CHM3980 – Chemistry Overseas Research Project

Monash University, School of Chemistry

Unit Information for Students Travelling in 2026

The CHM3980 unit, Chemistry Overseas Research Project, gives you the opportunity to conduct research in the laboratory of an academic in one of our overseas partner institutions. You will have a six week stay overseas in which to conduct research, with all assessment tasks conducted after your return during semester two.

This document guides you through some of the information that you'll need to make an informed decision regarding this unit, important dates, steps to take in order to apply, information about the assessments, and hopefully the answers to any questions that you have.

If you need any more information or advice, please contact the Unit Coordinator (david.turner@monash.edu).

ABOUT THE VISIT

Each year, projects are offered from a number of partner universities in Europe. You will spend six weeks working in the laboratory of a research group, closely supervised by a senior researcher. You are not expected to have any previous research experience – this is all about learning. Projects will be assigned in advance of the visit, with you having a choice over the topic. You will be able to conduct some pre-reading in advance of the visit so that you have some knowledge to start.

In 2026 the dates of the exchange are 15th June – 24th July 2026. This coincides with the northern hemisphere summer so you will be able to have some pleasant weather to enjoy your free time. All of the partner universities have good transport links for you to enjoy some of Europe during your stay.

The School of Chemistry and Monash Abroad will offer some financial assistance to help with your stay. Although this will not cover 100% of the expenses it should cover airfares and most of the accommodation.

ASSESSMENT TASKS

CHM3980 is formally a semester two unit, and all assessment tasks will have due dates within this period (*i.e.*, after you return to Monash). There are four assessment tasks:

TASK	WEIGHTING	DUE DATE
Written Report A 3000-4000	60%	Due S2 Week 7
Oral Presentation	10%	Presented in Swot-Vac
Reflective Essay	10%	Due S2 Week 3
Laboratory Grade	20%	Assessed by supervisor

ELIGIBILITY

There are both pre- and co-requisites for the CHM3980 unit.

PRE-REQUISITES: You must have achieved an 80 average over three Level 2/3 CHM units. We will offer conditional places in the unit if you require your S2 2025 grades in order to meet this pre-requisite (with a final offer and enrolment taking place after the grades are released).

CO-REQUISITES: Completion of 18 credit points from CHM3 units. These units can be completed prior to or within the calendar year of the CHM3980 enrolment (or across two years if applicable). You essentially need to have completed, or be enrolled in, three Level 3 CHM units. If your degree is split across non-calendar years this may be trickier, but chat to the Unit Coordinator who will be able to help.

APPLICATION PROCESS

There are a limited number of spaces available in the CHM3980 unit and therefore there is an application process. Applications for entry into the unit can be made using the link on this webpage: https://www.monash.edu/science/schools/chemistry/current-students/exchange-programs

Applications for 2026 will close 5pm Friday 7th November 2025. The selection panel will meet soon after this and we hope to inform you of conditional acceptance into the unit within 2 weeks. Final acceptances and enrolment will occur soon after S2 grades are released.

At the time of application, you will be asked to specify preferred projects or placements (ranked 1-3). Please read the information below about partner universities very closely before applying so that you make the correct selections. We will try to allocate people to their most preferred institutions/projects but there is no guarantee that you will get your first choice.

You will need to upload a partial transcript, or a screengrab from WES, so that we can check your eligibility. You will also need to supply a personal statement as part of your application – why do you want to do this unit and what will you gain from it? There is a limit to the number of places that we can offer and this statement, alongside your academic record, will help us allocate these spots.

FAQs

Q. The start of the exchange period overlaps with end-of-semester exams, what do I do if I have an exam scheduled when I am meant to be overseas?

A. You can apply for permission to sit the exam remotely, which should be granted as this is an official exchange program. The School of Chemistry and Monash Abroad will support your application.

Q. The pre-requisites need grades from three units but I've only completed two eligible units to date, what do I do?

A. If you are completing units in this current semester (S2 2024) that will be required to meet the pre-requisite then this is fine. We will provisionally offer places in the unit on the basis that you will meet the pre-requisite and the final enrolment will take place after the S2 grades are released.

Q. I want to enrol, but I need to have my unit selections in earlier than the selection date for the CHM3980 cohort, what do I do?

A. Enrol in another 2025 unit for the time being. If you are selected into the CHM3980 cohort you can select which unit to replace (but make sure you're not enrolled into a unit that you're not prepared to take, just in case your CHM3980 application is not successful).

Q. I've never done research before, I don't know a lot about the research topics, and this is all quite intimidating. Can I really do this?

A. Of course! A research project is all about learning how to conduct research and immersing yourself in a topic. You'll start off not knowing much, but the overwhelming experience of students is that they grow in confidence and start to become competent researchers as the experience progressed. By the end, student reports and presentations prove to us that everyone becomes quite knowledgeable in their research topics.

Q. I still have questions, where can I get answers?

A. Contact the Unit Coordinator (david.turner@monash.edu) who will be able to answer any questions that you have.

PARTNER UNIVERSITIES - 2026

We have partnered with five universities for the Jun-Jul 2026 placement period (S2 2026 unit). These have slightly different ways of managing their incoming exchange cohorts, so please read the information below carefully before applying.

IMPERIAL COLLEGE, London, UK

https://www.imperial.ac.uk/chemistry/

Applications for Imperial College will be assigned a placement but not a project. After you have been formally invited into the unit you will need to approach academics at Imperial directly to arrange supervision and a project. *You should not approach anyone until your placement is confirmed.* A short CV, covering your academic performance and scientific interests, should be provided. Most academics in the department will be taking students, covering all areas of chemistry. The CHM3980 Unit Coordinator and the local exchange coordinator can offer you support and guidance in finding a project.

UNIVERSITY OF WARWICK, Coventry, UK

https://warwick.ac.uk/fac/sci/chemistry/

Applications for University of Warwick will need to choose a project from those listed later in this booklet, these are the academics who have volunteered to take on a placement student in 2026. Each has provided details of the specific project and links to some additional background reading in order that you can see if you are interested.

DURHAM UNIVERSITY, Durham, UK

https://www.durham.ac.uk/departments/academic/chemistry/

Applications for Durham University will need to choose from one of three broad areas of research interest. The specific project within this area will be assigned closer to the time of the exchange. The three areas are:

- Inorganic Chemistry – Experimental (solid state, batteries, electrochemistry, diffraction, synthetic inorganic, synthetic organometallic).
- Organic Chemistry – Experimental (organic synthesis, supramolecular chemistry, fluorine chemistry, peptide chemistry, biocatalysis, kinetics).
- Physical Chemistry – Experimental and Computational (pharmaceuticals, solid forms, crystallisation, Mechanochemistry, spectroscopy, molecular dynamics, DFT).

You can nominate one or two members of academic staff within these areas that you would like to work with (see link above). Whilst there is no guarantee of being assigned to those people, your preferences will be considered.

TECHNISCHE UNIVERSTÄT DRESDEN (TUD), Dresden, Germany

https://tu-dresden.de/mn/chemie?set_language=en

Applications for TUD will need to choose a project from those listed later in this booklet, these are the academics who have volunteered to take on a placement student in 2026. Each has provided details of the specific project and links to some additional background reading in order that you can see if you are interested.

CHIMIE PARISTECH, Paris, France

https://www.chimieparistech.psl.eu/en/

Applications for Chimie ParisTech will need to choose a project from those listed later in this booklet, these are the academics who have volunteered to take on a placement student in 2026. Each has provided details of the specific project and links to some additional background reading in order that you can see if you are interested.

