development of tailored photonic devices with enhanced functionalities and performance across a spectrum of applications.

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I completed my Bachelor studies in Physics at the University of Patras (Greece) where I specialized in Materials' Physics, and later I pursued a Master Degree in Nanoscience and Nanotechnology at the Aristotle University of Thessaloniki (Greece). Since November 2023 I am a member of the NANOPTO group at the Institute of Materials Science of Barcelona (ICMAB-CSIC), where I am conducting my PhD research on the development and characterization of tunable photonic architectures to enhance light extraction and polarization control under the supervision of Dr. Agustín Mihi and Dr. David Amabilino.

# P 13

## All-Natural, Robust, and pH-Responsive Glycyrrhizic Acid-Based Double Network Hydrogels for Controlled Nutrient Release

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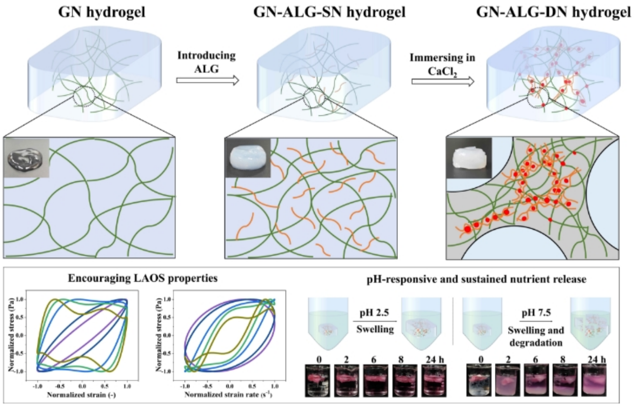

Supramolecular hydrogels self-assembled from naturally occurring small molecules (e.g., glycyrrhizic acid, GA) are promising materials for controlled bioactive delivery due to their facile fabrication processes, excellent biocompatibility, and versatile stimuli-responsive behavior. However, most of these natural hydrogels suffer from poor mechanical strength and processability for practical applications. In this work, through adopting a multicomponent gel approach, we developed a novel mechanically robust GA-based hydrogel with an interpenetrating double network (DN) that is composed of a $Ca^{2+}$-enhanced hydrogen-bond supramolecular GA nanofibril (GN) network and a $Ca^{2+}$ cross-linked network consisting of the natural polysaccharide sodium alginate (ALG). Compared to single GN network (SN) hydrogels, the GN-ALG hybrid hydrogels (GN-ALG-DN) with a hierarchical double-network structure possessed excellent mechanical properties and shaping adaptation, encouraging small and large amplitude oscillatory shear (SAOS and LAOS) rheological performances, better thermal stability, higher resistance to large compression deformations, and lower swelling behaviors. Furthermore, the GN-ALG-DN hydrogels exhibited a pH-responsive and sustained release behavior of nutrients such as vitamin B12 (VB12), showing a faster VB12 release rate with a higher swelling ratio in alkaline conditions (pH 7.5) than in acidic conditions (pH 2.5). This is ascribed to the fact that the higher dissociation degree of carboxylic groups in GA and ALG molecules in an alkaline environment induces the erosion and looseness of the self-assembled GN network and the ionic-crosslinked ALG network, which could lead to the decomposition of the hybrid hydrogels and thereby increases the release of nutrients. Cytotoxicity tests further demonstrated the excellent biocompatibility of the GN-ALG-DN hydrogels. This study highlights the design of robust shaped and structured supramolecular hydrogels from natural herb small molecules, which can serve as solid, edible, and stimuli-responsive active cargo delivery platforms for food, biomedical, and sustainable applications.

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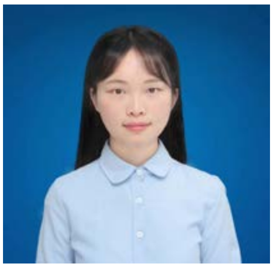

**Qing Li** (*Qing.Li@UGent.be*), received her BSc degree in food science from the Central South University of Forestry and Technology (CSUFT, China). She is now a PhD student at the South China University of Technology (SCUT, China). Since December 2023, she also has been studying at Ghent University (Belgium) as a visiting PhD student under the funding of the Chinese Scholarship Council (CSC). Her research focuses on the development of novel colloidal soft materials (e.g., hydrogels, emulsions, and foams) and explores their potential applications in the controlled release of bioactive/functional cargoes and wound healing.

# P 14

## Piezo- and piezophoto-catalytic waste water remediation by ZnO micro- and nano-structures

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Pesticides, drugs and antibiotics dissolved in potable and wastewater represent a serious environmental and health risk. Purification of wastewater from these substances identified as emerging pollutants (EPs) is of course an urgent need [1]. In this context, photocatalysis has been proposed as a promising technique [2]. On the other hand, photocatalysis exhibits some limitations, such as the fast recombination rate of the photogenerated excitonic species. This can reduce the possibility to promote the formation of the radical species that take part to the pollutant's degradation [3]. An interesting strategy for enhancing and improving the degradation efficiency of a photocatalyst is to utilize piezoelectric materials.

