2025

CQMF/QCAM

Colloque annuel sur la recherche des **matériaux fonctionnels**

Advanced Materials Annual Meeting

MAI 12-13 MAY, 2025
UQAM Pavillon Sherbrooke

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MERCI POUR VOTRE SOUTIEN! THANK YOU!

SFR SYSTEMS FOR RESEARCH

the 2nd lab

Institut Courtois Université de Montréal

PRIMA Les matériaux pour avancer

Université de Montréal

UNIVERSITÉ DE SHERBROOKE

McGill

POLYTECHNIQUE MONTRÉAL UNIVERSITÉ D'INGÉNIERIE

INRS Institut national de la recherche scientifique

AIM

UNIVERSITÉ Concordia UNIVERSITY

UQÀM UQAR UQAC

UNIVERSITÉ DU QUÉBEC À TROIS-RIVIÈRES UQTR

ÉTS

UNIVERSITÉ LAVAL

RÉSEAU DES CCTT SYNCHRONEX

cegep de Saint-Jérôme SAINT-JÉRÔME MONT-TREMBLANT MONT-LAURIER

cégep de Sherbrooke

COLLÈGE MONTMORENCY

Remerciements / Acknowledgements

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Codirecteur / Co-director: Fiorenzo Vetrone (INRS)

Comité étudiant / Student committee

Nous remercions les commanditaires de leur généreux appui à notre colloque annuel. Grâce à eux, nous sommes en mesure de vous offrir un programme stimulant et enrichissant.

Nous sommes donc heureux de vous accueillir à cette fête des matériaux fonctionnels et le comité organisateur espère que ce colloque vous sera agréable.

We thank the sponsors for their generous support of our annual meeting. They have allowed us to offer you an exciting and rewarding program.

We are therefore pleased to welcome you to this celebration of advanced materials and the organizing committee hopes that you will enjoy this meeting.

Message du directeur du CQMF

C'est avec un immense plaisir que je vous souhaite la bienvenue à la 9e édition de notre colloque annuel du Centre québécois sur les matériaux fonctionnels. Cet événement constitue un moment privilégié pour réunir chercheurs, étudiantes et étudiants, ainsi que professionnels, tous animés par la même passion : repousser les frontières de l'innovation dans le domaine des matériaux avancés.

Grâce à l'appui du Fonds de recherche du Québec – Nature et Technologies, notre communauté s'efforce chaque jour de relever les défis scientifiques et technologiques qui façonnent notre avenir : atténuer les effets du changement climatique, améliorer la santé humaine et répondre aux besoins énergétiques croissants.

Cette année, notre programme illustre la vitalité et la diversité de nos actions : les projets collaboratifs ont été relancés pour 2025–2026 selon les nouvelles modalités du FRQNT, tandis que le cours CQMF hiver 2025 a réuni 17 étudiant·e·s de cinq institutions (Concordia, McGill, Laval, UdeM, UdS) autour de dix leçons thématiques - de la cellulose avancée à l'intelligence artificielle pour le stockage d'énergie - enrichies d'ateliers sur la propriété intellectuelle et le travail en équipe. Par ailleurs, grâce au nouveau programme de bourses de mobilité, trois étudiantes ont effectué des séjours de formation à Heidelberg, Yokohama et Bâle, et le CQMF a soutenu l'école d'été MATES à Bordeaux tout en représentant fièrement le Québec au sommet de Paraná (Brésil) et au 7e congrès ICMES à Saïdia (Maroc).

Au programme de cette édition, vous aurez également l'occasion d'assister à des interventions d'orateurs d'exception, dont les travaux avant-gardistes dessineront les grandes lignes des développements à venir. Les sessions orales et d'affiches, riches et variées, couvriront un large éventail de thématiques, de la synthèse de nouveaux matériaux à leurs applications industrielles et environnementales.

Je tiens à remercier chaleureusement les membres du comité d'organisation, ainsi que nos partenaires et commanditaires, dont l'engagement et la rigueur sont la pierre angulaire de notre réussite collective.

Je vous souhaite un colloque stimulant, riche en échanges et en découvertes ! Au plaisir de vous rencontrer et de bâtir ensemble les solutions de demain.

Mohamed Siaj

Message from the QCAM director

It is with great pleasure that I welcome you to the 9th edition of our annual symposium of the Québec Center for Advanced Materials (QCAM). This event is a privileged opportunity to bring together researchers, students, and professionals, all driven by a shared passion: pushing the boundaries of innovation in the field of advanced materials.

Thanks to the support of the Fonds de recherche du Québec – Nature et technologies (FRQNT), our community works every day to tackle the scientific and technological challenges that shape our future: mitigating the effects of climate change, improving human health, and meeting growing energy demands.

This year, our program reflects the vitality and diversity of our initiatives: collaborative projects have been relaunched for 2025–2026 under the new FRQNT guidelines, while the 2025 winter CQMF course brought together 17 students from five institutions (Concordia, McGill, Laval, UdeM, UdS) around ten thematic lessons – from advanced cellulose to artificial intelligence for energy storage – enhanced by workshops on intellectual property and teamwork. Additionally, through our new mobility scholarship program, three students had the opportunity to train in Heidelberg, Yokohama, and Basel. CQMF also supported the MATES summer school in Bordeaux, while proudly representing Québec at the Paraná summit (Brazil) and the 7th ICMES congress in Saïdia (Morocco).

This edition also features outstanding speakers whose groundbreaking work will outline the major trends shaping future developments. The oral and poster sessions, both rich and diverse, will cover a wide range of topics, from the synthesis of new materials to their industrial and environmental applications.

I would like to extend my heartfelt thanks to the members of the organizing committee, as well as to our partners and sponsors, whose commitment and dedication are the cornerstone of our collective success.

I wish you an inspiring symposium filled with meaningful exchanges and discoveries. I look forward to meeting you and building the solutions of tomorrow together.

Mohamed Siaj

Horaire / Schedule

Centre Québécois sur les Matériaux Fonctionnels
Colloque Annuel - 9e édition – 12-13 mai 2025

Présentations (Exposé/Q&R) : 2 plénières (40/10), 4 invitées (20/5) and 24 inscrites (8/2)

47 affiches - panneaux : 80'' (2m) par 40'' (1m)

		Lundi, 12 mai
10h00	Hall d'entrée	Inscription
SH-2800		
10h30		Mot d'ouverture – Mohamed Siaj
		Présidence: A. Badia
10h45		**Présentation plénière : Cathleen Crudden - Université Queen's**
11h35		**Présentation invitée : Jérôme Claverie - Université de Sherbrooke**
12h05		Présentation Cœur des sciences : Perrine Poisson - UQAM
12h20	SH-4800	Lunch présenté par Institut Courtois
SH-2800		Présidence: R. Izquierdo
13h20		**Présentation invitée : Gaixia Zhang - ETS**
13h45-14h45		**Présentations étudiantes - Énergie - groupe A**
13h45		Mohammad Masaeli (Huot, UQTR)
13h55		Samaneh Salek (Byers, UQAM)
14h05		Zhao Yang (Li, Concordia)
14h15		Nooshin Zeinali Galabi (McCalla, McGill)
14h25		Israt Ali (Beyerlein, INRS)
14h35		Marie-Chloé Michaud Paradis (Dollé, UdeM)
14h45	SH-4800	Pause énergie
15h15-16h15		**Présentations étudiantes - Énergie - groupe B**
SH-2800		Présidence: D. Ma
15h15		Khawla Talbi (Wustrow, UdS)
15h25		Rupinder Kaur (Skene, UdeM)
15h35		Camilo Perdomo (Truong, Concordia)
15h45		Ilyes Oubaha (Hanan, UdeM)
15h55		Zahra Kalantari Bolaghi (Ma, INRS)
16h05		Hanine Slama (Bio) (Hermawan, ULaval)
		Présidence: M. Shagar
16h15		Atelier du 2nd lab, Gad Sabbatier - Ce qui se passe après un doctorat
16h15	SH-2580	Assemblée générale annuelle des membres
SH-4800		
17h30		Session d'affiches et réception commandité par SFR
18h00-19h15		Visite des affiches : # PAIRS
19h15-20h30		Visite des affiches : # IMPAIRS
21h00		Ajournement

Mardi, 13 mai

8h30	Hall d'entrée	Inscription
SH-2800		Présidence: D. Ma
9h10		**Présentation plénière : Alexander Govorov - Université Ohio**
10h00		**Présentation invitée : May Griffith - Université de Montréal**
10h25	SH-4800	Pause-Café
SH-2800		Présidence : M.Duca /A. Badia
11h00-12h00		**Présentations étudiantes - Polymères - groupe C**
11h00		Mohammad Hossein Gohari (Perepichka, McGill)
11h10		Anthony Olivier (Laventure, UdeM)
11h20		Niloofar Zamanian (Zhao, UdS)
11h30		Betty Kane (Volel, Polytechnique/Collège Montmorency)
11h40		Mohammad Bakhtiari (Momen, UQAC)
11h50		Zi Xin Zhang (Cao, McGill)
12h00		Tech bite: David Polcari - Systems for Research Corp. (SFR)
12h15	SH-4800	Lunch présenté par Prima
SH-2800		Présidence : R. Naccache
13h20		**Présentation invitée: Thomas Auvray - UQTR**
13h45-14h45		**Présentations étudiantes - Auto-Ass. / Bio / Nano / Env.- groupe D**
13h45		Guido Merino (Blum, McGill)
13h55		Thi Linh Giang Hoang (Nguyen-Tri, UQTR)
14h05		Assira Keralta (Landry, ULaval)
14h15		Hamid Ebrahimi Orimi (Hoesli, McGill)
14h25		Laura McKay (Kakkar, McGill)
14h35		Hannah Williams (Masson, UdeM)
14h45	SH-4800	Pause – Nous recyclons vos cocardes ♻
SH-2800		
15h30		Remise des prix étudiants par 2nd lab et SFR suivie d’un mot de clôture
16h00		Ajournement

Quebec Centre for Advanced Materials Annual Meeting
9th edition – May 12,13, 2025

Remarks (Talk/Q&A): 2 keynotes (40/10), 4 invited (20/5) and 24 registered talks (8/2)

47 Posters – panels : 80'' (2m) par 40'' (1m)

Monday, May 12		
10:00am	Entrance hall	Registration
SH-2800		
10:30am		Opening remarks – Mohamed Siaj
		Chair: A. Badia
10:45am		**Plenary talk: Cathleen Crudden- Queen's University**
11:35am		**Invited talk: Jérôme Claverie – Université de Sherbrooke**
12:05pm		Cœur des sciences : Perrine Poisson - UQAM
12:20pm	SH-4800	Lunch presented by Institut Courtois
SH-2800		Chair: R. Izquierdo
1:20pm		**Invited talk: Gaixia Zhang - ETS**
1:45-2:45pm		**Student presentations - Energy - group A**
1:45pm		Mohammad Masaeli (Huot, UQTR)
1:55pm		Samaneh Salek (Byers, UQAM)
2:05pm		Zhao Yang (Li, Concordia)
2:15pm		Nooshin Zeinali Galabi (McCalla, McGill)
2:25pm		Israt Ali (Beyerlein, INRS)
2:35pm		Marie-Chloé Michaud Paradis (Dollé, UdeM)
2:45pm	SH-4800	Pause energy
3:15-4:15pm		**Student presentations - Energy - group B**
SH-2800		Chair: D. Ma
3:15pm		Khawla Talbi (Wustrow, UdS)
3:25pm		Rupinder Kaur (Skene, UdeM)
3:35pm		Camilo Perdomo (Truong, Concordia)
3:45pm		Ilyes Oubaha (Hanan, UdeM)
3:55pm		Zahra Kalantari Bolaghi (Ma, INRS)
4:05pm		Hanine Slama (Bio) (Hermawan, ULaval)
		Chair: M. Shagar
4:15pm	SH-2800	Workshop by 2nd lab, Gad Sabbatier - What comes after a PhD
4:15pm	SH-2580	Annual general meeting of members
SH-4800		
5:30pm		Poster session and reception sponsored by SFR
6:00-7:15pm		Visit of posters: EVEN numbers
7:15-8:30pm		Visit of posters: ODD numbers
9:00 pm		Adjournment