PROJECTS / PLACEMENTS - 2025

When completing the application form for CHM3980 you will need to list three projects/placements in order of preference. Please use the numbers in the list below to indicate your preferences. Additional details for projects at Warwick, ParisTech and Dresden can be found on the next pages.

Project Number	Institution	Project Title
1	Imperial	N/A – projects to be assigned after enrolment (see above).
2	Durham	Inorganic Chemistry - projects to be assigned after enrolment (see above).
3	Durham	Organic Chemistry - projects to be assigned after enrolment (see above).
4	Durham	Physical Chemistry - projects to be assigned after enrolment (see above).
5	TUD	Isolation and structural elucidation of tyrosine-tryptophan heterodimers.
6	TUD	Separation of critical elements from black mass by ionometallurgy.
7	TUD	Synthesis and crystal growth of metal oxides and hydroxides in alkaline hydroflux.
8	TUD	Colour developers in thermal paper in Australia.
9	TUD	Analysis of PFAS in food contact papers using thermal desorption-gas-chromatography-mass spectrometry (TD-GC-MS).
10	TUD	Sustainable polymer structures.
11	TUD	Complexation of phosphorylated amino acids and oligopeptides with europium(III).
12	TUD	Efficient extraction agents for lithium recovery from batteries.
13	TUD	Synthesis and characterization of imidazoliumyl-substituted phosphaalkenes.
14	Warwick	Synthetic antibodies for the sensing of snake venoms.
15	Warwick	Mechanically interlocked molecules as smart biosensors.
16	Warwick	Photo-modification of ether-containing polymers to introduce (bio)degradability.
17	Warwick	Synthesis of novel diazirine-based probes for mapping protein-protein interactions.
18	Warwick	Cation dynamics in halide double perovskites by solid-state NMR
19	Warwick	Synthesis and characterisation of Pt^{II}-containing polymeric arsenical nanoparticles.
20	Warwick	Understanding the bioactivity of copper picolinamide complexes
21	Warwick	Understanding the templating effect in the formation of multivariate nanoporous materials.
22	Warwick	Copper-oxo clusters and photocatalysis.
23	Paris	Material/environment interaction for photovoltaic installations in new environments (AgriPV and FloatingPV).
24	Paris	Synthesis of non-PFAS fluoropolymers and their recycling via plasma/microfluidic technologies.
25	Paris	Towards cancer-cell selective, near-infrared-absorbing photosensitizers for photodynamic therapy under hypoxia.
26	Paris	Rare earth doped thin films for optical quantum technologies.
27	Paris	Organometallic chemistry of methylaluminoxane: structural, reactivity and catalytic studies.
28	Paris	Study of perovskite solar cells by electrical impedance spectroscopy.
29	Paris	Machine learning potentials for ab initio multiple spawning dynamics of excited states.

PROJECT #5

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Michael Hellwig
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/lc/lc3

PROJECT DETAILS

PROJECT TITLE

Isolation and structural elucidation of tyrosine-tryptophan heterodimers

PROJECT DESCRIPTION

Protein oxidation is of major importance both in food and in vivo, as it affects protein functionality, nutritional quality, and health. In foods, it alters solubility, texture, and digestibility, while in biological systems it serves as a marker of oxidative stress and is implicated in aging and disease. Dityrosine, a stable cross-link formed between tyrosine residues, is widely used as a fluorescent marker of protein oxidation and contributes to protein aggregation and structural changes.

However, intermediate tyrosyl radicals may also react at different sites than tyrosine in a protein. Tryptophan is a likely candidate as it easily undergoes radical reactions. First works point to the formation of several heterodimeric structures formed between tyrosine and tryptophan (Fig. 1). In the project, these products will be prepared by transition metal-induced oxidation, isolated by semi-preparative HPLC and characterized by mass spectrometry, fluorescence spectrometry, and NMR.

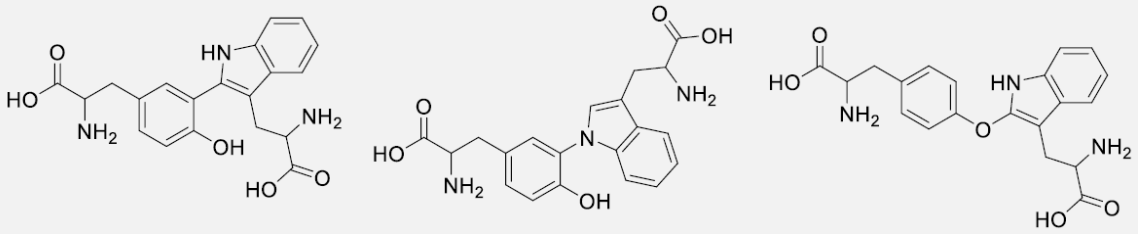

Fig. 1. Possible structures of tyrosine-tryptophan heterodimers

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[2] Leinisch et al. Peroxyl radical- and photo-oxidation of glucose 6-phosphate dehydrogenase generates cross-links and functional changes via oxidation of tyrosine and tryptophan residues. *Free Radic Biol Med* **2017**, *112*, 240-252.

[3] Mariotti et al. Mass-spectrometry-based identification of cross-links in proteins exposed to photo-oxidation and peroxyl radicals using 18 O labeling and optimized tandem mass spectrometry fragmentation. *J Proteome Res* **2018**, *17*, 2017-2027.

PROJECT #6

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Michael Ruck
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/ac/ac2

PROJECT DETAILS

PROJECT TITLE

Separation of critical elements from black mass by ionometallurgy

PROJECT DESCRIPTION

The widespread application of lithium-ion batteries (LIBs) has led to a significant accumulation of end-of-life batteries, necessitating efficient and environmental-friendly recycling strategies. A key component in LIB recycling is the “black mass”, the shredded anodic and cathodic part of the battery containing critical elements such as lithium, copper, nickel, and manganese. Traditional recycling methods for black mass primarily include pyrometallurgical and hydrometallurgical processes. Pyrometallurgy involves high-temperature treatments but often results in substantial energy consumption, greenhouse gas emissions, and the generation of hazardous slags. Hydrometallurgy, on the other hand, utilizes aqueous solutions to leach metals, offering lower energy requirements. However, it typically involves the use of strong acids and oxidizing agents, leading to challenges in waste management and potential environmental hazards. In response to these limitations, ionometallurgy has emerged as a promising alternative. This approach employs ionic liquids (ILs) and deep eutectic solvents (DESs) as environmentally benign media for metal extraction and recovery. It has been shown that metal oxides dissolve in task-specific ILs and that the elemental metals can be electrodeposited directly from such solutions. Since the IL is neither consumed nor decomposed, it can be reused. The overall reaction is metal oxide to metal and oxygen gas.

Project: Explore pathways to use ionometallurgy for the separation of critical elements from black mass. Dissolution and electrodeposition experiments, spectroscopic characterization of the solutions, investigation of the deposited material with SEM and EDX.

PROJECT #7

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Michael Ruck
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/ac/ac2

PROJECT DETAILS

PROJECT TITLE

Synthesis and crystal growth of metal oxides and hydroxides in alkaline hydroflux

PROJECT DESCRIPTION

A highly efficient alternative for crystal growth of metal oxides and hydroxides is the synthesis in alkaline hydroflux. This is a hybrid strategy integrating aspects of both hydrothermal synthesis and molten hydroxide flux methods.[9] In this approach, small amounts of water are used to drastically reduce the melting point of the alkali metal hydroxide (AOH). A typical hydroflux has a base concentration $n(H_2O)/n(AOH)$ in the range of 0.8 to 2, corresponding to 69 and 28 molar “solutions”. Hydroflux syntheses proceed within a few hours and require only a polytetrafluoroethylene lined autoclave that is inert to the alkaline medium and ensures that no water is lost during the reaction. The unique conditions afforded by hydroflux synthesis have enabled the discovery of novel compounds, even within chemical systems that have been the subject of extensive investigation for decades. Key advantages of the hydroflux approach also include relatively low reaction temperatures, operation under ambient or moderate pressure, the formation of highly crystalline products, and high solubility of a wide range of starting materials. Moreover, hydroxido-metalates obtained from hydroflux can be used as precursors for the efficient synthesis of functional metal oxides.