The induction of a piezo-potential across a material able to photo-decompose organic pollutants, as zinc oxide (ZnO), has been used to enhance the properties of photocatalyst for the treatment of water containing organic pollutants [4]. In this contribution the application of zinc oxide nanostructures as piezo-, photo- and piezophoto-catalyst to promote the decomposition of TC upon a double external trigger, i.e. light and ultrasounds stimulation is proposed. ZnO nanostructures in the wurtzite phase have been synthetized according to wet method envisaging the chemical treatment of the precursor (zinc acetate, zinc sulphate and zinc nitrate) in alkaline conditions. The synthetized material was characterized by means of Raman spectroscopy, AFM, SEM and XRD. Ultrasounds were chosen as external mechanical stimulus to induce the piezopotential. Pollutants degradation processes (photo-degradation, piezo-degradation and piezo-photodegradation) in ultrapure water were monitored by means of UV-Vis absorption spectroscopy in order to clarify both the physical-chemical and kinetics aspects. The degradation tests were also performed in presence of specific reactive oxygen species (ROS) scavengers in order to allow a deep understanding of the process.

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**Actually** PhD Student in Photoinduced Processes and Technologies (curriculum: Sustainable Procedures and Innovative Materials) of the National Interest PhD course at the University of Perugia/University of Salento (Italy).

**Master's degree** in Environmental Sciences (Thesis title: Development of biomimetic sensors based on molecularly imprinted polymers for the detection of amoxicillin in aqueous samples of environmental interest)

**Bachelor's degree** in Sciences and Technology for the Environment (Thesis title: Development of Raman active systems for the detection of compounds of environmental interest)

# P 15

## Emulsions and catastrophic phase inversion

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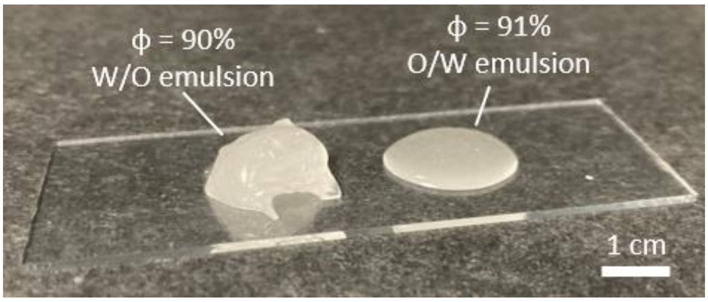

*Figure 1 : collapse of emulsion viscosity at the inversion point*

Emulsions are dispersions of two immiscible liquids consisting of droplets of an internal phase dispersed within a continuous matrix, the external phase. There are two simple emulsion types : O/W and W/O, which correspond respectively to the dispersion of oil droplets in water and vice versa. Passing from one to the other is referred to as phase inversion.

The phase inversion can be described as transitional if it is triggered by changing a parameter that affects the spontaneous curvature of the surfactant, or catastrophic if it is induced by changing the water-to-oil ratio. The phenomenon has been tackled in many research studies [1]. Although much empirical know-how has been accumulated in recent years, the research effort to build a predictive model has failed [2] and the mechanism is still under investigation [3].

Here we study the catastrophic phase inversion. Emulsions are formulated at the macroscopic scale : the external phase is initially introduced in a beaker and then, under constant stirring and constant temperature, the internal phase is gradually added at a constant flow rate. We use a key observable : the inversion point $\phi^*$, which is the volume fraction of the internal phase at which catastrophic phase inversion is spotted by the collapse of the emulsion's viscoelasticity (*Figure 1*).

As the occurrence of catastrophic phase inversion depends on both formulation and emulsification variables, we first sought to identify the parameters that have a major influence on the inversion point. We noticed that formulation variables such as mixer shape, stirring speed or beaker diameter that control the shearing rate barely affect the phase inversion while composition variables such as viscosity of the continuous phase, surfactant choice and its concentration have a strong impact on it. These first results have enabled us to hypothesize that the mechanism could be linked to the surfactant dynamics at the interface. Subsequently a study of the catastrophic phase inversion at the microfluidic scale would enable us to investigate droplets dynamics.

The understanding of the catastrophic phase inversion mechanism has a twofold interest : firstly theoretical because it will lead to a better understanding of the emulsions stability and secondly practical as this phenomenon is often used in industrial processes to make multiple emulsions or produce concentrated emulsions with fine droplet size and involving very viscous oils.

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**Elise Merville** (*elise.merville@espci.fr*). Graduate of a French chemical engineering school, I'm currently a first year PhD student in the LCMD team from the CBI research unit at the ESPCI Paris. Trained as a chemist, my work now focuses on the physical chemistry of emulsions.