Tuesday, May 13

8:30am	Entrance hall	Registration
SH-2800		Chair: D. Ma
9:10am		**Plenary talk: Alexander Govorov - Ohio University**
10:00am		**Invited talk: May Griffith – Université de Montréal**
10:25am	SH-4800	Coffee break
SH-2800		Chairs: M. Duca / A. Badia
11:00-12:00am		**Student presentations - Polymer- group C**
11:00am		Mohammad Hossein Gohari (Perepichka, McGill)
11:10am		Anthony Olivier (Laventure, UdeM)
11:20am		Niloofar Zamanian (Zhao, UdS)
11:30am		Betty Kane (Volel, Polytechnique/Collège Montmorency)
11:40am		Mohammad Bakhtiari (Momen, UQAC)
11:50am		Zi Xin Zhang (Cao, McGill)
12:00pm		Tech bite: David Polcari - Systems for Research Corp. (SFR)
12:15pm	SH-4800	Lunch presented by Prima
SH-2800		Chair: R. Naccache
1:20pm		**Invited talk: Thomas Auvray – UQTR**
1:45-2:45pm		**Student presentations- Self-Ass./ Bio / Nano / Env. - group D**
1:45pm		Guido Merino (Blum, McGill)
1:55pm		Thi Linh Giang Hoang (Nguyen-Tri, UQTR)
2:05pm		Assira Keralta (Landry, ULaval)
2:15pm		Hamid Ebrahimi Orimi (Hoesli, McGill)
2:25pm		Laura McKay (Kakkar, McGill)
2:35pm		Hannah Williams (Masson, UdeM)
2:45pm	SH-4800	Pause – we recycle your badges ♻
SH-2800		
3:30pm		Award ceremony presented by 2nd lab and SFR followed by closing remarks
4:00 pm		Adjournment

Poster # Affiche

#	Prénom First Name	Nom Last Name	Nom du direct.eur.rice Supervisor	Votre thématique de recherche / Your research theme
1	Daniel	Chartrand	Per. de rech. / Res. Prof.	Infrastructure
2	Mohini	Ramkaran	Per. de rech. / Res. Prof.	Infrastructure
3	Patricia	Moraille	Per. de rech. / Res. Prof.	Infrastructure
4	Jatinder	Singh	Ashlee Howarth	Auto-assemblage moléculaire / Molecular self-assembly
5	Myriam	Lessard	Christian Pellerin	Auto-assemblage moléculaire / Molecular self-assembly
6	Félix	Côté Dubuc	Antonella Badia	Auto-assemblage moléculaire / Molecular self-assembly
7	Olivier	Roy	Christian Pellerin	Chimie des polymères / Polymer chemistry
8	Maxime	Goulet	Audrey Laventure	Chimie des polymères / Polymer chemistry
9	Xinshi	Chen	Yue Zhao	Chimie des polymères / Polymer chemistry
10	Meng	Liu	Yue Zhao	Chimie des polymères / Polymer chemistry
11	Yaru	Ma	Yue Zhao	Chimie des polymères / Polymer chemistry
12	Ramzi	Zidani	Audrey Laventure	Chimie des polymères / Polymer chemistry
13	Tristan	Perodeau	Audrey Laventure	Chimie des polymères / Polymer chemistry
14	Lucas	Paris	Ali Nazemi	Chimie des polymères / Polymer chemistry
15	Thomas	Jacquemin	Ali Nazemi	Chimie des polymères / Polymer chemistry
16	Javier	Vargas	Audrey Laventure	Chimie des polymères / Polymer chemistry
17	Iannick	Lepage	Mathieu Frenette	Chimie des polymères / Polymer chemistry
18	Katia	Cherifi	Simon Matoori	Matériaux pour applications biomédicales / Materials for biomedical applications
19	Sirirat	Khemasiri	Mohamed Siaj	Matériaux pour applications biomédicales / Materials for biomedical applications
20	Victor	Passos Gibson	Pierre Hardy	Matériaux pour applications biomédicales / Materials for biomedical applications
21	Ahmed	Mahmoud	Corinne Hoesli	Matériaux pour applications biomédicales / Materials for biomedical applications
22	Gabriela Isabel	Manrique Vera	Simon Matoori	Matériaux pour applications biomédicales / Materials for biomedical applications
23	hiba	roubio	Jacques Huot	Matériaux pour applications en énergie / Materials for energy applications
24	Jean-Danick	Lavertu	Eric McCalla	Matériaux pour applications en énergie / Materials for energy applications
25	Rupinder	Kaur	Will Skene	Matériaux pour applications en énergie / Materials for energy applications
26	Yuxiao	Zhang	Xia Li	Matériaux pour applications en énergie / Materials for energy applications
27	Susmit	Som	Will Skene	Matériaux pour applications en énergie / Materials for energy applications
28	Sixiang	Liu	Shuhui Sun	Matériaux pour applications en énergie / Materials for energy applications
29	Siyi	Cao	Shuhui Sun	Matériaux pour applications en énergie / Materials for energy applications
30	ZHANGSEN	CHEN	Shuhui Sun	Matériaux pour applications en énergie / Materials for energy applications
31	Elizabeth	Lamothe	Garry Hanan	Matériaux pour applications en énergie / Materials for energy applications
32	Cédric	Gros	Garry Hanan	Matériaux pour applications en énergie / Materials for energy applications
33	Zafar	Ali	Jacques Huot	Matériaux pour applications en énergie / Materials for energy applications
34	Vivian Alexandra	Montanez Valderı	Mihaela Cibian	Matériaux pour applications en énergie / Materials for energy applications
35	Mathieu	Lepage	Mihaela Cibian	Matériaux pour applications en énergie / Materials for energy applications
36	Édua	Dray	Garry Hanan	Matériaux pour applications en énergie / Materials for energy applications
37	Indra	Guzman Moreno	Ayse Turak	Matériaux pour applications en énergie / Materials for energy applications
38	Théo	Cha-Cossette	François Perreault	Matériaux pour le développement durable / Materials for sustainable development
39	Rima	Chand	Lionel Roué	Matériaux pour le développement durable / Materials for sustainable development
40	Anna	Bisio	François Perreault	Matériaux pour le développement durable / Materials for sustainable development
41	Anthony	Jolly	Audrey Laventure	Matériaux pour le développement durable / Materials for sustainable development
42	Saman	Vakili	Véronic Landry	Matériaux pour le développement durable / Materials for sustainable development
43	Gilbert Romeo	NKANA NKANA	Bruno Chabot	Matériaux pour le développement durable / Materials for sustainable development
44	Maryam	Hosseini	Gelareh Momen	Matériaux pour le développement durable / Materials for sustainable development
45	Ngara	Diouf	Mohamed Siaj	Matériaux pour le développement durable / Materials for sustainable development
46	Navid	Ghane	Daniel Guay	Matériaux pour le développement durable / Materials for sustainable development
47	Susanna	Vu	Mohamed Siaj	Nanosciences

Conférences plénières / Plenary lectures

The power of organometallics: From catalysis to self-assembled monolayers to atomically precise nanoclusters

Cathleen Crudden

Queen's University

The use of N-heterocyclic carbenes to modify homogeneous metal catalysts is widespread since the high metal–NHC bond strength renders high oxidative and chemical stability to the resulting metal complexes. The use of NHCs to modify metal surfaces has received considerably less attention. We will describe the modification of planar metallic surfaces with NHCs and compare these monolayers to more typical SAMs. The nature of the surface overlayer is strongly dependent on the nature of the NHC. Similarly, NHCs are useful new ligands for the stabilization of metal clusters, with the structure of the cluster being strongly influenced by the nature of the NHC. The use of NHC-stabilized clusters in biological studies and in catalysis will be presented.

BIO Cathy

Dr. Cathleen Crudden is the A.V. Douglas Distinguished Professor of Chemistry and Canada Research Chair (Tier 1) in metal organic chemistry at Queen’s University in Kingston, Ontario. She holds a Research Professorship at the Institute of Transformative Bio-Molecules (ITbM) in Nagoya, Japan, where she runs a satellite laboratory. She is a Fellow of the Royal Society of Canada, the Chemical Institute of Canada, the Royal Society of Chemistry (UK) and an elected member of the American Association for the Advancement of Science.

Dr. Crudden has made significant impact on diverse areas of science. She described one of the first cross-coupling reactions with chiral, enantiopure molecules that has made considerable impact on the preparation of pharmaceutical compounds. More recently, she has demonstrated the strength and versatility of N-heterocyclic carbene ligands in materials science, showing these ligands to be viable and versatile alternatives to thiolates as ligands for planar metal surfaces, nanoparticles and nanoclusters. This work has been called "game changing", "elegant" and "the new gold standard" by experts in the field.

Crudden has served as President of the Canadian Society for Chemistry and Chair of the Chemical Institute of Canada. She is currently Scientific Director of the Carbon to Metals Coating Institute (C2MCI) at Queen's University and Editor-in-Chief for ACS Catalysis. She has won numerous awards including the 2023 John Polanyi Award, a 2019 Cope Scholar award of the American Chemical Society, the Montreal Medal (2019), and the 2018 Carol Taylor award from the International Precious Metals Institute.

Short stories from the world of optical metamaterials: From chiral biomolecules to chiral nanocrystals, the origin of chirality, hot electrons and chiral plasmonic photochemistry, and more

Alexander O. Govorov

Ohio University

Plasmonic nanostructures and metamaterials are very efficient at the absorption and scattering of light. The studies to be presented in this talk concern special designs of hybrid nanostructures with electromagnetic hot spots, where the electromagnetic field becomes strongly enhanced and spatially concentrated. Overall, plasmonic nanostructures with hot spots demonstrate strongly amplified optical and energy-related effects, and this talk will review some of such phenomena. (1) Using nanoparticle arrays made of different metals, one can transfer plasmonic signals coherently and with minimal losses [1]. (2) Plasmonic hot spots efficiently generate energetic electrons, which can be used for photochemistry and photodetection [2,3,4]. (3) Nanostructures with small interparticle gaps can strongly enhance heat's optical generation and confine high photo-temperatures in small volumes [5,6,7]. (4) Colloidal nanocrystal assemblies and metastructures with plasmon resonances allow us to strongly enhance the chiral optical responses (circular dichroism) of biomolecules and to induce chiral photo-chemical effects [8,9,10,11,12].