Project: Exploration of the chemical versatility of the hydroflux approach. Synthesis and chemical and structural characterization of the reaction products with SEM, EDX, powder and single crystal X-ray diffraction, and thermal analyses

PROJECT #8

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Thomas Simat
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/lc/lc2

PROJECT DETAILS

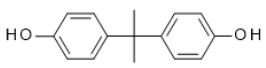
PROJECT TITLE

Colour developers in thermal paper in Australia

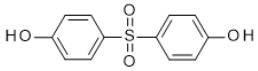
PROJECT DESCRIPTION

Receipts, admission tickets, parcel labels - thermal paper is often used for these applications. The printed image is created selectively by a heat-induced, reversible reaction between a leuco dye and a colour developer serving as H^+ donor. The leuco dye appears colourless until it is converted to the coloured compound by protonation. These colour developers can migrate into food (e.g. if directly applied on food), be transferred to the skin by touching (e.g. by cashiers) or contaminate recycled paper. Some colour developers such as bisphenol A (BPA) und bisphenol S (BPS) are knowns as endocrine disruptors. Therefore, thermal paper containing BPA was banned from the European market in 2020. Manufacturers are turning to other colour developers such as Bisphenol S (BPS) and 'phenol-free' alternatives such as Pergafast® 201 (PF201).

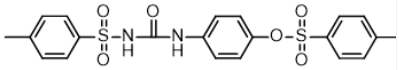
In this study, you should collect as much as possible thermal paper samples from the Australian market with and without food contact. These shall be analysed at TU Dresden for the colour developers in use: In short, after methanolic extraction, the colour developers will be identified and quantified using HPLC-DAD [1,2]. The results could provide a market overview of the colour developers contained in thermal papers to date in Australia.



BPA



BPS



PF201

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PROJECT #9

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Thomas Simat
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/lc/lc2

PROJECT DETAILS

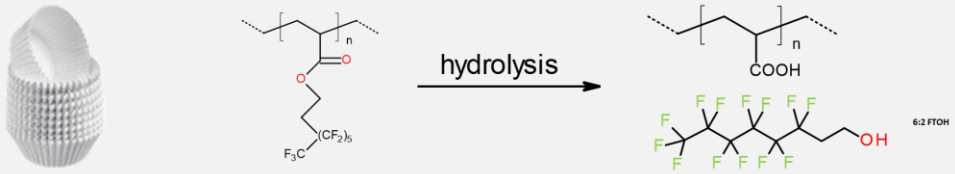
PROJECT TITLE

Analysis of PFAS in food contact papers using thermal decomposition-gas-chromatography-mass spectrometry (TD-GC-MS)

PROJECT DESCRIPTION

Paper and board in contact with liquids, fatty foods or in use at high temperatures require an additive or coating to improve moisture and grease resistance. Frequently, this is achieved by applying a coating onto the paper consisting of a polymeric or oligomeric backbone esterified with fluorinated substances with a maximum concentration of up to 2 % in the final product. These coated papers are in use in fast food restaurants, in high temperature contact applications such as baking paper and muffin cups, and in microwave applications. Furthermore, PFAS residues can obviously be found in recycled paper products since PFAS treated papers end up in the waste paper collection.

The aim of this project is to determine free and ester bound fluorotelomer alcohols (FTOHs), in intentionally treated papers as well as recycled paper products. Unbound residual fluoro-telomer alcohols (FTOHs) will be analysed by thermal desorption in a micro-chamber by transfer of the analytes to adsorption tubes. These tubes will be subsequently analysed by TD-GC-MS [1]. Alkaline hydrolysis will be used to release the ester bound FTOH's from the polymer backbone and analysed after extraction of the hydrolysate.



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PROJECT #10

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Brigitte Voit
ACADEMIC WEBSITE	https://www.ipfdd.de

PROJECT DETAILS

PROJECT TITLE

Sustainable polymer structures

PROJECT DESCRIPTION

Possible internship topics will be allocated in the area of sustainable polymer structures. The internship can cover (upon interest):

- synthesis and characterization (e.g. NMR, FT-IR) of bio-based building block for epoxy and acrylate resins.
- synthesis and characterization of functional bio-based components for engineering thermoplastic polymers.
- introduction of dynamic bonding and reversible bonding for recycling-on-demand into engineering resins and thermoplastic polymers; study of properties.
- resin and polymer synthesis from those building block with respective polymer characterization (NMR, Size Exclusion Chromatography, thermal and mechanical analysis).

PROJECT #11

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Jan Weigand
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/ac/ac3

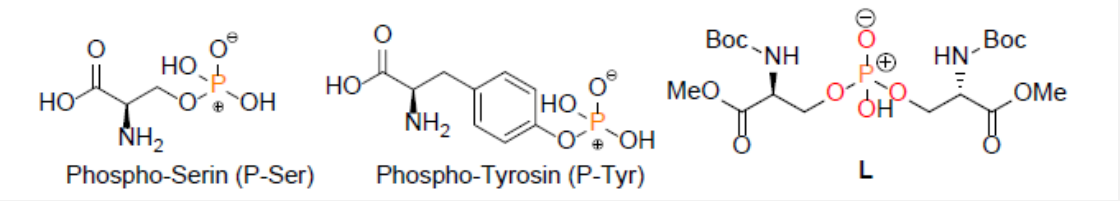
PROJECT DETAILS

PROJECT TITLE

Complexation behaviour of phosphorylated amino acids and oligopeptides with europium(III)

PROJECT DESCRIPTION

Phosphorylation of amino acid residues in peptides/proteins is one option to significantly change the complex formation properties. As the parent as well as the resulting functional groups often provides the donor atoms within the binding sites of proteins, the presence of such phosphorylated amino acids has an immense effect on the stability of the complexes formed in biological systems.
Lanthanides are characterized by the formation of very similar structural motifs in complexes their Ln(III) complexes due to their very similar properties. Europium(III) can be used as a representative for binding in complexes. Since changes in the coordination sphere of europium(III) are reflected in the fluorescence spectra of the complexes, the method can be used to investigate the complex formation properties.
The complex formation behaviour of phosphorylated amino acids and oligopeptides with europium(III) is to be investigated by means of fluorescence measurements and further techniques.



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PROJECT #12

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Jan Weigand
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/ac/ac3

PROJECT DETAILS

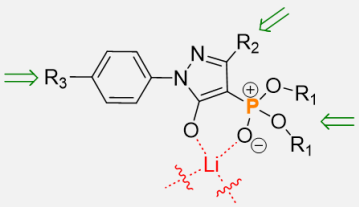
PROJECT TITLE

Efficient extraction agents for lithium recovery from batteries

PROJECT DESCRIPTION

Due to its use in lithium batteries, among other things, a steady increase in Lithium demand is expected and without recycling of secondary raw materials, a corresponding shortage is foreseeable. Liquid-liquid extraction (LLE) or solid-liquid extraction can be used to selectively separate lithium from a variety of solutions or solids. In order to make the corresponding processes more efficient, the extraction agents used must be specifically adapted to the target species. Powerful receptors for Lithium ions are 4-phosphorylpyrazolones (see Image), whose properties can be precisely adjusted by varying the various substituents.