# P 16

## Theory and Design of Passive Daytime Radiative Coolers

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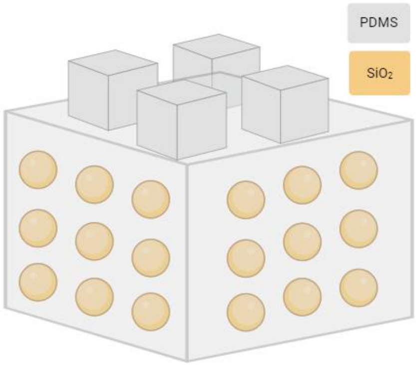

**Figure 1. Photonic design for Passive Daytime Radiatve Cooling.**

Passive Daytime Radiative Cooling (PDRC) is a phenomenon by which a body exposed to solar radiation can cool by thermal radiation passively [1]. For this to happen, the body should backscatter all of the solar radiation with a high efficiency and exhibit a strong thermal emissivity in the atmospheric transparency window (ATW) in the [7-14 µm] range [2]. According to Kirchhoff's law of thermal radiation, the emissivity of a body at thermal equilibrium is equal to its absorptivity, such that designing a perfect absorber in a spectral window corresponding to its blackbody radiation is the same as designing a perfect emitter in that range. Following this principle, we aim to design and build a metamaterial that operates as a passive daytime radiative cooler. The metamaterial should exhibit maximal reflectance in the [0.5-2.5 µm] interval and maximal absorption in the ATW. Our ultimate goal is to come up with a design concept that is versatile enough to conform to any surface, to decrease the temperature of a desired object by covering it with the metamaterial. This would happen typically when the total emitted power outweighs the total absorbed power, and as a result, the temperature of the desired object would decrease. Here we focus on various potential photonic structures made of $SiO_2$ microspheres embedded in PDMS (see Fig.1). $SiO_2$ and PDMS appear as materials of choice because they both exhibit very good emittance in the ATW [3, 4]. Additionally, the engineered photonic structure will help to enhance the average emittance of the metamaterial by leveraging phonon polariton resonances in the $SiO_2$ microspheres. The computations are carried out by solving Maxwell's equations using the finite-element method.

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She graduated from UFAZ University with a Chemical engineering diploma in 2020. For her master's, she joined the EMJMD FAME+ (Functionalized Advanced Material's Engineering) program between the years 2021 and 2023 during which she spent her M1 in Grenoble, France, and her M2 in Louvain-la-Neuve, Belgium. Since October 2023, she has been working as a PhD candidate in the Centre Recherche de Paul Pascal laboratory under the supervision of Alexandre Baron.

# P 17

## Plankton cells as an active matter probe

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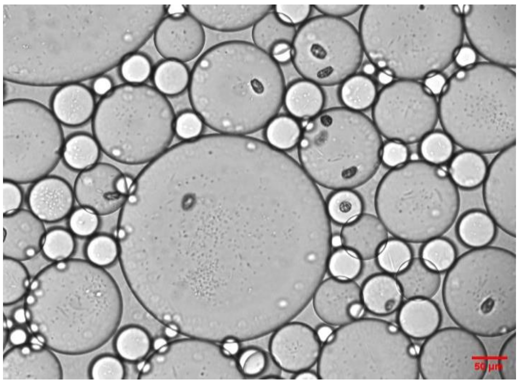

Phytoplankton is a community of organisms at the base of the marine food chain that also plays a crucial role in the atmospheric carbon and oxygen cycle. Because phytoplankton is an active system of living organisms presenting a wide variety of morphologies and mobilities, our research group is going to use it to create an active bath acting on the properties of soft matter systems at the microscopic and mesoscopic scales. Current research on active materials acting on soft matter has focused on synthetic active colloids, and bacteria are the current reference using living systems. We are proposing an innovative method using populations of plankton as model swimmers of active particles. Using the diversity of plankton that exists in nature, we seek to establish a well-defined active matter model to induce sharp transitions in soft matter. Based on a selection of different axenic active systems of *Isochrysis galbana*, *Tetraselmis suecica*, and *Dunaliella salina*, a microfluidic technology already implemented in the lab will be adapted to encapsulate planktons within controlled size microdroplets of water, thus creating a controlled environment enabling the extraction of swimming features (speed, directions, patterns etc.) with the use of a particle tracking algorithm we have developed in Matlab.

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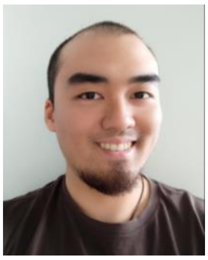

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- Bachelor degree in Biology – University of Bordeaux
- Master degree in Health engineering *(biophotonic)* – University of Bordeaux
- PhD student in Biophysics – University of Bordeaux

# P 18

## Novel phenothiazine-based oxime esters acting as visible light sensitive high performance radical photoinitiators and potential photobase generators