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[9] A. Kuzyk et al., Nature 483, 311 (2012). [10] T. Liu et al., Nano Letters, 19, 1395–1407 (2019).
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BIO Sasha

Alexander O. Govorov is a Distinguished Professor of Physics at Ohio University, United States. His research is focused on the theory of optical and electronic properties of nanostructures and bio-assemblies. His theoretical predictions have motivated experiments and have been implemented in many research labs worldwide. Dr. Govorov is a Fellow of the American Physical Society and the European Academy of Sciences (EurASc). He received several international awards for collaboration, including the Bessel Research Award (A. v. Humboldt Foundation), the Walton Visitor Award (Ireland), the 2014 Jacques-Beaulieu Excellence Research Chair Award (INRS, Montreal), etc.

Conférences invitées / Invited lectures

Exploration d'architectures nanométriques pour la photocatalyse hétérogène plasmonique

Jérôme P Claverie

Université de Sherbrooke

Dans un photocatalyseur hétérogène plasmonique, le photocatalyseur semi-conducteur est décoré d'une nanoparticule plasmonique qui agit comme une antenne pour convertir la lumière en porteurs de charge photogénérés. Dans cette communication, nous présenterons nos tentatives de préparation de photocatalyseurs plasmoniques plus actifs pour la production d'hydrogène ainsi que pour la photoréduction de l'azote en ammoniac. Nous démontrerons d'abord que l'installation de résonances en mode galerie au sein du semi-conducteur est une stratégie efficace pour amplifier l'effet plasmonique. La préparation d'une collection de nanoparticules de TiO_2 présentant une ingénierie des facettes et de morphologies uniques a également permis de fournir des lignes directrices pour la conception de photocatalyseurs hautement actifs. Nous présenterons ensuite différentes stratégies pour concevoir des photocatalyseurs plasmoniques exempts d'or, en nous concentrant d'abord sur le cuivre, puis sur le nitrure de titane plasmonique. Enfin, nous présenterons des résultats préliminaires sur la chimie fascinante des oxynitrures de titane.

BIO Jérôme

Jérôme Claverie, originaire de France, a obtenu sa maîtrise à l'École normale supérieure de Lyon et son doctorat à Caltech (États-Unis). Au fil des ans, il a occupé divers postes universitaires en France, aux États-Unis et au Canada. Depuis 2016, il est professeur et directeur du département de chimie de l'Université de Sherbrooke (Québec, Canada). Titulaire d'une chaire de recherche du Canada (niveau 1) en chimie des matériaux organiques et hybrides, il est également, pendant son temps libre, rédacteur en chef de la revue ACS Applied Nano Materials

Gaixia Zhang

École de Technologie Supérieure (ÉTS)

Battery technology plays a pivotal role in achieving a decarbonized future by enabling renewable energy integration, ensuring grid stability, and advancing electrified transportation. Despite significant progress, challenges remain in enhancing the energy density, safety, and sustainability of batteries. Due to their high theoretical capacity (10 times that of commercial graphite anodes in Li-ion batteries), lithium (Li) metal anodes represent a promising solution. However, the commercialization of Li-metal batteries is hindered by Li dendrite formation, which degrades performance and poses safety risks. To address this challenge, we developed a series of cost-effective electrolyte additive strategies to prevent dendrite growth while maintaining compatibility with existing production processes. Further, by employing advanced techniques such as synchrotron-based X-ray absorption spectroscopy and microscopy, we demonstrate a novel interface chemistry that enables safer and more efficient lithium batteries. In parallel, we are exploring alternative battery technologies beyond Li, such as zinc (Zn) and aluminum (Al) batteries, which offer improved sustainability and resource efficiency. Several representative works will be presented, addressing critical issues such as battery material design, component development, and cell assembly. We will cover liquid batteries, flow batteries, and all-solid-state batteries. Finally, we highlight key challenges that remain, including safety management, battery recycling, and the broader implications for supporting the energy transition.

Bio Gaixia

Prof. Gaixia Zhang holds the Canada Research Chair in Energy Devices for Sustainability at École de Technologie Supérieure (ÉTS). She received her Ph.D. from Polytechnique Montréal and subsequently continued her research at Western University, General Motors (US), and INRS. Her research primarily focuses on the design and fabrication of functional materials and energy conversion/storage systems, including batteries, fuel cells, green hydrogen production, and CO2 reduction, as well as their integration into the power grid. Additionally, she is interested in interface and device engineering, in-situ diagnostics of energy systems, and theoretical simulations. She has extensive experience collaborating with industry partners such as GM, Toyota, Ballard Power Systems, NanoXplore, and EleQtrion. She is a member of the Royal Society of Canada (RSC College) and serves on various committees for grant evaluations. She has been the recipient of several prestigious awards, which include the Canadian Light Source Early Career Investigator Excellence Award, DeCarbon Rising Star Award, CAP 20-25 Visiting Scholar, and the Marcelle-Gauvreau Engineering Research Chair. She is listed among the World's Top 2% Scientists (Stanford University, since 2021).

Designing Biomimetic Materials for Cornea Regeneration

May Griffith

Université de Montréal

Inflammation and fibrosis are linked to scarring and, if extensive, organ failure. The human cornea is the transparent front of the eye that transmits 2/3s of the light into the eye for vision. Being superficial, it is prone to infection and injury. Minor wounds usually heal rapidly. However, in aged individuals or compromised ones with chronic health problems (diabetes, peripheral arterial disease, cancer treatment), or if they become infected, they may not heal. Non-healing or chronic corneal wounds can result in fibrosis and scarring. Corneal scars are opaque (white) and block vision, resulting in blindness. Like the cornea, excess fibrosis in the kidneys, liver, and lungs, for example, is associated with organ failure. Organ transplantation is the generally accepted treatment, but there is a severe shortage of donor organs, even for corneas, the most frequently transplanted tissue, with an estimated 1 in 70 patients receiving a corneal graft globally and >50% of nations without eye banking or trained specialists. The cornea's extracellular matrix (ECM) is responsible for the early development of the cornea in embryogenesis, and ECM macromolecules are involved in wound healing. I will be discussing how we can design ECM peptide mimics to stimulate endogenous regeneration, and phosphorylcholine mimics to control inflammation to regenerate the human cornea in animal models and in first-in-human studies.

Bio May

May Griffith is a Professor at the Department of Ophthalmology, University of Montreal, Canada, working at the Maisonneuve-Rosemont Hospital Research Centre. She holds the Canada Research Chair in Biomaterials and Stem Cells in Ophthalmology and the Caroline Durand Foundation Research Chair in Cellular Therapy of the Eye. She is currently the Director of the Emerging Technologies Axis of the Quebec Vision Sciences Research Network. MG is known for pioneering work in translational regenerative medicine and in situ tissue regeneration. She and her team pioneered cell-free biosynthetic implants that promoted corneal tissue and nerve regeneration in a clinical trial showing that the adult cornea can regenerate for the first time. They then incorporated an inflammation-suppressing polymer network into their implants, allowing stable regeneration in patients at high risk of rejecting conventional allografts. Most recently, MG and her team developed a synthetic, biocompatible, and adhesive liquid hydrogel (LiQD Cornea) inspired by dental fillings and vaccines to allow for a revolutionary treatment of patients in the clinic and not the operating room, which can potentially reach the over 12.7 million patients worldwide still waiting for transplantation despite a severe shortfall of tissues. LiQD Cornea is applied as a liquid but quickly adheres and gels within corneal tissue defects, where its similarity at a molecular level to a natural tissue framework promotes tissue and nerve regeneration. MG continues her bench-to-bedside work in cornea regeneration, developing biomimetic biomaterials for regenerative medicine to meet unmet medical needs.

A place for alternative synthetic methods in the development of materials for alternative energies

Thomas Auvray

Université du Québec à Trois-Rivières

Our society has entered a critical and intense transition period, touching all aspects of our lives, with changes needed in our energy sources and their use, our relationship to our environment and our health, in order to adapt to a rapidly evolving global situation. As researcher, communicator and educator, we are in a unique position to tackle some of these challenges, generate new knowledge and communicate them to better inform both the public and the scientific communities, and develop new methods, materials and technologies that would provide solutions to our many urgent needs. That urgency has however created additional problems, as we started by developing solutions that themselves introduced additional challenges (e.g. environmental impact of rare-earth mining or recycling of batteries and e-waste impeded by device design). Considerations around sourcing, design, (re)use and disposal/recovery of materials are integral to the implementation of a material circularity, a core concept of circular economy, and require us to adapt and modify our practices. There are many ways to apply the unique transformative power of chemistry to materials design, and alternative synthetic methods such as mechanochemistry, based on the use of mechanical forces to initiate and sustain chemical transformation, provide a unique opportunity as they offer potential access to new chemical spaces while reducing the environmental impact of material synthesis. To illustrate this and give a preview of the research that will be conducted by my research team, I will present two cases we explored with mechanochemistry and the lessons we learned.

The first example will take us back to the very first steps of material development: sourcing of the starting materials. Developing safer and environmentally friendly methods for the extraction and processing of critical elements is a major challenge of sustainability, economy and technology. Among rare metals, gold occupies a unique place, surrounding us in many forms - from jewellery to electronic devices - with numerous commercial and technological applications, as well as fascinating chemical properties. However, outstanding resistance to chemical attack means that gold processing and recycling rely on particularly aggressive and toxic methods, requiring specialised equipment, safety precautions, and careful waste management. Aiming to improve on the sustainability of these process, we explored mechanochemical activation of metallic gold with alternative oxidants and salts, and developed a fast, straightforward and efficient methods to generate common precursors for gold-based materials.

In a second part, I'll present a collaborative project on the development of 2D-chalcogenide materials used for the electrocatalytic production of hydrogen. Hydrogen is a promising alternative energy source, with high energy density and zero-emission potentials, making it highly suitable for application in mobility (especially for heavier vehicle where battery technologies are not always able to provide the power needed) but also as a transportable low-emission fuel for remote communities, such as those in the North of Quebec and Canada. Through mechanochemical treatments, we obtained materials with mixed composition (based on group 6 metals combined with S, Se or Te) and modified morphologies – exfoliation and phase change induced by strain introduction in the materials. These physico-chemical parameters are known to impact and potentially enhance catalytic activity. Indeed, testing the electrodes prepared by electrodeposition of the mechanochemically-treated materials showed lower overpotential, enhanced kinetics with moderate benefit on stability for water electrolysis.

BIO Tom

Dr. Thomas Auvray is not an stranger for QCAM, being a member since 2014 as a student. He is now assistant professor in Physical Chemistry of Materials at the Université du Québec à Trois-Rivières since November 2024 and regular member of the Institut de Recherche sur l'Hydrogène. He obtained his B.Sc. (2012) and M.Sc. (2014) in Chemistry from Université Pierre et Marie Curie (Paris VI, France), working with Prof. Proust and Prof. Petit on self-assembled binary superlattices based on superparamagnetic nanoparticles and giant polyoxometalates for his final master project. He then moved to Canada where he obtained his Ph.D. in 2020, working with Prof. Garry S. Hanan at the Université de Montréal on the development of supramolecular systems for artificial photosynthesis. After a year as postdoctoral research associate with Prof. Matson at the University of Rochester (NY, US) exploring the use polyoxometalates as ligands for actinide cations, he joined McGill University as a Fonds de Recherche du Québec – Nature et Technologies postdoctoral fellow (2021-2022) working with Prof. Tomislav Friščić (a former QCAM member) on the use of mechanochemistry for the synthesis of coordination compounds and sustainable methods for metal purification. He moved with the Friščić group in 2022 to the School of Chemistry at the University of Birmingham (UK) as senior research fellow, coordinating the group relocation while focusing his research on advancing mechanochemistry for the preparation inorganic and organometallic materials and the use of spectroscopic in-situ methods for the study of mechanochemical processes. He was awarded the 2024 Nina McClelland Memorial Award by the Green Chemistry Institute of the American Chemical Society for his engagement in the development and diffusion of more sustainable laboratory practices.