A variety of receptors based on the basic structure of 4-phosphorylpyrazolones are to be prepared and investigated for their extraction properties.



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PROJECT #13

INSTITUTION	Technische Universtät Dresden
ACADEMIC SUPERVISOR	Jan Weigand
ACADEMIC WEBSITE	https://tu-dresden.de/mn/chemie/ac/ac3

PROJECT DETAILS

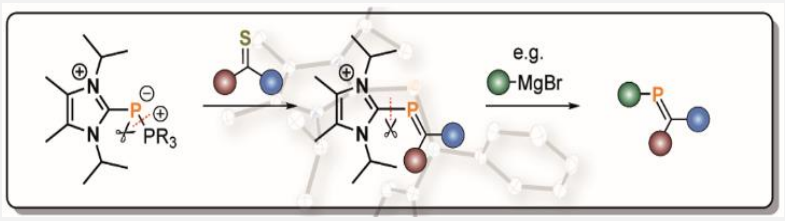
PROJECT TITLE

Synthesis and characterisation of imidazoliumyl-substituted phospsaalkenes

PROJECT DESCRIPTION

Phosphaalkenes (compounds containing a P=C double bond) represent a unique class of organophosphorus compounds with exciting applications as ligands in coordination chemistry and as precursors for functional materials. Their reactivity can be strongly influenced by substituents directly attached to phosphorus. In this project, we focus on **imidazoliumyl-substituted phosphaalkenes**, where a stable cationic substituent provides electronic stabilization and opens new reactivity pathways.

The project involves the synthesis of simple imidazoliumyl-substituted precursors, their conversion into phosphaalkene derivatives, and the subsequent **characterization by multinuclear NMR spectroscopy and IR spectroscopy**. The work will give students direct experience with modern inorganic synthesis under inert-gas conditions, as well as skills in the analysis and interpretation of spectroscopic data. By comparing structural and electronic features of different derivatives, students will learn how substituents affect the bonding and stability of the P=C unit. The project highlights the role of main-group chemistry in designing novel molecules that can act as **building blocks for catalysis and materials chemistry.**



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PROJECT #14

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Alex Baker
ACADEMIC WEBSITE	https://alexbakerweb.co.uk/aboutbaker-hcg

PROJECT DETAILS

PROJECT TITLE

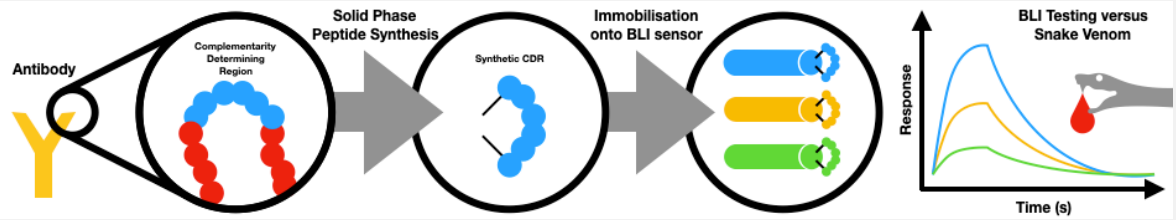
Synthetic antibodies for the sensing of snake venoms

PROJECT DESCRIPTION

Every 5 minutes, 50 people are bitten by a snake worldwide, 4 will be permanently disabled and 1 will die. Snake envenomation is a neglected tropical disease (NTD) that requires urgent attention. The current treatment for snake envenomation utilises antibody-based antivenoms and diagnostics. However, this reliance on proteins does not need to be the case.

Small peptides (<10 amino acids long) derived from antibody complementarity determining regions (CDRs) and presented on small organic linker molecules have been shown to exhibit similar binding properties to their antibody counterparts.[1] This project will seek to deploy this strategy to sense for snake venoms using biolayer interferometry (BLI) and aggregation assays. BLI is a biosensing technique used to analyse molecular interactions in real-time without the need for labelling. While gold nanoparticle-based aggregation assays further interrogate binding partners in an environment similar to a lateral flow assay.[2] These techniques have been used previously by Baker et al. to develop diagnostics for SARS-COV-2.3

The project will involve designing and synthesising by solid phase peptide synthesis (SPPS) and organic synthesis techniques a library of peptides. These peptides will be presented on organic scaffolds and immobilised onto BLI sensors and particles for testing versus snake venoms.



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PROJECT #15

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Fredrik Schaufelberger
ACADEMIC WEBSITE	https://www.schaufelberger-group.com/

PROJECT DETAILS

PROJECT TITLE

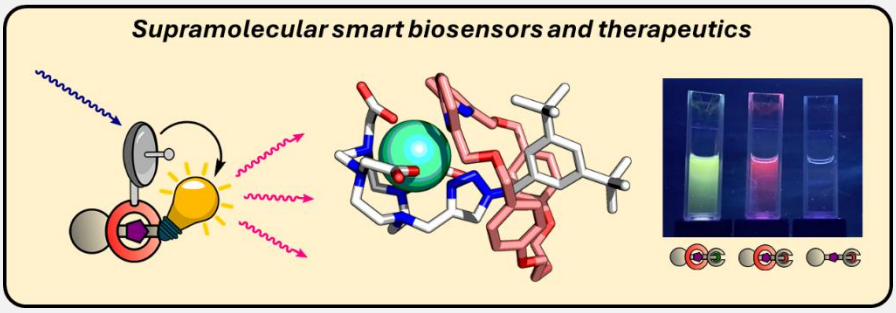
Mechanically interlocked molecules as smart biosensors

PROJECT DESCRIPTION

The Schaufelberger group is an interdisciplinary group working at the interface of supramolecular chemistry, nanomedicine and biomaterials, using the toolbox of synthetic organic chemistry to engineer new nanotechnology for biomedical diagnostics and therapeutics. Our main tool-of-choice is the mechanical bond, i.e. a mechanical linkage between two molecular component that cannot be broken without breaking a covalent bond.

We like to use mechanically interlocked molecules such as rotaxanes to design "smart" diagnostic devices or therapeutics. Our goal is always that the mechanical bond should improve pharmacokinetic properties of the functional compound or give it new and useful functional properties such as stimuli-responsiveness.

This project builds on making mechanically interlocked biosensors with switchable lanthanide luminescence. Many mechanically interlocked molecules also act as artificial molecular machines when exposed to the right stimuli, and in this project we will use these machine-like movements to create smart diagnostic systems that can detect cancer cells. Our work uses a diverse set of tools, and students interested in working on these projects will likely encounter a mix between synthesis and measurements, and between subjects such as supramolecular chemistry, organic chemistry, coordination chemistry, chemical biology and photophysics



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PROJECT #16

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Hannes Houck
ACADEMIC WEBSITE	https://warwick.ac.uk/fac/sci/chemistry/staff/hanneshouck/

PROJECT DETAILS

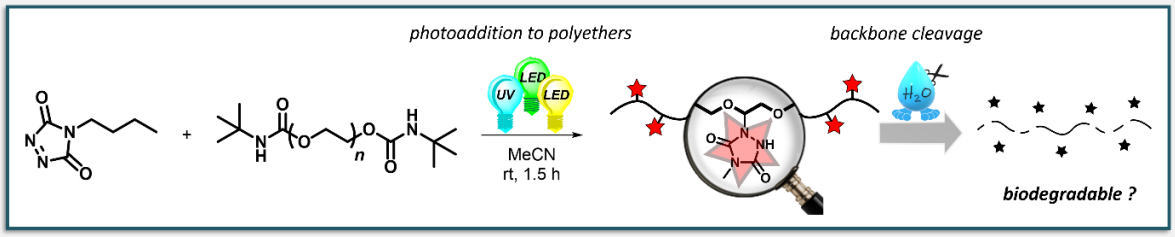
PROJECT TITLE

Photo-modification of ether-containing polymers to introduce (bio)degradability

PROJECT DESCRIPTION

The implementation of stimuli-responsive bonds into polymer materials is a key concept to design more sustainable materials that can be reshaped, recycled and degrade at their end-of-life. Poly(ethylene glycol) is a commodity polymer that is widely found in consumer products (e.g. personal care products, medicines), but its longer-term waste accumulation raises concerns. In this project, you will continue our investigations to chemically modify PEG-based materials, thereby installing water-degradable and potentially biodegradable bond-cleavage sites in relevant polymer materials.