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*[1]Université de Haute-Alsace, IS2M UMR, Mulhouse, France.*
*[2]Université Strasbourg, France.*
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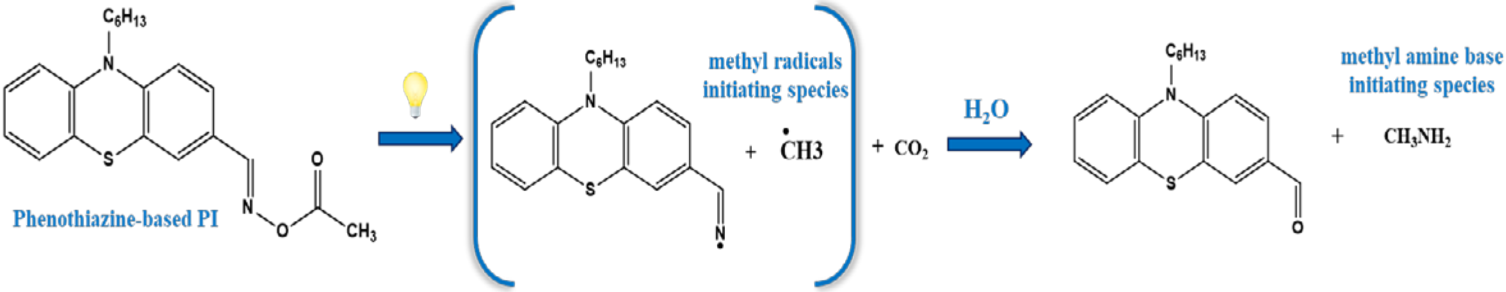
In this work, two new photoinitiators, based on the phenothiazine scaffold as a chromophore and potentially bearing the oxime ester functionality as an initiating group were designed and synthesized as Type I PIs for the free radical polymerization of acrylates upon irradiation with a light emitting diode emitting at 405 nm. These phenothiazine-based oxime esters revealed impressive photoinitiation ability manifested by excellent polymerization rates and high final reactive function conversions. Photoinitiation mechanisms were investigated by means of different complementary techniques. Besides, the thermal initiation behavior of the different oxime esters was also studied by using differential scanning calorimetry, highlighting their dual thermal/photochemical initiation ability. Furthermore, 3D printed objects were successfully fabricated by conducting both direct laser write and 3D printing experiments[1]. Additionally, one of the previously designed and synthesized phenothiazine-based oxime esters was investigated as a photobase generator for the formation of thiol-acrylate networks through the polymerization of thiol-acrylate reactions and more appealingly the base-catalyzed thiol-acrylate Michael addition reactions. This system accomplished a complete disappearance and a full conversion of the characteristic acrylate peak within 10 min of irradiation with a light-emitting diode (λ = 405 nm) or within 1 or 2 min of the same irradiation source and 24 hours of heat exposure (T = 60 °C). Photobase generation was evidenced using phenol red as a pH-indicator, enabling to confirm the production of methyl amine ($CH_3NH_2$) as initiating species. Photoinitiation mechanisms by which the thiol-acrylate polymerization proceeds were investigated. Finally, differential scanning calorimetry scans and Shore A and Shore D hardness experiments have been performed on the polymers obtained to examine their thermal properties and surface hardness features[2].



"Photochemical generation of active species upon irradiation of phenothiazine-based PI"

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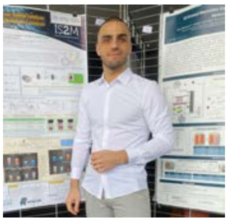

Adel NOON (*adelnoon@gmail.com*).

A highly diligent and dedicated doctoral student pursuing my research in the field of photopolymerization at the Institute of Materials Science of Mulhouse (IS2M-UHA).

# P 19

# β-alanine substitution in KLAKLAK-peptides with low mammalian cytotoxicity: alteration of glycerophospholipid membrane properties

*Victoria Vitkova[1], Krassimira Antonova[1], Ognyan Petkov[1], Angelina Stoyanova-Ivanova[1],*
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*1) Institute of Solid State Physics, Bulgarian Academy of Sciences, Sofia, Bulgaria*
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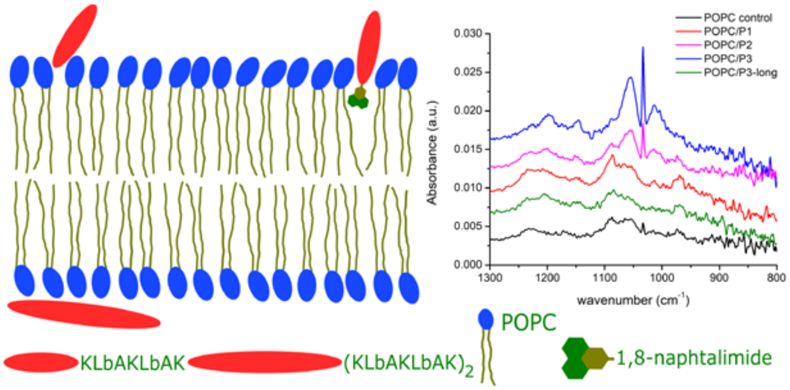

Vitkova, V.; Antonova, K.; Petkov, O.; Stoyanova-Ivanova, A.; Jaber, S.; Ivanova, V.; Naydenova, E.; Danalev, D. Interaction of KLAKLAK-NH2 and Analogs with Biomimetic Membrane Models. *Pharmaceutics* 2024, 16, 340.

Specifically designed peptide mimetics exhibit enhanced selectivity in their cytotoxicity towards mammalian cells. Besides adopting the α-helix conformation, their effectiveness is closely tied to their ability to penetrate cellular membranes. We investigated alterations in lipid membrane properties in the presence of the peptide KLAKLAK-$NH_2$ and analogs incorporating β-alanine, which augment antibacterial activity, and/or naphtalimide, known for its anticancer properties [1,2].