Conférences vedettes / Featured lectures

Faire découvrir l’étude des matériaux fonctionnels aux élèves du secondaire

Perrine Poisson

Université du Québec à Montréal

En collaboration avec le CQMF, le Cœur des sciences de l’UQAM a développé une activité de transfert de connaissances pour les élèves du secondaire. Objectif : sensibiliser les élèves aux matériaux fonctionnels et à leurs caractéristiques. De cette collaboration est né un Sprint de science, un atelier participatif en ligne, animé en direct par une étudiante chercheuse : Batterie à plat? Branche-toi!
L’activité propose aux élèves, en une période de cours, de réfléchir à la batterie du futur. Quelle serait celle qu’ils aimeraient développer pour leur cellulaire ? En se basant sur de vraies données de recherche, les élèves devront choisir le meilleur matériau pour obtenir la cathode la plus efficace et durable.

BIO Perrine

Perrine Poisson est chargée de projets au Cœur des sciences de l’UQAM. Ce centre culturel scientifique offre de multiples occasions de rencontres entre le grand public et les scientifiques. Perrine coordonne le programme des Sprints de science pour les élèves du secondaire, et développe d’autres événements et activités pour le public adulte et les élèves. Elle gère des initiatives de culture scientifique depuis plus de 18 ans dans différentes institutions. Des plus conventionnelles : festivals, animations, conférences; aux plus originales comme des soirées ciné-science ou des ateliers science et jeux de société.

What Comes After a PhD? From Idea to Job Market

Gad Sabbatier

Axelys & 2nd lab

Goal:
Help Ph.D. students find a **personalized and successful strategy** for impactful employment after their doctorate.
Overview:
The post-Ph.D. journey can be both exciting and uncertain. Many doctoral students and candidates find themselves wondering: *What's next?* This workshop is designed to bring clarity to that question by addressing the mindset of early-career researchers in transition and offering practical tools to confidently approach the job market.
Participants will explore the wide range of career opportunities available to Ph.D. graduates and learn how to align their skills, values, and goals with meaningful roles across sectors.
What You'll Learn:

- **Explore Career Options**
  Discover the diverse professional paths accessible to Ph.D. holders across academia, industry, government, and beyond.
- **Use Self-Reflection Tools**
  Identify your strengths, interests, and values to create a job search strategy that truly fits you.

Outcomes:
By the end of this workshop, you will be able to:

- Clearly understand the career possibilities that align with your background and aspirations
- Apply self-assessment tools to define your professional goals
- Start building a strategy for your job search
- Connect with others who are navigating similar transitions

BIO Gad

Gad Sabbatier a une formation d'ingénieur avec plus de 15 ans d'expérience dans les biotechnologies, les technologies « deeptech » et la RetD. Actuellement directeur Entrepreneuriat et Transfert chez Axelys, Gad est un expert du transfert technologique, de l'accompagnement d'entreprises scientifiques et du développement de produits de technologie de pointe. Il accompagne les chercheurs et entrepreneurs scientifiques dans le développement d'innovation, d'entreprise, et transfert du laboratoire au marché. En tant que cofondateur du 2nd Lab, un incubateur de talents qui aide les chercheurs diplômés et postdoctoraux à construire leurs plan de carrières après le doctorat, en combinant mentorat et développement professionnel.

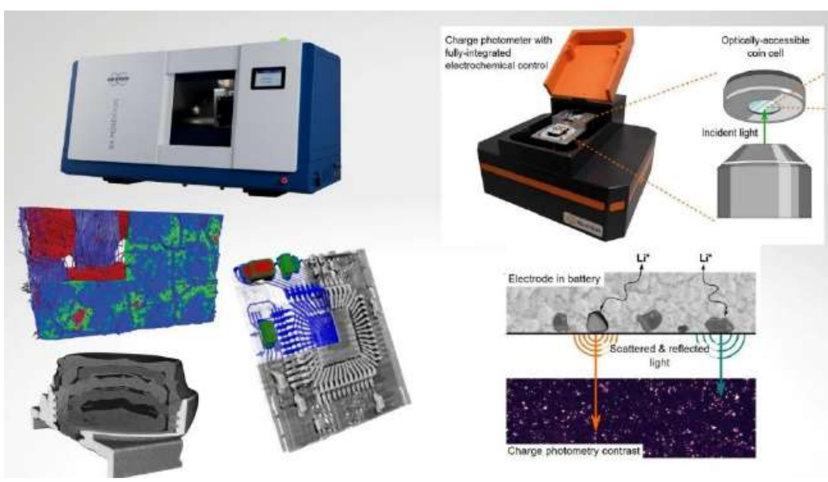
Expanding Scientific Insight through Advanced Imaging Technologies: 3D X-ray Microscopy and Charge Photometry

David Polcari

SFR

Systems for Research (SFR) has proudly partnered with universities, industry, and health science institutions for over 30 years, delivering state-of-the-art scientific instrumentation to advance research and innovation. In line with this mission, SFR has recently expanded its portfolio through new partnerships with Bruker and Illumion, incorporating next-generation technologies that enable deeper insights into complex materials.

This presentation will highlight recent developments in benchtop 3D X-ray microscopy (microCT) and introduce a novel technique known as charge photometry—a light-scattering microscopy method capable of visualizing state-of-charge dynamics in individual active battery particles during cycling. Application examples will be presented in the context of battery research and nanomaterial characterization.



BIO Dave

David Polcari completed his PhD in Chemistry at McGill University with Prof. Janine Mauzeroll, where he focused on using Scanning Electrochemical Microscopy (SECM) to measure the activity of drug-resistant cancer cells. He then moved a few blocks over to UQAM and completed a postdoc with Prof. Steen Schougaard, focusing on lithium diffusion. He joined Systems for Research as a business manager in 2018, and was recently promoted to Director of Business Development. As a small fun fact, David's very first conference as a student was the 1st edition of the CQMF Annual meeting, where Prof. Jerome Claverie presented him with a poster award.

Présentations étudiantes / Student orals

Crystal Structure and Hydrogen Storage Properties of the High-Entropy Alloy $TiZrHfVNb_{1-x}Fe_x$

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Abstract:

High-entropy alloys (HEAs) have attracted significant interest for hydrogen storage applications due to their tunable phase structures and favorable thermodynamic properties. In this study, we investigate the effect of Fe substitution on the microstructure and hydrogen storage performance of $TiZrHfVNb_{1-x}Fe_x$ (x = 0, 0.2, 0.4, 0.6, 0.8, 1) alloys. X-ray diffraction (XRD) and electron microscopy analyses reveal that increasing Fe content leads to the formation of a two phases microstructure consisting of a body-centered cubic (BCC) phase and a hexagonal C14 Laves phase. The fraction of the C14 Laves phase increases with Fe content, enhancing hydrogen absorption kinetics and activation behavior. Hydrogenation experiments demonstrate that the TiZrHfVNb alloy absorbs 2.1 wt.% H_2 at 350°C under 2 MPa H_2, while Fe-containing alloys exhibit improved hydrogenation rates and facile activation at room temperature under 1.2 MPa H_2. This enhancement is attributed to the increased C14 phase fraction, which provides additional hydrogen diffusion pathways and interfacial sites for absorption.

Keywords: High-entropy alloys, hydrogen storage, phase transformation, Laves phase.

Voltametric Measurements in a Room Temperature Ionic Liquid Using Scanning Electrochemical Cell Microscopy

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Scanning electrochemical cell microscopy (SECCM) uses a pipet probe to form a tiny meniscus droplet cell to carry out highly sensitive electrochemical measurements with high spatial resolution [1]. Room temperature ionic liquids (RTILs) have high viscosities and low vapour pressures compared to conventional solvents enabling the formation of a highly stable droplet at the end of a SECCM pipet probe [2]. This has led to the use of SECCM to map a variety of electrode materials including polycrystalline Pt, individual single walled carbon nanotubes, electroactive polymers, Li-ion cathode materials, as well as for single molecule electrochemical detection measurements [3-7]. The mass transport of a redox mediator in a RTIL is highly influenced by solvent viscosity which impacts its diffusion coefficient, and ultimately the voltametric response. While microelectrodes have been used to carry out voltametric measurements in RTILs and achieve a steady state response, this has not been explored in detail using SECCM. Even with the enhanced mass transport using microelectrodes, achieving a steady-state response still requires ultramicroelectrode smaller than 1 μm in size or conducting voltammetric measurements at potential scan rates lower than those theoretically expected for a disk electrode [8]. In the case of SECCM, mass transport rates are a fraction of the value for an equal sized microelectrode [9]. In this work, we will present our results that explore the effect of the pipet diameter, which influences the rate of mass transport, for a ferrocene redox mediator in the RTIL 1-ethyl-3-methylimidazolium tetrafluoroborate to evaluate the conditions where a steady-state response can be achieved to enable the determination of the diffusion coefficient and heterogeneous rate constant at a glassy carbon substrate. The experimental results, validated by finite element simulations, as well as analytical expressions demonstrate that SECCM as an effective and practical tool is capable of performing reliable kinetic measurements in RTIL with excellent reproducibility.

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Unravelling the Impact of Carbon Hosts on Chemistry and Microstructure Evolution in Sulfur Cathodes for High-Performance Solid-State Li-S Batteries

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The energy emission and electrochemical behavior of elemental sulfur rely heavily on carbon hosts in Li-S batteries. The distribution and microstructure of elemental sulfur should be well designed by selecting suitable carbon hosts to achieve high-performance solid-state Li-S batteries (SSLSBs). In addition, enough three-phase contact between sulfur, electrolytes, and carbon hosts is a critical factor which leads to fast ionic/electronic transport in sulfur cathodes. In this study, three typical commercialized caron hosts with different surface areas and porosity were employed to investigate the effects on the performance of SSLSBs. The influence of carbon structure on interfacial behaviors and cathode microstructure evolution was investigated by operando X-ray absorption near-edge spectroscopy (XANES) combined with scanning electron microscopy (SEM). The carbon host structure is shown to have a big influence on performance, carbon hosts with larger specific surface area and porosity result in more electrolyte decomposition and capacity contribution initially, but worse cycling stability and rate performance, whereas carbon hosts with smaller specific surface area and porosity offer the potential for sufficient three-phase contact and better electrochemical performance. The assembled SSLSBs with BP800 exhibit a higher capacity retention of 93.3% after 100 cycles at 0.1 C, and an excellent rate performance, confirming the superiority of carbon host with low specific surface area and porosity.