Specifically, we developed a straightforward initiator-free photo-modification strategy that allows for the tailored fabrication of functional PEG materials that can be readily erased by water, even without the need for acid or base. This post-polymerisation modification reaction operates through a photo-addition of triazolinedione reagents onto the PEG backbone. Hence, polymer properties (e.g. hydrophilicity, glass transition temperature), can be tuned upon visible LED irradiation (λ > 515 nm). The thus modified polymers are stable in organic media but rapidly degrade upon the addition of water, which holds potential to design PEG-based consumer products with pre-programmed (bio)degradability. In this project, you will screen different reaction conditions to optimise the photo-modification reaction, and investigate the degradability of the modified PEG polymers under biologically relevant stimuli.



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(3) Angew. Chem. Int. Ed. 2023, 62, e202301102, https://doi.org/10.1002/anie.202301102.

PROJECT #17

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Mark Greenhalgh
ACADEMIC WEBSITE	https://cha06mg.wixsite.com/greenhalghgroup

PROJECT DETAILS

PROJECT TITLE

Synthesis of novel diazirine-based probes for mapping protein-protein interactions

PROJECT DESCRIPTION

Protein-protein interactions (PPIs) drive most biochemical processes. Detecting and mapping these interactions is crucial for understanding molecular biology and guiding drug discovery. One approach is known as carbene foot-printing, which utilizes a photoactivatable diazirine probe to covalently modify surface residues of proteins. In the presence of a binding partner, there is a decrease in the covalent labelling in areas where two proteins meet – termed 'masking' – and the specific residues at this interface can then be determined using standard bottom-up proteomics protocols (Fig. 1A).

Whilst current diazirine-based probes work well for many systems, the molecular characteristics of these probes (neutral or negatively charged, hydrophobic) tend to preferentially label certain amino acid residues sites, leaving large areas unlabelled and thereby reducing sequence / surface coverage. This project will involve the synthesis of a selection of novel diazirines bearing neutral or cationic amino substituents (Fig. 1B). The diazirines synthesised in this project will be supplied to a collaborator to carry out the carbene foot-printing investigations. It is expected these novel probes will provide complementary sequence coverage and labelling efficiency, making carbene foot-printing a more powerful technique.

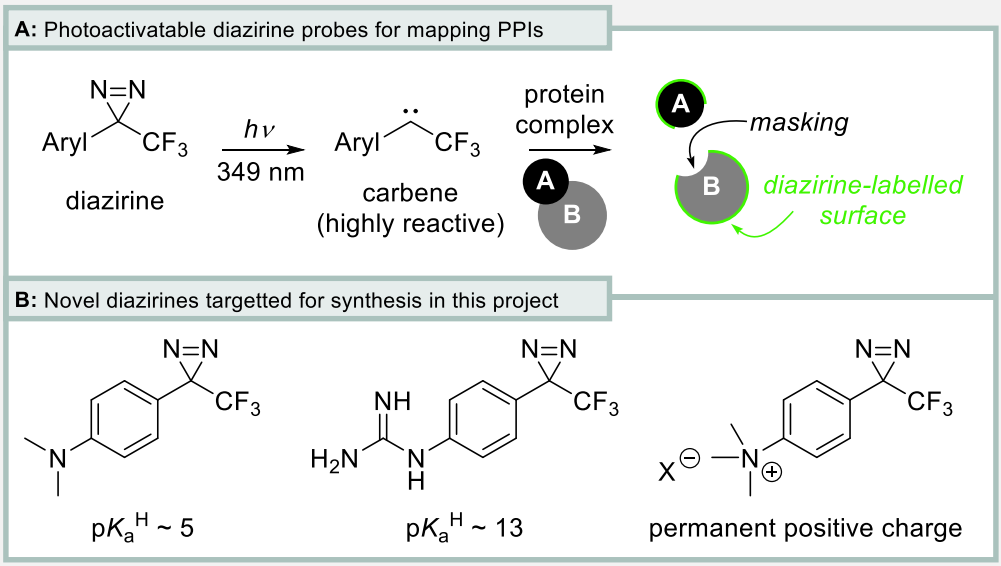

Figure 1

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PROJECT #18

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Michael Hope
ACADEMIC WEBSITE	https://warwick.ac.uk/fac/sci/chemistry/research/hopegroup/

PROJECT DETAILS

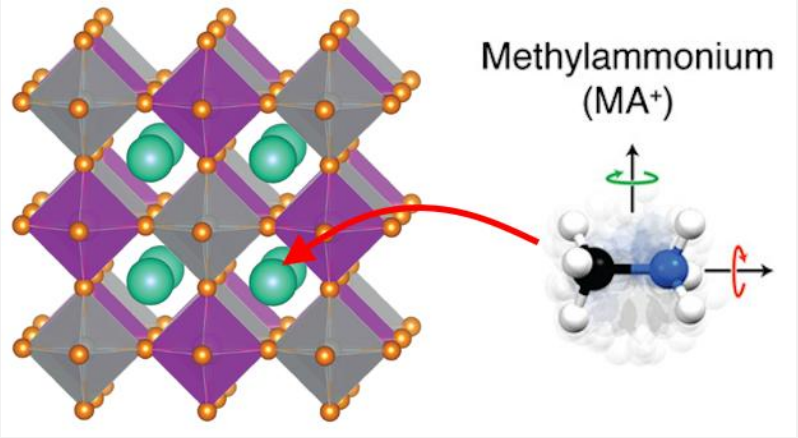
PROJECT TITLE

Cation dynamics in halide double perovskites by solid-state NMR

PROJECT DESCRIPTION

Lead halide perovskites are the subject of intense research interest owing to their excellent optoelectronic properties for applications in solar cells and LEDs, however they suffer from issues of stability and lead toxicity. Double perovskites, where Pb^{2+} is replaced by alternating 1+/3+ cations, are a promising alternative.[1] Previous work has shown that rapid rotational dynamics of the organic cations in lead perovskites impact the electronic properties, but little is known for the double perovskite analogues. Solid-state NMR is ideally suited to measure site-specific dynamics and has been extensively applied to lead perovskites.[2,3]

In this project, you will use mechanosynthesis to make MA_2KBiCl_6 double perovskite (MA = methylammonium), characterise by XRD, and then use variable temperature ^{2}H and ^{14}N NMR and T_1 relaxation data to measure the rate and activation energy for MA rotation, comparing the results to lead-based perovskites. This will use the excellent solid-state NMR facilities at the University of Warwick.