The molecular interactions of the peptide mimetics with POPC bilayers were studied using FTIR-ATR spectroscopy [3]. Thermal shape fluctuation analysis of quasispherical unilamellar vesicles was employed to explore membrane bending elasticity. The impedance characteristics of bilayer lipid membranes were measured using fast Fourier-transform electrochemical impedance spectroscopy.

β-alanine-containing peptides exhibited lateral association with the membrane, with the NphtG-KLβAKLβAK-$NH_2$ analog showing the most significant membrane softening. This effect aligned with indications of 1,8-naphthalimide penetration into the lipid hydrophobic region observed in FTIR-ATR spectra analysis. Even at low concentrations, β-alanine substitution induced substantial membrane rigidification in both β-alanine-containing peptides.

The findings provide a thorough understanding of the molecular interactions between the investigated peptide mimetics and lipid membrane models. The observed effects on the structural, mechanical, and impedance characteristics of lipid membranes offer valuable insights for advancing the development of liposome-based formulations in drug delivery and biomedical applications.

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## Acknowledgments:

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I have MSc in Optics and Spectroscopy from Sofia University ‘St. Kliment Ohridski’. I’ve done research in the Institute of Solid State Physics of the Bulgarian Academy of Sciences for about 5 years now in the field of Soft matter physics. The focus of our research group is lipid membranes, their properties and their interaction with biomacromolecules. I am about to start my PhD journey soon.

# Study of bio-mimetic membranes composed of glycosylated lipids

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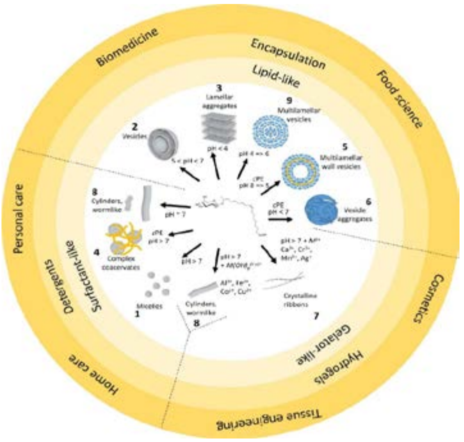

*Figure 1: Phase behaviour of G-C18:1 (C<5 wt% in water) with pH and salt addition*

Bio-based surfactants gained popularity in recent years due to their advantage over conventional petroleum-derived surfactants. The chemical process is required for the production of a conventional surfactant, which causes pollution whereas bio-based surfactants are derived from biomass by fermentation of glucose and vegetable oils[1, 2]. Microbial bio-surfactants are bio-based surfactants, due to their origin but due to the higher cost/profit ratio, commercialization on a wide scale has not been done yet. Interestingly, other than their use as an alternative to petroleum-derived surfactants, the amphiphilic nature of microbial glycolipids (MGs) enables them to interact with lipid bilayer membranes, which is the basic cell structure in all living organisms[3]. In addition, these microbial glycolipids have been reported to have properties such as antibacterial, anticancer as well as antiviral activities [4, 5]. Furthermore, any modification to lipid membranes might affect the cell function.

So far, the self-assembly behaviour of microbial glycolipids has not been studied in depth yet, if compared to other more classical amphiphiles. In particular, some MGs can assemble themselves into bilayers and thus may modify the structure and properties of the biological membranes upon interaction. The physical properties of these bio-mimetic membranes have not been studied thoroughly yet. Some physical properties i.e., bending rigidity, thickness of bilayer, area/lipid etc. still need to be elucidated as well as the impact of MGs on phospholipid-based bio-mimetic membranes, which are known models to investigate microbial phospholipid/phospholipid interaction under controlled conditions, and by extension, MG/phospholipid interactions. This background motivates this work aiming at studying the behaviour of the MG membranes as well as the effect in the behaviour (thickness, bending rigidity, composition) of MG inside the phospholipid (PL)-based biomimetic membranes.

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P 21

# Interfacial behavior of yeast proteins at the oil-water interface

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Proteins are necessary in the human diet, as they are essential for several functions in the human body. For reasons of animal and climate protection as well as other ethical or religious reasons, there is an ever-increasing demand for alternatives in terms of protein sources and protein-based products. In addition to plants and insects, yeasts are a promising raw material because of their nutritional composition, decentralized and weather-independent cultivation and their acceptance by consumers.

To formulate alternative yeast-based food, knowledge about the techno-functional properties of yeasts and their components is necessary. In addition to the mannoproteins of the cell wall, yeasts also possess intracellular proteins that can be released during cell disruption or lysis. The existing knowledge regarding the interface stabilizing properties of these proteins is not yet sufficient.

To investigate the interfacial functionality of the proteins, we use pendant drop tensiometry. At this model interface, we carry out dynamic and oscillating experiments. The first one allows conclusions about the interfacial tension, the latter about the elasticity of the interfacial film formed by yeast proteins. We want to transfer these results to the production of emulsions where the elasticity is relevant for the break-up and stabilization step in the emulsion production and subsequent storage. Pendant drop and emulsification experiments are carried out by varying formulation and process parameters as well as different pretreatments of the proteins.