HIGH-THROUGHPUT DEVELOPMENT OF DOPED Li-RICH Mn-BASED CATHODES

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Abstract

The rapid expansion of lithium-ion batteries (LIBs) to support the global transition to electric vehicles (EVs) and renewable energy systems has amplified concerns regarding the economic, environmental, and geopolitical issues of cobalt-containing cathodes. Li-rich Mn-based layered oxides (LMRs) are considered promising alternatives due to their lower cost, non-toxicity, and energy densities that surpass traditional Co- and Ni-rich materials such as $LiNi_xMn_yCo_zO_2$. However, LMRs face significant barriers to commercialization, with cycling stability remaining the most critical challenge. Of the factors impacting long term cycling, transition metal (TM) dissolution during battery operation remains an important problem, especially in Co-free compositions, and must be addressed to unlock the full potential of LMR materials.

In this work, we employed high-throughput techniques to investigate the structural and electrochemical properties of LMR cathodes doped with 57 different elements. Materials were synthesized at three distinct sintering temperatures. For the first time, TM dissolution was systematically studied using a novel high-throughput test using an accelerated degradation protocol involving a high-temperature voltage hold. This approach provided critical insights into the interplay between structural integrity, electrochemical performance, and TM stability. Ultimately, we systematically studied 171 LMR dopant/temperature combinations, identifying 45 combinations that offered significant improvements with both increased energy density and suppressed TM dissolution compared to undoped materials. Machine learning (ML) techniques were also applied and revealed predictive correlations between structural features, electrochemical properties, and TM dissolution.

These results advance the development of sustainable LMR materials with beyond-state-of-the-art energy densities, addressing key challenges in transportation, electrification and energy storage. Through the integration of high-throughput experimentation and machine learning-driven insights, this work establishes a comprehensive framework to guide the design of next-generation cathode materials, contributing to a future of scalable and sustainable lithium-ion battery technologies.

Detailed *in-situ* analysis of laser induced reduction of Graphene Oxide by Dynamic Transmission Electron Microscope

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Abstract

Graphene oxide (GO), a functionalized derivative of graphene, is a widely used precursor for large-scale production of reduced graphene oxide (rGO) due to its ease of synthesis and dispersion in water. GO's oxygen-containing functional groups can be removed by various reduction methods, including chemical, thermal, and photoreduction techniques. However, chemical methods involve hazardous reagents like hydrazine, while thermal approaches require temperatures exceeding 1000°C, limiting their practical application. Laser-assisted photoreduction offers a rapid, spatially selective, and environmentally friendly alternative, making it ideal for scalable graphene device fabrication.

In this study, we performed in situ laser-induced reduction of GO using a dynamic transmission electron microscope (DTEM) equipped with a 532 nm nanosecond pulsed laser (11 ns duration). The experimental setup, based on a modified JEOL 2100Plus TEM at INRS-EMT, enabled real-time monitoring of the reduction process as laser fluence was varied between 6.36 and 15.88 mJ/cm². GO sheets, prepared via a modified Hummer's method, were deposited onto lacey carbon grids. The photoreduction process was analyzed using electron energy loss spectroscopy (EELS), capturing low-loss and core-loss spectra to quantify changes in oxygen atomic composition. Thickness changes were assessed using the log-ratio method.

Experimental results revealed a strong correlation between laser fluence and oxygen reduction efficiency. Increased fluence led to enhanced oxygen removal, with minimal structural damage observed at optimized conditions. The estimated temperature rise during irradiation ranged from 342°C to 824°C, matching well with the decomposition temperatures of oxygen groups in GO.

In this presentation, we will discuss the photoreduction kinetics, fluence-dependent thickness variation, and temperature modeling. This study demonstrates the power of in situ DTEM for studying laser–matter interactions and provides insights into the development of high-quality rGO for flexible electronics and energy applications.

HIGH THROUGHPUT ELEMENTAL ANALYSIS ON SYNTHETIC PRECURSORS AND MATERIALS FOR DISCOVERY

Michaud Paradis, Marie-Chloé[1]; Özcan, Lütfü[2]; Doucet, François[2]; Rifai, Kheireddine[2]; Chénier, Charles[1]; Rousselot, Steeve [1]; Bertrand, Marc [1]; and Dollé, Mickaël[1,*]
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With the rapid growth of materials discovery and self-driving laboratories, the need for fast, reliable sensors is ubiquitous to the automation implementation. A good sensor for high-throughput discovery must have high acquisition rates, maximize the gain and quality of information, and be low maintenance. Depending on the application field, high-throughput sensors on the market must provide a signal diagnostic of the synthesis yield and targeted properties. For inorganic materials for instance, chemists often rely on X-ray diffraction high-throughput methods to validate lattice structures and then on sensors related to the targeted application (photoemission sensors, electrochemical probes, etc.) However, to validate elemental contents, few high-throughput methods exist. Relying on high-maintenance inductively coupled plasma methods doesn't output elemental contents fast enough and bottlenecks high-throughput and self-driving workflows. Furthermore, bulk digestions of samples don't deliver any information about content homogeneity or diagnostic of the synthesis method. The solution investigated for this study is to use a universal laser-induced breakdown spectroscopy digitalizer to report contents down to low ppm in real-time (i.e. a few seconds per sample to validate contents). The nature of the chemical signal exhibits high sensitivity to even lightweight elements such as lithium, and since the acquisition is done on a point-to-point raster, signals are spatially resolved, meaning homogeneity for instance can be assessed using the same sensor. The methodology has been applied to synthetic precursors and products to report main and trace contents in less than 5 seconds per 10 mg sample.

FIGURE

ÉTUDE DE L'EFFET DE L'APPLICATION D'UN CHAMP ÉLECTRIQUE EXTERNE SUR L'OXYDATION DES SULFURES

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Dans le but d'explorer de nouvelles stratégies de synthèse pour les solides inorganiques cristallins, il est essentiel d'avoir recours à des méthodes non conventionnelles. L'électrosynthèse en phase solide constitue une approche prometteuse, reposant sur l'application d'un champ électrique externe à un échantillon maintenu à haute température. Cette méthode permet notamment de cibler des matériaux non-centrosymétriques, de moduler l'état d'oxydation des éléments présents, ainsi que de générer des défauts structuraux contrôlés. Pour mettre en œuvre cette approche, un four compatible avec l'électrosynthèse, capable d'atteindre 1000 °C, a été installé dans notre laboratoire. Il est équipé d'un creuset en platine (anode) et d'un filament en platine (cathode), l'ensemble étant connecté à un potentiostat permettant l'application de tensions allant jusqu'à 10 V. Les composés sulfurés représentent d'excellents systèmes modèles pour étudier les processus d'oxydation sous champ électrique. Nous avons ainsi choisi d'étudier le ZnS, un semi-conducteur bien connu cristallisant dans une structure cubique de type Fm-3m. Une série d'expériences à haute température a permis d'obtenir différentes phases cristallines de sulfates et d'oxysulfates de zinc ($Zn_3O(SO_4)_2$, $ZnSO_4 \cdot H_2O$, $ZnSO_4$), résultant de l'oxydation du ZnS et de son interaction avec le platine. Le suivi de la cristallisation, en fonction de la température, de la durée de traitement et du potentiel appliqué, a permis de contrôler l'évolution structurale des phases formées. Ces travaux mettent en lumière le rôle déterminant du champ électrique dans la maîtrise des processus d'oxydation, la modulation de leur cinétique, ainsi que dans la formation de nouvelles phases sulfatées à partir de composés sulfurés.

OPTIMIZATION OF PHOTOACTIVE COATINGS FOR ENHANCED LIGHT-ASSISTED BATTERY CHARGING

RUPINDER KAUR[1], ELSA BRIQUELER, MOHAN RAJ, MICKEL DOLLE* and WILL SKENE[2,*]

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Meeting global energy demands through renewable sources is an urgent priority, with solar energy standing out due to its abundance, sustainability, and non-polluting nature. However, its variability and intermittency require efficient storage solutions to ensure consistent power availability. One promising approach is the development of photo-rechargeable batteries, which integrate solar harvesting and energy storage in a single system by storing energy at the molecular level.

This study focuses on the design of a photoactive polymer-based coating that facilitates light-assisted battery charging. By directly incorporating light-absorbing materials into the battery structure, these coatings eliminate the need for separate photovoltaic devices and improve overall system compactness and efficiency.

In this study, we focus on the development of a photoactive coating designed to facilitate light-assisted battery charging at the molecular scale. This study will assess the synthesis of the molecular components of the coating, which both absorb solar energy and efficiently transfer it into the electrochemical system of the battery.

Additionally, we will explore the methods of incorporating these photoactive materials into a functional coating, which encapsulates and interfaces with the active battery components. The research will also analyse the photophysical and electrochemical properties of these coatings, shedding light on how varying polymer loadings impact light absorption and charge storage capabilities. This work will provide crucial insights into optimizing the design of photoactive coatings for enhancing both the efficiency and compactness of solar energy storage systems, paving the way for more sustainable, high-performance solutions for on-demand electricity.

This work contributes to the advancement of integrated solar energy solutions, supporting sustainable, reliable electricity generation—particularly in regions lacking traditional power infrastructure.

EXPLORING LIQUID ASSISTED RESONANT ACOUSTIC MIXING TO SYNTHESIZE OF ACTIVE CuO_X/TiO_2 NANOPARTICLES FOR PHOTOCATALYTIC HYDROGEN GENERATION

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Conventional methods for synthesizing catalytic materials usually involve utilizing large volumes of solvents, auxiliary substances, and additives to give the desired properties and reactivity to the final products. Consequently, these routes imply the production of waste with potential negative impacts on the environment and living organisms [1]. In this regard, mechanochemical, solvent-free, and biological methods emerge as interesting options for producing these materials, offering advantages from the point of view of their environmental impact, mainly owing to the reduction of wastes produced and the more efficient use of energy. In the last decade, resonant acoustic mixing (RAM), has been widely reported as an alternative to traditional mechanochemical methods to produce pharmaceuticals, cocrystals, and MOFs, as well as for coupling reactions catalyzed by metals in direct mechanocatalytic routes [2]. However, its implementation for synthesizing heterogenous catalysts and photocatalytic semiconductors is still limited.

In this work, a simple, liquid-assisted resonant acoustic mixing (RAM) process to produce CuO_x-modified TiO_2 heterostructures was explored. The proposed route of synthesis involved a mixture of precursors and a neglectable amount of water, resulting in the elimination of unnecessary work-up stages. RAM acceleration and water content were adjusted to achieve the most homogenous catalysts that show a significant enhancement in photocatalytic hydrogen generation compared to pure TiO_2. These promising results open the possibility to further explore RAM-based methods as greener synthesis routes for the obtention of a wider diversity of materials.

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New Photosensitizers for the Photochemical Production of Hydrogen

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The recent climate crisis has focussed attention on the need for green and affordable energy; however, many avenues are available to produce green energy. One of the most promising ways is the photocatalyzed production of hydrogen, as sunlight is the most abundant and widely available energy source on Earth. The development of novel molecular platform then becomes necessary to harness such energy emitted from our sun. The development of a highly stable tridentate polypyridine-based ligand bearing three exterior pyridine moieties, 4,4',4''-(4'''-pyridyl)-2,2':6',2''-terpyridine (py$_3$tpy), allows for easier electron transfer to the cobalt catalyst for hydrogen evolution. The synthesis and characterisation of the resulting complex with ruthenium will be presented as a photosensitizer for the hydrogen evolution reaction (Figure). It displays high photostability (> 10 days) and photoproduction of hydrogen at different wavelengths of light (445 nm, 495 nm and 630 nm).