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PROJECT #19

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Paul Wilson
ACADEMIC WEBSITE	https://warwick.ac.uk/fac/sci/chemistry/staff/paulwilson/

PROJECT DETAILS

PROJECT TITLE

Synthesis and characterisation of Pt^{II}-containing polymeric arsenical nanoparticles

PROJECT DESCRIPTION

Platinum and arsenic (e.g. cis-platin, As_2O_3) have been used extensively in modern medicine due to their strong anticancer and antimicrobial activity. However, intrinsic and acquired resistance are major problems associated with Pt^{II} and (in)organic arsenicals are notoriously toxic. Consequently, the development of alternative chemistries and delivery strategies for Pt and As containing molecules and materials is of high importance.

Polymeric nanomaterials have emerged as effective platforms for metallo-drug delivery. Careful design can address the limitations associated with conventional drug delivery such as non-specific biodistribution/targeting, poor solubility and rapid clearance from the body all leading to poor bioavailability overall. The goal is to enhance efficacies and improve dosing regimens which can have a positive effect of therapies such as reducing systemic toxicity and delaying/avoiding the development of resistance.

Polymeric arsenicals are tuneable, reactive, responsive and biocompatible scaffolds with the potential for application in drug delivery.[1-3] In this project, these will be combined with Pt(II) salts, building on preliminary work that has demonstrated that Pt(II) stimulates the formation of antimicrobial hydrogels from polymeric arsenical scaffolds (submitted). The resulting nanoparticles will be fully characterized including NMR, SEC, IR, DLS, TEM, AFM, which the student(s) will engage with either directly of with support of authorised users, before undergoing biological evaluation (e.g. cell viability, anticancer activity).

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PROJECT #20

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Rianne Lord
ACADEMIC WEBSITE	https://warwick.ac.uk/fac/sci/chemistry/staff/riannelord/

PROJECT DETAILS

PROJECT TITLE

Understanding the bioactivity of copper picolinamide complexes

PROJECT DESCRIPTION

Picolinamide moieties are found in a variety of drugs and are active as both cancer and microbial agents. Previously, we have designed functionalized picolinamide ligands and shown their versatility in forming bioactive complexes with various metals. While ruthenium and rhodium complexes,[1-2] were highly active against human cancer cell lines, the corresponding cobalt complexes were non-toxic to human cells but effective in treating pathogenic fungi.[3]

More recently, we have complexed these picolinamide ligands to copper, and created potent anticancer compounds (**Figure 1**), with unique links between complex stability and activity, which was similar to their catalytic properties. This divergent behaviour in activities is not fully understood, and to assess their uptake and cellular distribution, this project will focus on the design of new fluorescence Cu(II) compounds for applications in both cancer (in collaboration with Dr Riccardo Bonsignore, Università degli Studi di Palermo), and as antifungal agents (in collaboration with Dr Stefan Bidula, University of East Anglia). To then allow for protection against decomposition in aqueous/ biological conditions and to improve their cell uptake, the complexes will be attached to polymers for effective encapsulation (in collaboration with Professor Paul Wilson, University of Warwick) and their release mechanisms monitored.

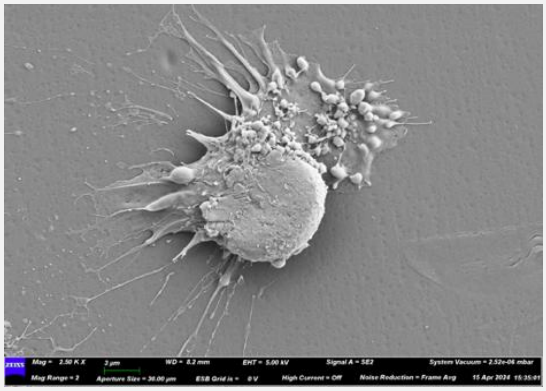

Figure 1: Scanning electron microscopy (SEM) of an osteosarcoma cell after being treated with a Cu(II)-picolinamide complex.

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3. L. H. D. Ghandhi et al. *ChemMedChem*, 2021, **16(**20), 3210-3221, doi: 10.1002/cmdc.202100159

PROJECT #21

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Richard Walton
ACADEMIC WEBSITE	http://www.warwick.ac.uk/go/waltongroup

PROJECT DETAILS

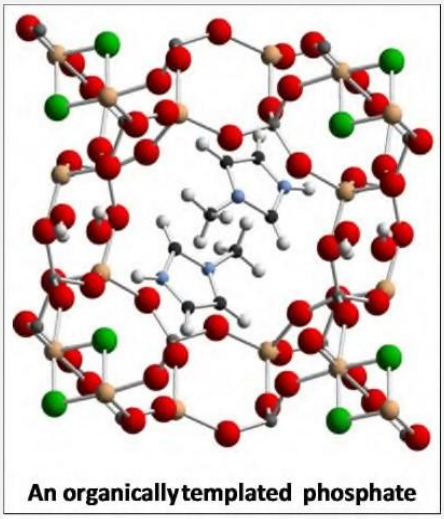
PROJECT TITLE

Understanding the templating effect in the formation of multivariate nanoporous materials

PROJECT DESCRIPTION

Although zeolites and other nanoporous materials have been synthesised for many years and are used in important applications (from water softening to industrial catalysis), but their mechanism of crystallisation remains poorly understood. One important aspect of this research is the idea of 'templating': using an organic molecule of a certain and size and shape to form pores of a matching dimensions in the inorganic solid product. In further tuning the properties of materials, elemental substitution is an important strategy, where replacement of one element by another can tune the porosity, interaction with the template molecule, as well as stability and properties. These so-called multivariate materials are complex, as the distribution of the two, or more, elements could feasibly occur in various configurations, which can be influenced by the choice of template

This project will aim to prepare new examples of aluminium-gallium phosphates to assess how template molecules interact with the inorganic solid structure. We have only recently reported this family of materials[1] and the aim now is to prepare new examples for systematic study. Materials will be prepared using hydrothermal methods, and characterised by use of thermogravimetric analysis and in situ powder X-ray diffraction to determine their stability, structures, and structural transformations



An organically templated phosphate

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PROJECT #22

INSTITUTION	University of Warwick
ACADEMIC SUPERVISOR	Seb Pike
ACADEMIC WEBSITE	https://warwick.ac.uk/pikegroup/

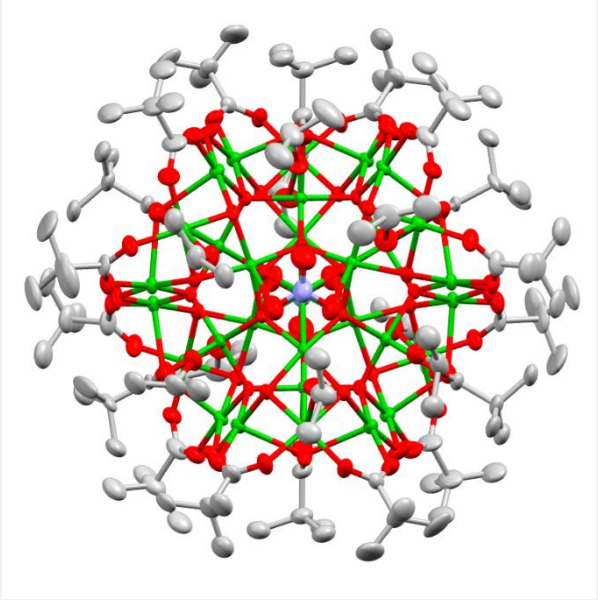
PROJECT DETAILS

PROJECT TITLE

Copper-oxo clusters and photocatalysis

PROJECT DESCRIPTION

Copper oxide (CuO) is a low-cost, Earth-abundant, semiconductor material, which can absorb sunlight and promote chemical redox reactivity. Recent discoveries have highlighted that when particles of CuO are smaller than 3 nm size effects cause the electronic structure of the material to change (a process known as quantum confinement) so that it becomes effective for photochemical water splitting[1] – this important reaction can produce hydrogen (a fuel) from water and sunlight. In this project the student will explore the synthesis of 1 nm Cu-oxo cluster molecules (see figure)[2] and ultrasmall 2-3 nm CuO nanoparticles. These new materials will be explored in photocatalysis. The student will gain expertise in inorganic and materials synthesis, and will learn analytical techniques such as (variable temperature) powder-X-ray crystallography, thermal gravimetric analysis and UV/visible spectroscopy.