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After graduating from high school, I started studying food chemistry at the KIT in Karlsruhe. During my course of study, I was particularly interested in the topics of process engineering and food production. That's why I wrote my master's thesis at KIT in food process engineering on emulsion stabilization using pectins.

After completing my studies, I worked in food monitoring for a year and gained insights into the control, analysis and assessment of food production and gastronomy according to food law standards.

I have been working as a research assistant and doctoral student in food process engineering for about 1.5 years now and am working on the emulsion-stabilizing properties of various proteins.

# P 22

## Potential improvements to cytokine microdialysis using colloidal agents and surfactants.

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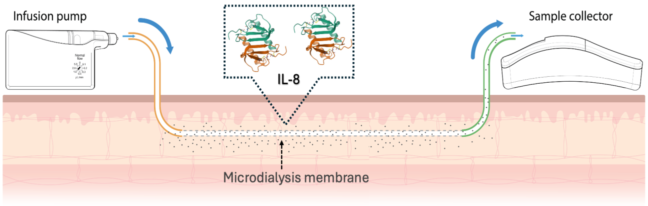

Cytokines are low molecular weight proteins that play an essential role in health and disease by modulating immune responses [1]. The U-RHYTHM is a portable, automated device that uses a microdialysis membrane in the abdominal skin to collect interstitial fluid. This allows sampling at different intervals, providing a dynamic view of molecular activities in the tissue. However, cytokines can adhere to the microdialysis membrane or PTFE tubing surface, which represents a significant challenge for accurate cytokine quantification. Strategies to minimise such adsorption and molecular loss, such as coating materials with poloxamers [3,4], can improve the sensitivity of U-RHYTHM microdialysis for cytokine detection and enhancing understanding of their dynamics in physiological and pathological contexts. Furthermore, the addition of colloidal osmotic agents such as dextran increases *fluid recovery* (FR) and protein *relative recovery* (RR) [5]. However, excessive FR may cause bias in data interpretation.

We investigated the antifouling properties of Pluronic F127 (Poly(propylene oxide)–poly(ethylene oxide)–poly(propylene oxide) triblock copolymers [PPO–PEO–PPO]) and its impact on cytokine exposure over time. We coated PTFE tubes with F127 and perfused them with an IL-8 solution for 24 hours, then analysed IL-8 recovery over time. In a second experiment, the effect of coating the microdialysis probe with F127 together with the addition of dextran (500 kDa) to the perfusion fluid was investigated using in vitro microdialysis as a strategy to improve the consistency of fluid recovery and relative recovery of IL-8.

Our experiment demonstrated that IL-8 adsorption depended on the exposure time of the molecule to the PTFE tube surface. Furthermore, the F127 coating reduces the interaction of IL-8 with the tube surface, decreasing the variation between sampling points compared to untreated tubes. In microdialysis, FR close to 100% was obtained with probes coated with F127 and perfused without dextran (102%). The addition of dextran increased FR by 10%. In terms of IL-8 recovery, probes treated with F127 and perfused with dextran showed the highest RR (84%). Coating the probes with F127 increased the IL-8 RR by more than 10%. In addition, the addition of dextran increased the IL-8 RR by 10% in F127-treated probes and by 5% in untreated probes.

In conclusion, IL-8 perfusion along PTFE tubing (U-RHYTHM) was modelled. Coating PTFE with F127 can reduce IL-8 adsorption along the tubing. However, specific surface chemistry approaches are required to corroborate these findings. We report *in vitro* microdialysis with IL-8 RR ranging from 61 to 84%. The addition of dextran as a colloidal osmotic agent increases FR and IL-8 RR. Coating the probes with F127 also increases IL-8 RR.

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# P 23

## Investigation of plant-based surfactants to replace synthetic surfactants in cosmetic and food industries.

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Synthetic surfactants have been widely used in various industries, including cosmetics and food, due to their versatile surface-active properties. However, their production and use pose significant environmental and health concerns, including non-biodegradability, toxicity, and potential adverse effects on aquatic ecosystems and human health[1]. As a result, the increasing demand for sustainable and environment friendly alternatives to synthetic surfactants has led to growing interest in exploring natural sources of surfactants. Natural sources of surfactants, such as plants, microorganisms, and marine organisms, offer promising alternatives with potential advantages in terms of biodegradability, low toxicity, and renewable sourcing.

In this study, we are investigating Albizia amara as a potential source of natural surfactant to replace synthetic surfactants in the cosmetic and food industries. Albizia amara, a plant species native to tropical regions, was selected based on its abundance, phytochemical composition, and potential surfactant properties[2]. Although this plant has been studied widely for its medicinal properties, its surfactant properties have not been explored enough. Our research aims to evaluate the surface-active properties of surfactant extracted from Albizia amara and assess their suitability for various applications in cosmetics and food products.

In our initial study, we have compared various methods of extraction, investigated their surface active properties like surface tension reduction, emulsification, and foaming abilities[3]. Comparative studies were conducted to assess the performance of Albizia amara surfactants against synthetic surfactants (SDS and Tween 20) commonly used in cosmetic and food formulations.

Overall, this study contributes to the growing body of research on natural surfactants and their potential applications for replacing synthetic surfactants in the cosmetic and food industries. The findings underscore the importance of exploring plant-based alternatives for sustainable and eco-friendly formulations, paving the way for future developments in green chemistry and biotechnology.