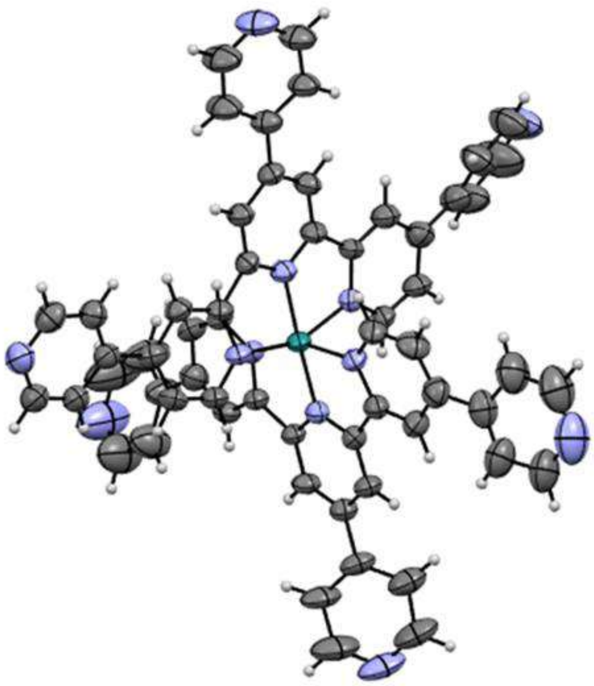

Figure: Single-crystal-X-ray diffraction of the presented Ru(py$_3$tpy)$_2$(PF$_6$)$_2$ complex

THE REMARKABLY HIGH PHOTOCATALYTIC EFFICIENCY OF ULTRA-THIN POROUS GRAPHITIC CARBON NITRIDE NANOSHEETS

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your abstract / votre résumé

(300 words - maximum 1page)

Graphitic carbon nitride (g-C_3N_4) is a metal-free photocatalyst that is widely used for visible-light-driven hydrogen production, CO_2 reduction, and the degradation of organic pollutants. Its most appealing feature is its activity under visible light, complemented by benefits such as thermal and photochemical stability, cost-effectiveness, and straightforward large-scale synthesis. However, its performance is hindered by low absorption at longer wavelengths within the visible spectrum and high rates of charge recombination. Additionally, exfoliated nanosheets of g-C_3N_4 tend to aggregate, which reduces the specific surface area and, in turn, its photocatalytic activity. To enhance photocatalytic performance, 2D g-C_3N_4 nanosheets significantly improve light absorption and increase surface area. The incorporation of pores further enhances the specific surface area, active sites, and charge separation, rendering these nanosheets more efficient than bulk g-C_3N_4 in photocatalytic applications. In this presentation, I will detail our work on the synthesis of ultra-thin, porous g-C_3N_4 nanosheets aimed at overcoming these limitations and improving photocatalytic performance. By optimizing a novel multi-step synthetic protocol that includes an initial thermal treatment, the application of nitric acid (HNO_3), and an ultrasonication step, we successfully obtained very thin and well-tuned materials. These materials exhibited exceptional photodegradation performance of methyl orange (MO) under visible light irradiation, degrading approximately 96% of MO in just 30 minutes, which corresponds to a normalized apparent reaction rate constant (k) of 1.1 $\times$ 10^{-2} $min^{-1}mg^{-1}$. This is the highest k value ever reported for C_3N_4-based photocatalysts in the degradation of MO, based on our extensive literature review. The ultrasonication process in acid not only prevents the agglomeration of g-C_3N_4 nanosheets but also aids in tuning the pore size distribution, which contributes significantly to this achievement. We also explored their performance in photocatalytic hydrogen evolution reactions (HER), achieving a production rate of 1842 μmol h^{-1} g^{-1}.

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ÉVALUATION DE LA CORROSION ÉLECTROCHIMIQUE DES ALLIAGES A HAUTE ENTROPIE BASE TITANE POUR APPLIACATION DENTAIRE

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Résumé

Les alliages à haute entropie (HEA) à base de titane émergent comme de nouveaux candidats pour les implants dentaires à diamètre réduit en raison de leur excellente résistance à la corrosion dans des milieux physiologiques. Cette étude évalue les comportements électrochimiques de deux nouveaux alliages HEA à base de Ti, TiZrHfNbTa et TiZrHfNb0.4, et les compare avec les alliages commerciaux Ti et Ti6Al4V dans de la salive artificielle (SA) et de la salive artificielle contenant du fluorure (SAF) à 37°C. Des évaluations électrochimiques, comprenant la polarisation cyclique, la spectroscopie d'impédance électrochimique (EIS) et l'analyse Mott-Schottky, ont été complétées par des analyses de surface (SEM, AFM) pour examiner les mécanismes de dissolution et de passivation. Les résultats ont montré que TiZrHfNbTa présentait la densité de courant de corrosion la plus basse (18,38 nA dans SA), le potentiel de corrosion le plus élevé (300,1 mV) et une résistance supérieure à la formation de piqûres, en raison de la formation d'un film passif stable enrichi en Ta_2O_5. Le TiZrHfNb0.4 a également montré une excellente passivation, avec la densité de courant de corrosion la plus basse (6,976 nA) et le potentiel de piqûre le plus élevé (2,0 V) en raison de la formation de HfO_2. En revanche, les alliages CP-Ti et Ti6Al4V étaient plus susceptibles à la corrosion localisée, comme l'indiquent des densités de courant plus élevées et des potentiels de piqûre plus faibles. Les résultats de l'EIS ont révélé que les deux HEAs possédaient une résistance au transfert de charge plus élevée, et l'analyse Mott-Schottky a confirmé la meilleure stabilité de leur film passif. L'ajout de fluorure à la solution SAF a causé une dégradation des films passifs, mais TiZrHfNbTa a maintenu une meilleure résistance à la corrosion, bénéficiant de l'effet synergique du Ta et du Nb dans la stabilisation de la couche d'oxyde.

FIGURE

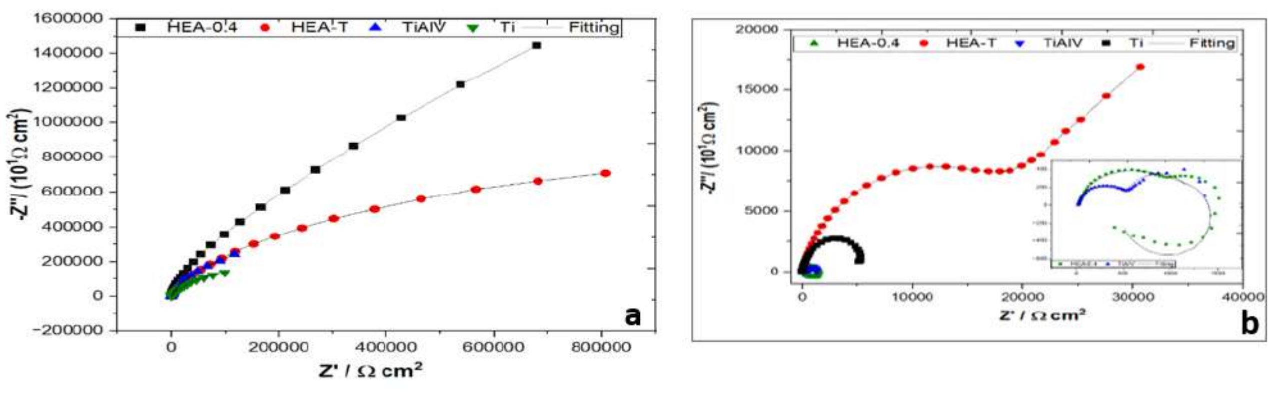

Figure : Montre les résultats de la spectroscopie d'impédance électrochimique : a) dans une solution de salive artificielle, et b) dans une solution de salive artificielle avec fluorure.

Isomeric π-conjugated thiophene cores for 2D Covalent Organic Frameworks made via solvothermal and mechanochemical methods

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The metallic nature of graphene makes it unsuitable for most electronic applications requiring a semiconducting (non-zero) band-gap. In 2005 Yaghi *et al*.[1] introduced a new family of crystalline, porous materials called Covalent Organic Frameworks (COFs), which raised hopes of making 2D π-conjugated materials from molecular building blocks, allowing tuning their band gap and other optoelectronic properties.[2] 2D COFs with sheet-like layers and π-stacking interlayers enable efficient charge transfer, making them promising for optoelectronics.[3] However, limited precursor options drive efforts to expand COF synthesis. Thiophene-based polymers are known for their optical, conductive, and chemical properties, and incorporating them into COFs enhances conductivity and photocatalytic activity. Despite their use in semiconductors, thiophene cores lack diversity. Tetragonal topologies often show strong conductivity and magnetic properties,[4] but twisted structures can hinder π-electron delocalization. We study isomeric planar tetrathienonaphthalane (TTN) aldehydes namely 2TTN and 3 TTN, beside asymmetric benzotrithiophene (As-BTT) core and the corresponding symmetric one (S-BTT).

This presentation will discuss π-conjugated 2D COFs based on TTN and BTT cores, including design of the monomers, their synthesis and polymerization *via* solvothermal and mechanochemical aldol condensation reaction. The characterization of the materials is based on established methodologies in the field (e.g., PXRD, FTIR, NMR, ...), while the optoelectronic properties of the materials are investigated via absorption, and conductivity measurements.

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CHARACTERIZATION OF POLY(HYDRAZINOPHOSPHINE DIAZIDE)S (PHPDS): THERMAL AND MECHANICAL PROPERTIES

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The omnipresence of polymers in modern materials drives the pursuit of optimized properties, which are directly influenced by the molecular structure of monomers and the microstructure of polymers. While polymer chains composed of one-dimensional motifs or incorporating two-dimensional rings have been extensively studied, those containing three-dimensional units, such as molecular cages, remain relatively unexplored. This project investigates the use of rigid three-dimensional structures, referred to as «cages» composed of nitrogen and phosphorus, to develop new polymers and analyze their physical properties. More specifically, we examine how variations in the functional groups surrounding these cages influence material properties, highlighting a new family of polymers enriched with inorganic cages developed in the Chitnis group: poly(hydrazinophosphine diazide)s (PHPDs). These polymers are characterized by remarkable thermal stability as well as varying thermal transitions depending on the chain composition. These polymers exhibit decomposition temperature exceeding 200°C and glass transition temperatures higher than those of analogous polymers lacking these molecular cages. This allows PHPDs to perform effectively at elevated temperatures. Moreover, the integration of these cages imparts unique structural properties, such as increased lightness and rigidity, which are essential for materials intended for demanding environments. To further elucidate the contributions of molecular cages, mechanical property analyses will also be conducted on polyethylene oxide (PEO) without cages, enabling a direct comparison with cage-containing PEO chains. These findings underscore the potential of inorganic molecular cages to inspire the design of innovative, robust, and lightweight polymers, paving the way for new applications in extreme or specialized conditions.