A 1.5 nm Cu(II)-oxo cluster recently discovered by the Pike Group.[2]

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2. T. Barnes, J. Payne, S. Pike, *Chem. Commun.,* 2023, 59, 59 - 62

PROJECT #23

INSTITUTION	Chimie ParisTech
ACADEMIC SUPERVISOR	Polina Volovitch
ACADEMIC WEBSITE	https://sites.google.com/site/volovitchp/

PROJECT DETAILS

PROJECT TITLE

Material/environment interaction for photovoltaic installations in new environments (AgriPV and FloatingPV)

PROJECT DESCRIPTION

In the context of growing population with both food and energy needs, new solutions allowing a broader photovoltaic (PV) implantation have a great potential. Floating PV could use the non-exploited water areas and Agriphotovoltaics (AgriPV) allows to share the same land and solar irradiation for both photovoltaic electricity and agricultural production. The alteration of PV installations in atmospheric conditions specific to these applications can however heavily impact their reliability. Both module and structure can be severely impacted by high level of moisture and the presence of specific chemical pollutants. The internship proposes to study the effect of these new and harsh environments on the materials in AgriPV and Floating PV applications with the accent on the mechanisms of the material/environment interactions and possible mitigation strategies. Accelerated degradation tests and advanced surface and material and surface characterization techniques will be used to understand the mechanisms controlling these mechanisms. In function of the profile of the intern, metallic, glass, polymer or semiconductors and their assemblies relevant to the PV can be considered.

Some references describing the research methodologies:
https://doi.org/10.1016/j.corsci.2025.112829
https://doi.org/10.1002/pip.3834
https://doi.org/10.1002/pip.3527
https://doi.org/10.1016/j.corsci.2014.05.014

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https://doi.org/10.1016/j.corsci.2025.112829
https://doi.org/10.1016/j.corsci.2014.05.014

PROJECT #24

INSTITUTION	Chimie ParisTech
ACADEMIC SUPERVISOR	Emmanuel Lacôte
ACADEMIC WEBSITE	https://www.ircp.cnrs.fr/en/member/emmanuel-lacote/

PROJECT DETAILS

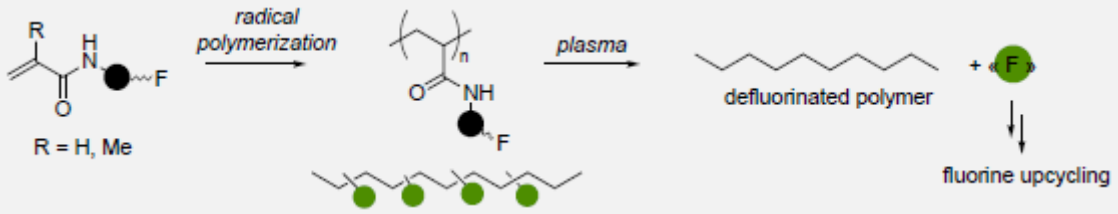
PROJECT TITLE

Synthesis of non-PFAS fluoropolymers and their recycling via plasma/microfluidic technologies

PROJECT DESCRIPTION

Fluoropolymers are high-performance materials used in electronics, medical devices, and sensors, of which they are vital components. However, their environmental impact is concerning due to the release of persistent perfluorinated substances (PFAS). This project seeks to develop a new generation of fluorinated polymers that are not persistent, and therefore more environmentally compatible.

The project will focus on the synthesis of the polymers via radical polymerization (both regular and in emulsion), and the characterization of their materials properties. Finally, we will examine the defluorination of the used polymers using the plasma technology. This would allow us to on the one hand recover and upcycle the fluorine, while neutralizing the PFAS character of the spent polymers. For this we will use the in-house Microlab system via a collaboration with the 2PM team (process chemists, also part of IRCP). This will enable automatic analysis and screening of the process operating conditions (plasma power, temperature) and fluidic parameters (gas and liquid flow rates, mixing).



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PROJECT #25

INSTITUTION	Chimie ParisTech
ACADEMIC SUPERVISOR	Gilles Gasser
ACADEMIC WEBSITE	www.gassergroup.com

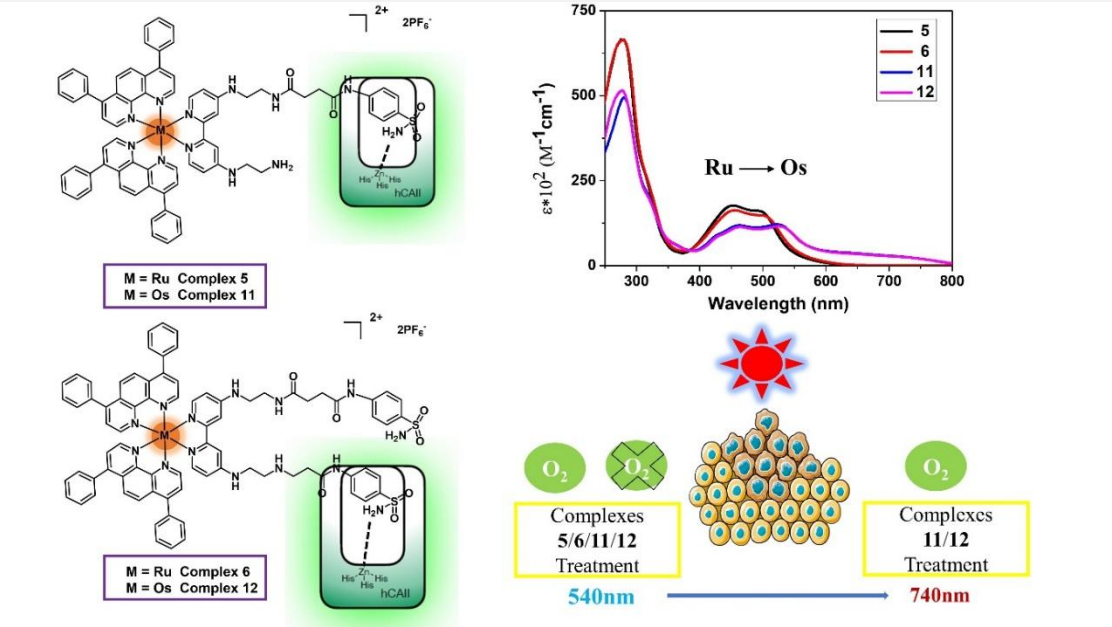
PROJECT DETAILS

PROJECT TITLE

Towards cancer-cell selective, near-infrared-absorbing photosensitizers for photodynamic therapy under hypoxia

PROJECT DESCRIPTION

Photodynamic Therapy (PDT) is an approved medical technique to treat certain types of cancer.[1] However, cancer cells have a lower amount of oxygen than healthy ones, limiting the success of PDT treatments since oxygen is one of the three required components with the presence of a photosensitizer and light. In this context, our group has recently demonstrated that some metal complexes could work under hypoxic conditions and under near-IR irradiation.[2] However, such compounds are not selective for cancer cells. In this project, we envision to target some cancer-cell overexpressed enzymes to increase the selectivity of our compounds, as recently demonstrated by our group [3].