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I am Yalini Sadasivam, a doctoral researcher working with Prof. Valerie Pinfield and Dr Anna Trybala, at the Department of Chemical Engineering, Loughborough University. Before starting my PhD, I did my master's in chemistry at VIT, Vellore, India and master's thesis research at The University of Edinburgh, Edinburgh. My research is focused on developing natural surfactants as a replacement for synthetic surfactants in the commercial markets for the food and cosmetic industries. I am interested in research focusing on product development and formulation, green chemistry, and sustainability.

# P 24

## Elaboration of nanostructured surfaces by deposition of polymeric Janus Nanorods

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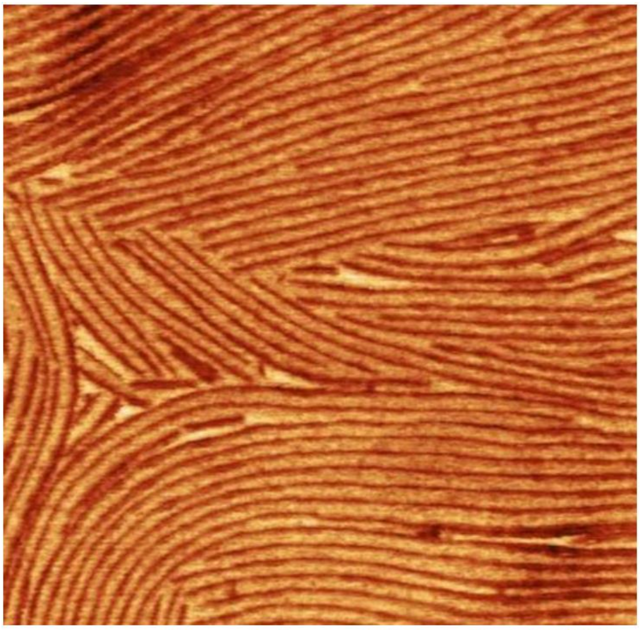

**Fig.1:** Adhesion AFM image of JNRs with poly(dimethylacrylamide) (PDMAc, $DP_n = 83$) on one side and Poly(N-acrylolmorphine) (PNAM, $DP_n = 48$) on the other side. Measurement carried out on a droplet of a JNRs colloidal suspension after evaporation.

Nowadays, producing well-ordered periodic nanoscale patterned surfaces at the sub-10 nm level with low density of defects and sharp interfaces still remains a great challenge. In this context, polymeric Janus nanorods (JNRs) which are asymmetrical nanoparticles that exhibits two faces of different chemistries, are considered as a promising candidate to achieve this purpose, but their potential remains very little explored.

Recently, our academic partners* have developed a robust and versatile strategy to self-assemble end-functionalized polymers into JNRs that are several hundreds of nanometers long (up to µm-range) with an average diameter ca. 10 nm[1]. By the deposition of such developed anisotropic objects on a solid substrate using different deposition techniques (i.e. Drop-casting, Spin-coating, Dip-coating), we have indeed proved that these JNRs has the ability to self-organize and form a highly anisotropic patterns on the substrate with a periodic distance of 12 nm (using AFM measurements in Peak-Force Quantitative Nanomechanical Mapping mode, see Fig.1). However, forming a 2D aligned surfaces relevant to advanced lithography applications requires a high level of control over the deposition as well as the orientation of these nanocylinders. For this reason, Langmuir-Blodgett deposition technique was also employed to guide their self-assembly into highly oriented nanopatterned monolayer.

The results concerning the deposition of JNRs on silicon substrate using several techniques including Langmuir-Blodgett deposition as a function of the deposition parameters and the experimental conditions that govern their orientation processes will be presented.

References :

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** This PhD project is a part of the ANR-JASUR research project. Collaboration between IPCM (Sorbonne University) for macromolecular synthesis of JNRs, IMMM (Le Mans University) for the supramolecular self-assembly in solution, and ICMN (Orleans University) for surface deposition as thin films and physical characterizations of the patterns.*

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## Design of hierarchical porous catalysts from colloidal dispersion

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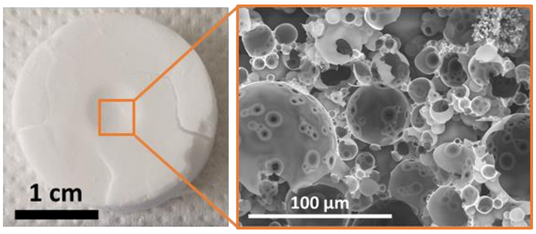