ANTIFOULING MEMBRANES BASED ON GAS-RESPONSIVE CHARGE-SWITCHING

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Abstract:

Membrane fouling, particularly by proteins, remains a critical limitation in pressure-driven separation processes, including those employed in the dairy and biopharmaceutical sectors. A promising approach to mitigate fouling is the development of membranes with stimuli-responsive surface functionalities that allow reversible modulation of surface charge and wettability. Among various triggers, carbon dioxide (CO_2) is particularly attractive due to its non-toxicity, low cost, and environmental compatibility. In this work, we report a novel CO_2-responsive charge-switchable membrane with antifouling properties, fabricated via the nonsolvent-induced phase separation (NIPS) method. The membrane incorporates an amphiphilic block copolymer comprising a hydrophobic segment to ensure structural integrity and a hydrophilic copolyelectrolyte segment containing both weak acidic and basic moieties, which enable reversible charge-switching behavior in response to CO_2/N_2 exposure. Upon CO_2 bubbling, the membrane surface transitions from negatively to positively charged due to protonation of the basic groups, while subsequent N_2 purging removes dissolved CO_2, reversing the surface charge to its original state. This reversible tuning of surface charge enables the electrostatic repulsion of foulants and membrane surface during cleaning. This CO_2-responsive system offers a sustainable and efficient green strategy to reduce membrane fouling, lower cleaning needs, and increase membrane lifetime. This work expands the scope of CO_2-responsive materials and offers new possibilities for adaptive membrane technologies.

RECONDITIONNEMENT DES CONSOMMABLES PLASTIQUES DE LABORATOIRE : IMPACTS DU NETTOYAGE ET DE LA STERILISATION SUR LEURS PROPRIETES PHYSICO-CHIMIQUES ET MECANIQUES.

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Les laboratoires de biotechnologie ont un impact environnemental significatif en raison de leur utilisation massive de consommables jetables tels que les pipettes et plaques de culture cellulaire. En 2014, ces laboratoires généraient mondialement 5,5 millions de tonnes de déchets plastiques par an, qui finissaient généralement incinérés, impliquant ainsi un grand dégagement de CO_2.

Ce projet, en partenariat avec Polytechnique Montréal, le Collège Montmorency et Phoenix Impact, vise à évaluer l'impact du reconditionnement sur ces consommables plastiques. Les objectifs incluent : 1) développer une batterie de tests pour caractériser les consommables neufs (référence pour comparaison avec les reconditionnés), 2) évaluer l'impact du nettoyage (procédé de Phoenix Impact), de la stérilisation (oxyde d'éthylène) et du cumul sur les propriétés des plastiques et 3) identifier le nombre maximal de réutilisations pour chaque consommable.

Les tests ciblés permettent de déterminer les propriétés mécaniques (résistance à la traction, perforation), thermiques (DSC), physico-chimiques (FTIR, XPS, SEM, spectrophotométrie UV-Vis, colorimétrie) et de surface (angle de contact) des consommables à base de : polypropylène, polystyrène (avec et sans traitement de surface), polyéthylène, ainsi que polycarbonate, après chaque cycle de reconditionnement (10 cycles visés).

À ce stade, la géométrie des échantillons pour la réalisation des divers tests décrits ci-dessus a été optimisée. Le polypropylène neuf présente un module de Young de 141 MPa et un module de cisaillement de 156 MPa alors que le polystyrène testé donne un module de Young de 222 MPa et un module de cisaillement de 155 MPa. L'analyse FTIR montre un accord de 89% entre le polypropylène testé et le polypropylène atactique et une concordance de 70% du polystyrène testé avec le polystyrène atactique, suggérant que ces consommables étudiés sont des composites. Les autres tests pour les consommables neufs sont en cours et les résultats des consommables reconditionnés seront obtenus dans les mois à venir. Ils permettront d'évaluer le potentiel du procédé pour une transposition à grande échelle.

Ce projet encouragera l'adoption de pratiques écoresponsables en biotechnologie, tout en assurant la sécurité et la conformité des matériaux reconditionnés selon des standards rigoureux.

HYBRID ICEPHOBIC STRATEGIES IN POLYURETHANE COATINGS: SOLAR ASSISTED AND SELF-LUBRICATION

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Ice accumulation on surfaces causes considerable operational and safety challenges across various industries. This study presents an innovative method by developing hybrid icephobic polyurethane (PU) coatings that utilize both photothermal strategies and self-lubricating properties. PU coatings are widely utilized due to their excellent mechanical strength and durability, making them a promising matrix for advanced functionalities[1]. This adaptability allows PU coatings to be modified to improve icephobicity and passive anti-icing. Among passive approaches, self-lubricating coatings have emerged as a promising approach by reducing ice adhesion and facilitating easy removal.

The initial phase of this study involved the integration of PEG/PDMS copolymers into PU matrices to develop self-lubricating coatings. These copolymers promote the formation of a quasi-liquid layer (QLL) at the ice–coating interface, significantly lowering ice adhesion strength to below 100 kPa compared to 273 kPa for the unmodified PU coating. Molecular weight, chemical structure, and concentration of PEG/PDMS copolymers critically influence anti-icing performance. Incorporating these copolymers also enhances flexibility and decreases Young's modulus, both associated with improved icephobicity. While lowering ice adhesion strength is crucial, efficient de-icing remains essential for real-world applications[2]. Mechanical and chemical de-icing methods are inefficient and damaging, making photothermal coatings attractive for autonomous ice removal due to their localized heating and autonomous ice removal under solar irradiation. To enhance active de-icing capabilities, the second part of this study developed photothermal PU coatings by dispersing various iron oxide nanoparticles. Ice adhesion strength, particularly after photothermal activation, dropped substantially, with PU- 10% silicon oil coated Fe_3O_4 achieving the lowest ice adhesion at 40 ± 8 kPa. Nevertheless, photothermal coatings are limited by their dependence on sunlight intensity and duration, and the potential for refreezing if the meltwater is not efficiently removed from the surface after de-icing[3].

The third section of this investigation focused on developing a hybrid PU coating by simultaneously incorporating photothermal and self-lubricating features to enhance overall icephobic performance. Hybrid coatings containing 10% Fe_3O_4 nanoparticles and PEG/PDMS copolymers provide rapid solar-assisted de-icing how rapid and low ice adhesion through lubrication. Notably, under simulated solar illumination, complete ice detachment occurred within 5 minutes solely under the influence of gravity on a surface inclined at 30°, demonstrating the coating's ability to passively activate photothermal de-icing without the need for mechanical intervention.

Keywords: Icephobic Coating, Polyurethane, Photothermal effect, Self-lubrication, Hybrid coatings

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DIW 3D Printing of 2D material-based Nanocomposites with Tunable Mechanical Properties

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Our study presents a novel approach to 3D freeform printing of 2D material-based nanocomposites with tunable mechanical properties using direct ink writing (DIW) combined with interfacial polymerization (IP). Traditional DIW methods face challenges in fabricating unsupported structures due to limitations in curing depth and structural stability. By integrating IP into the DIW process, we enable rapid in-situ solidification of 2D material-laden inks, such as graphene oxide (GO), through a chemical reaction at the interface of immiscible solutions. This method allows for the creation of freestanding, mechanically robust structures without the need for external supports. The process involves the extrusion of a shear-thinning ink containing GO and a polymer precursor, followed by the atomization of an organic solution that initiates polymerization upon contact. The resulting nanocomposites exhibit high structural integrity, with the ability to print complex geometries, including overhangs and cantilevers, at various scales. The mechanical properties of the printed structures can be tailored by selecting different polymers and 2D materials, such as Kevlar, Nylon, and MXene. This work demonstrates the potential of IP-assisted DIW 3D printing as a scalable and customizable method for producing lightweight, high-strength nanocomposites with intricate geometries.

Macroscale Hierarchically Structured Protein Fibers from Self-Assembling Recombinant Tobacco Mosaic Virus Coat Protein

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Biological organisms have emerged as crucial model systems for the development of next-generation sustainable materials. The hierarchical self-assembly of proteins observed in spider silk and mussel byssus has been shown to result in their greater toughness and adhesion, respectively, than current petroleum-based polymers. Viruses offer an exciting path for the advancement of these protein self-assembling structured materials. The supramolecular chemistry guiding their capsid formation can inspire the design of macroscale materials with novel hierarchical structures. The Tobacco mosaic virus (TMV) is of particular interest due to the well-characterized self-assembly of its capsid coat protein (TMVcp) into various conformations, such as disks and helical rods. Additionally, the latter can be further organized as a lyotropic (i.e., concentration dependent) liquid crystal. Interestingly, recombinantly produced TMVcp self-assembles into quaternary structures despite the absence of its viral genome, where the dominant conformation is determined by the solution physiochemical properties. Our lab has successfully formed reproducible hierarchically structured macroscale protein fibers from self-assembled recombinant TMVcp. These virus-like particles form hierarchical structures previously unreported in literature through solvent evaporation using the drying droplet technique. Methods such as confocal Raman spectroscopy, polarized light microscopy (PLM), transmission electron microscopy (TEM), and synchrotron X-ray diffraction (SAXS/WAXD) have been used to characterize the self-assembly process and the resulting protein fiber structures. Interestingly, recent experimental results show that the fiber hierarchical structure can be reproducibly modified based on initial TMVcp quaternary conformation (monomer, disk and helical rod), as well as offering recyclability through redissolution in various aqueous solutions. Furthermore, in-situ experiments seem to indicate the transition of the recombinant TMVcp suspension to a liquid crystal prior to final fiber formation which has not been previously seen in TMV virus-like particles. Ultimately, this research highlights the use of virus capsid supramolecular chemistry in protein building block self-assembly for advanced material design as an alternative to fossil-fuel-based synthetic polymers. This novel TMVcp hierarchically structured fiber with potentially tunable optical and mechanical properties has promising applications in biomedicine, plasmonics, and optoelectronics.