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PROJECT #26

INSTITUTION	Chimie ParisTech
ACADEMIC SUPERVISOR	Philippe Goldner
ACADEMIC WEBSITE	https://www.ircp.cnrs.fr/en/member/philippe-goldner/

PROJECT DETAILS

PROJECT TITLE

Rare earth doped thin films for optical quantum technologies

PROJECT DESCRIPTION

The excellent optical properties of rare-earth-doped crystals make them ideal candidates for many applications, particularly quantum technologies. Their long quantum state lifetimes make them particularly interesting for quantum telecommunications, quantum memories, qubits, etc. [1] Enhanced functionalities can be obtained by combining rare earth ions with other quantum materials in hybrid structures based on thin films [2]. In this project, rare earth doped thin films will be grown on diamond or silicon by Chemical Vapor Deposition and their structural and optical properties will be assessed with the goal of obtaining long-lived optical quantum states.

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PROJECT #27

INSTITUTION	Chimie ParisTech
ACADEMIC SUPERVISOR	Regis Gauvin
ACADEMIC WEBSITE	https://www.ircp.cnrs.fr/en/research-groups/cocp-group/

PROJECT DETAILS

PROJECT TITLE

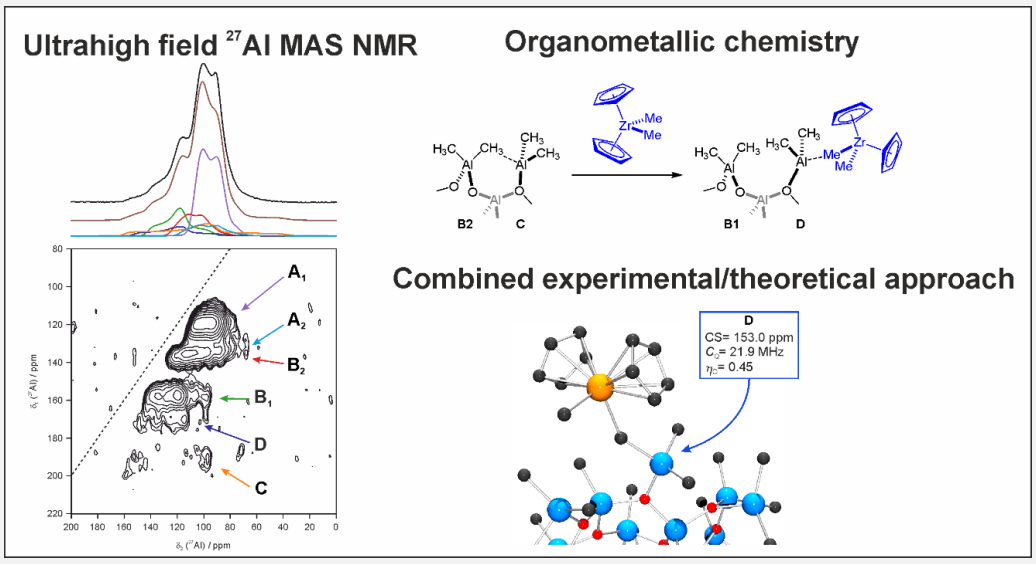
Organometallic chemistry of methylaluminoxane: structural, reactivity and catalytic studies

PROJECT DESCRIPTION

Methylaluminoxane (MAO), an organometallic aluminum species formulated as [AlO(CH3)]n, is a key activator in industrial polyolefin production processes.[1] Combined with metallocene precatalysts, in solution or as a supported reagent, it enables high activity in olefin polymerization with a high degree of control over composition and mass distribution. However, MAO is a poorly defined compound. Its precise structure and mode of action are still the subject of debate, which hinders its understanding and improvement. In addition, the search for alternative MAO-based activators is a highly promising direction.

As part of a multi-partner project, we propose to combine aluminum organometallic chemistry and advanced characterization techniques (notably ultrahigh-field solid-state 27Al NMR) to probe the structure and reactivity of MAO and to develop new activators with improved performance.[2]

This project involves aspects of synthesis, reactivity, and characterization of organometallic compounds under controlled atmosphere, polymerization catalysis, and advanced spectroscopy, in combination with theoretical chemistry studies.



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PROJECT #28

INSTITUTION	Chimie ParisTech
ACADEMIC SUPERVISOR	Thierry Pauporté
ACADEMIC WEBSITE	https://www.pauportegroup.com/

PROJECT DETAILS

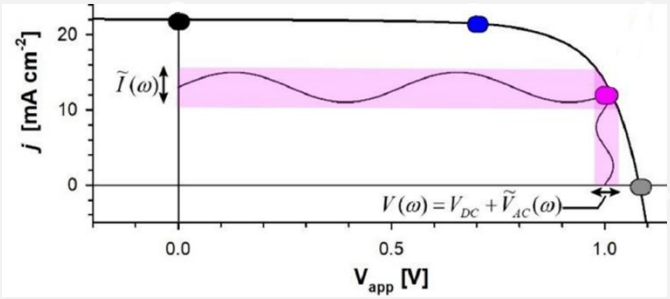
PROJECT TITLE

Study of perovskite solar cells by electrical impedance spectroscopy

PROJECT DESCRIPTION

New photovoltaic (PV) soar cells, which integrate organic and ionic compounds, are less stable and have different defect dynamics than conventional systems such as silicon or III-V-based solar cells. Their functioning and aging are greatly influenced by the ionic mobility, interface charging and conductivity limitations. It requires adaptation of the device characterization techniques and the development of robust protocols for analyzing the results. The sensitivity of electrical spectroscopy techniques to layer and interface phenomena makes them suitable tools for addressing these new issues [1-3].

The objective of the project is to develop the measurement of the electrical impedance spectroscopy (EIS) response of perovskite solar cells (PSCs) at varying applied voltages and light intensities. The repeatability and the reliability of the measurements will be checked. Then, the spectra will be analyzed by means of ad hoc equivalent electrical circuits. The physical origin of the various electrical elements of the circuits will be determined and their variation with opto-electrical conditions will be analyzed. Then aging of the PSCs under standard conditions will be followed by EIS measurement. The analysis of the parameter evolution will lead to an in-depth understanding of the degradation mechanism of the devices.



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PROJECT #29

INSTITUTION	Chimie ParisTech
ACADEMIC SUPERVISOR	Davide Avagliano and Thijs Stuyver
ACADEMIC WEBSITE	https://www.quanthic.org

PROJECT DETAILS

PROJECT TITLE

Machine learning potentials for ab initio multiple spawning dynamics of excited states

PROJECT DESCRIPTION

Non-adiabatic molecular dynamics (NAMD) is a powerful tool to unravel the excited-state processes underlying phenomena such as vision, energy conversion, or photostability. However, the steep computational cost of high-level electronic structure calculations required limits the scope of such simulations. Machine learning interatomic potentials (MLIPs) provide a promising strategy to reduce this cost by predicting electronic energies, forces, and couplings with near ab initio accuracy.

In this project, the student will generate high-quality reference data for a selected molecular system calculating, excited-state properties, namely energies, gradients, and non-adiabatic couplings. These data will serve as training sets for machine learning (ML) models designed to accurately predict the excited-state potential energy surfaces.

The trained ML models will then be employed within our in-house simulation framework that combines machine learning potentials with the ab initio multiple spawning (AIMS) method. This approach allows a rigorous quantum description of the nuclear wavepacket while efficiently handling the electronic degrees of freedom. By focusing on one molecule of chemical or photophysical relevance, the project will assess the feasibility and accuracy of ML-accelerated AIMS dynamics. The internship thus provides practical training at the intersection of quantum chemistry, molecular dynamics, and machine learning.

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