Porous materials are omnipresent in our environment, whether for adsorptive, filtration, soundproofing or thermal insulation applications, to name but a few. These materials have nano- and micrometric-sized pores that provide interesting properties. This presentation will focus on the study of catalysts with hierarchical porosity, starting with their synthesis, then their characterization and finally, their application. Hierarchical porosity means that the three types of porosity listed by IUPAC [1] coexist within the material. This makes it possible to combine convection phenomena, thanks to macropores, dispersion in the case of meso and diffusion for micropores. These porous materials are prepared using a bottom-up approach based on integrative chemistry combining emulsions, lyotropic mesophases and sol-gel chemistry [2]. Microporosity arises from interstitial voids between colloidal dispersion acting as nanobuilding block. Mesoporosity comes from surfactants at concentrations above the critical micellar concentration. Finally, macroporosity is provided by complex fluid chemistry via the use of emulsion molds. The resulting ceramics, presented in the TOC, are amorphous and composed mainly of silica with numerous silanol sites. They have multi-scale porosity, combining the three types of porosity, with very high volume porosity (~95%) and high specific surface area. In order to understand the morphology and structure of these innovative materials, it is necessary to carry out a wide range of characterizations at different scales. At the macroscopic scale, scanning electron microscopy and mercury intrusion are used to study the macroporosity and volume porosity of the materials, as well as their morphology. On a mesoscopic scale, transmission electron microscopy and small-angle X-ray scattering are used to characterize the structure of materials. At the microscopic level, the composition and local structure of materials can be assessed using wide-angle X-ray scattering and elemental analysis. These ceramics can be functionalized to make heterogeneous catalysts for specific applications, depending on the type of functionalization. For example, by incorporating copper into the matrix, the synthesized materials can be used in the oxidation of CO towards $CO_2$ [3]. To cite another example, the addition of tungsten to the matrix produces materials catalyzing Friedel-Craft reactions [4].

References:

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2018 Bachelor degree in Chemistry at University of Caen, France

# P 26

## Utilizing Machine Learning to Estimate Colloidal Interaction Parameters from Small Angle X-Ray Scattering Curves

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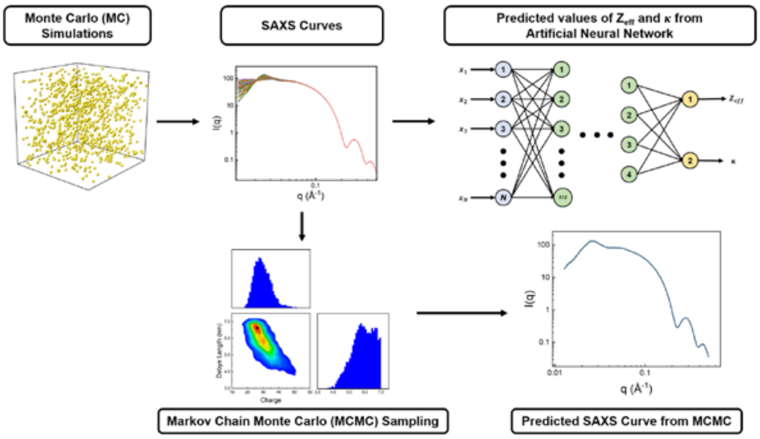

The Dejaguin-Landau-Verwey-Overbeek (DLVO) theory is a long-standing model in colloid science which explains colloidal interactions as the sum of attractive van der Waal's forces and repulsive electrostatic forces. Small angle X-ray scattering (SAXS) is a technique which can be used to study colloidal interactions as the obtained SAXS profiles provide information about the spatial configuration of the colloids in solution through the structure factor, *S(q)* [1]. The extraction of colloidal interaction parameters from *S(q)*, however, is typically carried out indirectly by solving the Ornstein-Zernike integral equation for a chosen interaction potential and closure relation. This approach has two key limitations, which are namely the limited number of interaction potentials for which the fitting can be performed, as well as approximations induced by the selected interaction potentials and closure relations [2].

In this work, we demonstrate a proof-of-concept for using an artificial neural network (ANN) to predict colloidal interaction parameters, which are the effective macroion valency ($Z_{eff}$) and the Debye length ($\kappa$), as described by the DLVO theory from a given SAXS curve. The ANN was trained on 250,000 simulated SAXS curves obtained from Monte Carlo simulations of colloidal particles and was found to estimate $Z_{eff}$ and $\kappa$ for a given SAXS curve with prediction errors within ±20% of the ground truth value. Subsequently, Markov Chain Monte Carlo (MCMC) sampling with an ANN surrogate model was used to develop an inverse model capable of identifying the *maximum a posteriori* (MAP) estimated values of $Z_{eff}$ and $\kappa$ for a given SAXS curve. Finally, the applicability of this approach was demonstrated on an experimentally obtained SAXS profile of a gold nanoparticle solution.

References:
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**Presenter name: Kelvin Wong (uceckwo@ucl.ac.uk)**

Kelvin is currently a PhD student at the Department of Chemical Engineering at University College London (UCL). His doctoral research project involves the use of both computational and experimental approaches to further the understanding of interactions of biomolecules at the nanoscale. Prior to joining UCL, he graduated from the National University of Singapore with a Bachelor of Engineering (Chemical Engineering) and worked at the Singapore-MIT Alliance for Research and Technology as a Research Engineer on manufacturing amorphous solid dispersions using microfluidics.

# Practical info

The talks, poster session and Meet and Greet will take place at ENSMAC

16 Av. Pey Berland, 33600 Pessac

We will take the lunches at the Passerelle

Av. Léon Duguit, 33600 Pessac

The Gala dinner will take place at the Café du Port

1 Quai Deschamps, 33100 Bordeaux

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