SUSTAINABLE SYNTHESIS OF ULTRATHIN TWO-DIMENSIONAL (2D) MIL-53(Al) NANOSHEETS

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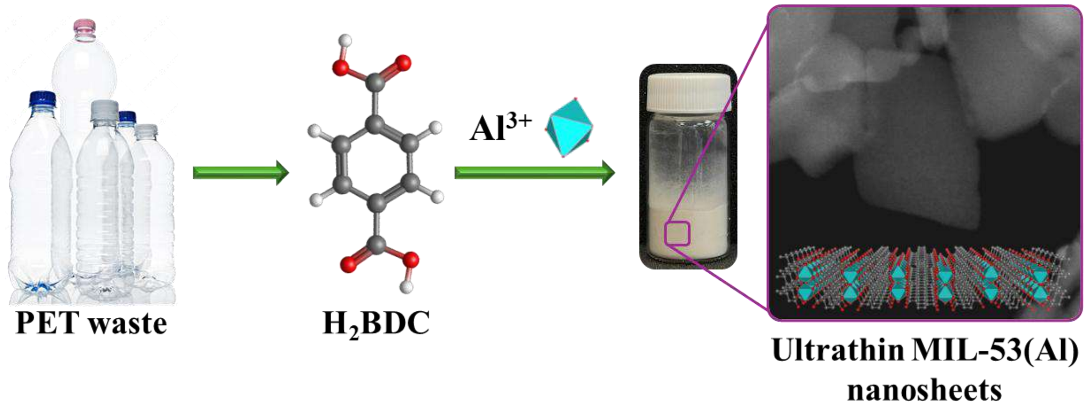
Abstract:

Two-dimensional metal-organic frameworks (2D MOFs) have been studied widely thanks to advantages over their three-dimensional (3D) counterparts including enhanced specific surface area, boosted electrical conductivity, improved mass transfer and better chemical stability. MIL-53(Al) is one of the most powerful MOFs, and it is well known for a strong 3D structure. Until now, only several studies have reported the successful synthesis of its 2D architecture using organic solvents and exfoliation methods. In addition, no discovery of its 2D crystal structure is reported. This study is the first successful endeavor in synthesizing the ultrathin 2D MIL-53(Al) nanosheets through a sustainable approach and exploring its structure at an atomic scale. The synthesis process uses plastic waste as a precursor source, and synthesis conditions are optimized to obtain the material with desirable properties. Structural features are then clarified by advanced techniques consisting of scanning transmission electron microscope (STEM) and atomic force microscopy (AFM). The material shows great surface area, good thermal stability and the 2D form of ultrathin nanosheets with an angstrom thickness (6.7 Å), which are beneficial for various applications such as adsorption, electrochemistry and catalysis. This finding provides a well-prepared 2D MOF for further research strategies as well as stimulates more efforts focusing on designing 2D MOFs via green protocols.

Graphical abstract:



Chemical Modification of Wood Using Whey Ultrafiltration Permeate and Biosourced Acids: A Circular Economy View

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Abstract

Chemical modification of wood has gained increasing attention in recent years, with polyesterification emerging as a promising approach. This method improves the dimensional stability, reduces moisture uptake, and enhances the durability of wood. However, it has been mostly studied on European wood species. Therefore, this study investigates the polyesterification of North American wood species using whey ultrafiltration permeate, a lactose-rich coproduct of the cheese industry that is abundantly available in North America. The whey ultrafiltration permeate was combined with two different biosourced acids, citric and malic acids, to prepare aqueous treatment solutions. Four North American wood species were treated with these solutions, while water-treated samples served as a control. The results showed improved physical and hygroscopic properties, along with enhanced thermal stability, attributed to the calcium phosphate present in the whey permeate. No significant changes in bending strength were observed compared to untreated samples, likely due to impregnation limitations. Surface hardness showed a slight increase relative to untreated wood. Between the two acids tested, no major differences were observed in the overall performance. However, citric acid led to slightly better results than malic acid, likely due to its molecular structure enabling a higher cross-linking density. These findings not only demonstrate the potential of this polyesterification process to enhance the properties of North American wood species but also offer a sustainable pathway for the valorization of dairy industry coproducts.

BIOFABRICATION OF PERFUSABLE STEM CELL-DERIVED PANCREATIC TISSUES VIA SACRIFICAIL EMBEDDED WRITING

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Type 1 diabetes (T1D) is an autoimmune disorder that leads to the destruction of insulin-producing pancreatic beta cells. Islet transplantation has emerged as an alternative to insulin therapy, with stem cell-derived islets offering a promising biomanufactured cell source. However, significant islet loss occurs after transplantation into the liver, highlighting the need for alternative vascularized or oxygenated transplantation sites. One potential solution is engineering pancreatic tissues with pre-established vascular networks using bioprinting.
Instead of conventional layer-by-layer bioprinting, which requires self-supporting bioinks and prolonged build times for human-scale tissues, we introduce a novel embedded writing approach. We developed a cytocompatible hydrogel support matrix using partially gelled alginate, a material commonly used for islet encapsulation. The self-healing properties of different alginate formulations were characterized, yielding a tunable yield stress (11.0±0.6 to 51.0±3.5 Pa) and rapid recovery of solid behavior (61.6±8.2% within 10 seconds). Using this matrix, Pluronic F127 filaments were embedded via 3D printing, followed by gelation in a calcium bath and subsequent liquefaction of the Pluronic to create perfusable, multi-branched internal flow networks.
This method enabled the fabrication of thick, centimeter-scale, cell-laden hydrogel constructs with up to 10 perfusable channels. Cell viability exceeded 90% post-printing, and MIN6 cells remained viable within a 600±85 μm radius around each channel after 48 hours of perfusion. To validate this approach with therapeutically relevant cells, pluripotent stem cells (H1) were differentiated into islet-like clusters (PSC-islets) containing C-peptide-positive (glucagon-negative) cells. PSC-islets remained viable for over 25 days under perfusion, demonstrating glucose-responsive insulin secretion.
This biofabrication technique provides a streamlined strategy for creating perfusable, human-scale bioartificial pancreatic tissues. These constructs could be further optimized for transplantation or utilized to study the impact of oxygenation and 3D microenvironments on cell fate decisions.

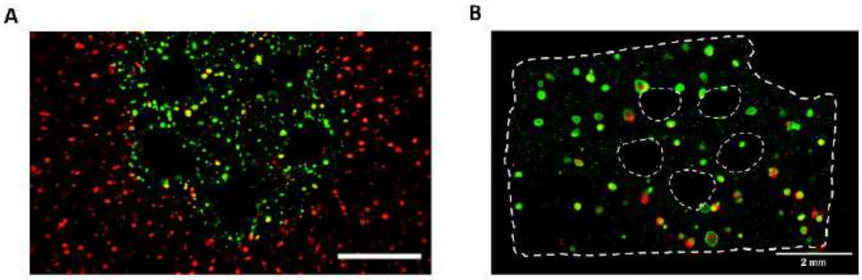

Figure 1. Live/Dead staining of cross-section of 3D perfusble construct containing MIN6 aggregates (A) and PSC-islets (B) (red/green present dead/live respectively)

TOWARDS TRACEABLE SOFT NANOPARTICLES : A BENZOXANTHENE TOOLBOX FOR THE IMAGING OF NANOCARRIERS FROM MIKTOARM STAR POLYMERS

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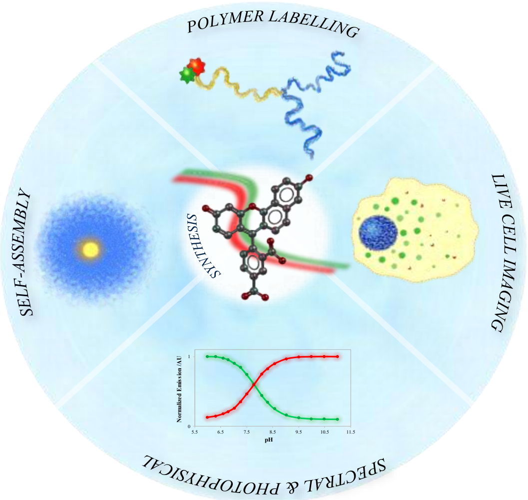
Soft nanoparticles continue to play a significant role in developing valuable therapeutic interventions in high morbidity rate diseases. While linear block copolymers have been widely investigated for the design of functional nanoformulations, the architecture and composition of the polymeric precursors to soft nanoparticles have been demonstrated to be central to tailoring their properties. Our group has utilized miktoarm star polymers, a branched architecture capable of optimizing performance in controlled release while offering a high degree of customizability. The overall clinical success of nanomedicines is intertwined with their mechanism of cellular internalization and subcellular localization, with fluorescence based tools having been extensively utilized for tracing their biological fate with a high degree of spatiotemporal resolution. Seminaphthofluorescein-C (benzo[c]xanthene SNAFL-C) is a unique and historically underutilized fluorophore resulting from careful extension of the xanthene skeleton of fluorescein. We sought to confer the exceptional features of SNAFL-C to polymeric soft nanoparticles while increasing ease to access of the fluorophore *via* practical synthetic information and a streamlined isomer separation method. Fluorescent nanoformulations of SNAFL-C were prepared both by ligation to polymer precursors and physical encapsulation, providing an ideal platform for direct comparison. Through detailed spectral and photophysical characterization, we demonstrate the necessity of a holistic and individualized understanding of each formulation prior to application in live cell fluoresence imaging. Beyond practical imaging utility, these systems provided new avenues to explore the nuances of xanthene behaviour in polymeric micelles, insights of broad importance to the fabrication of traceable soft nanoparticles for drug delivery and theragnostics.



Reinforcement learning for plasmonic nanomaterial discovery and sensing

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In a research landscape increasingly shaped by artificial intelligence (AI), we aim to accelerate the discovery and optimization of plasmonic nanomaterials for next-generation nanosensors. Surface-enhanced Raman scattering (SERS) is a non-invasive (bio)analytical technique that detects the vibrational signatures of molecules as they interact with a plasmonic nanostructured surface. Our aim is to develop highly sensitive SERS sensors optimized for near-infrared (NIR) light sources, due to their greater tissue penetration and suitability for biological analysis. This work focuses on advancing SERS-based chemical sensing through AI-driven nanomaterial innovation.

We have optimized the production of SERS substrates, gold nanostars (AuNS)—and have shown their highly tunable morphology in a continuous flow system. This setup allows precise control over AuNS optical responses influenced by its morphology via surface plasmon resonance (SPR), producing particles with optical responses spanning the visible to the NIR region (600 to 1100 nm), perfect for our goal of designing NIR SERS substrates. We validated this approach through electron microscopy, in-line and off-line UV-Vis spectroscopy, and COMSOL flow simulations, which together reveal how fluid dynamics and reaction conditions govern AuNS growth mechanisms.

Our in-line UV-Vis cell provides real-time SPR spectral monitoring and provides a platform for reinforcement learning (RL), one which we can iteratively learn and adapt the AuNS growth conditions—such as reagent pump speeds—to achieve a target reward SPR. The RL reward function is defined as the desired optical response and is experimentally realized through dynamic control over precursor concentrations and Reynolds numbers via programmable pumps. This interdisciplinary effort, bridging chemistry and computer science, lays the foundation for automated, AI-guided development of advanced plasmonic sensing platforms.

Affiches / Posters

NITROGEN-COORDINATED COBALT ATOMS AS HIGHLY ACTIVE AND DURABLE ORR/OER CATALYSTS FOR RECHARGEABLE ZN-AIR BATTERIES

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The development of inexpensive, highly active and stable non-noble-metal catalysts for the oxygen reduction reaction (ORR) is critical for the practical applications of electrochemical energy conversion devices, while grand challenges remain. Herein, we report a facile ammonium salt etching strategy to construct an electrocatalyst with atomically dispersed Co sites embedded on N-doped porous carbon (CoNC), which demonstrates excellent ORR performance in alkaline electrolyte. The NH_4Cl-treated catalyst exhibits equivalent or even better ORR performance than those of commercial Pt/C catalyst, for example, with an onset potential of 1.06 (vs 1.01 V for Pt/C) and half-wave potential of 0.893 V (vs 0.873 V for Pt/C). Additionally, methanol tolerance tests show that the CoNC catalyst is immune to methanol poisoning in actual operation, which is much better than the Pt/C catalyst. Moreover, this NH_4Cl-treated CoAC catalyst is stable in a long-term operation up to 110 h, which is superior to most Co-based catalysts. This work provides a promising strategy for the synthesis of next-generation highly active and durable Pt-free ORR catalysts for Zn-air batteries and beyond.

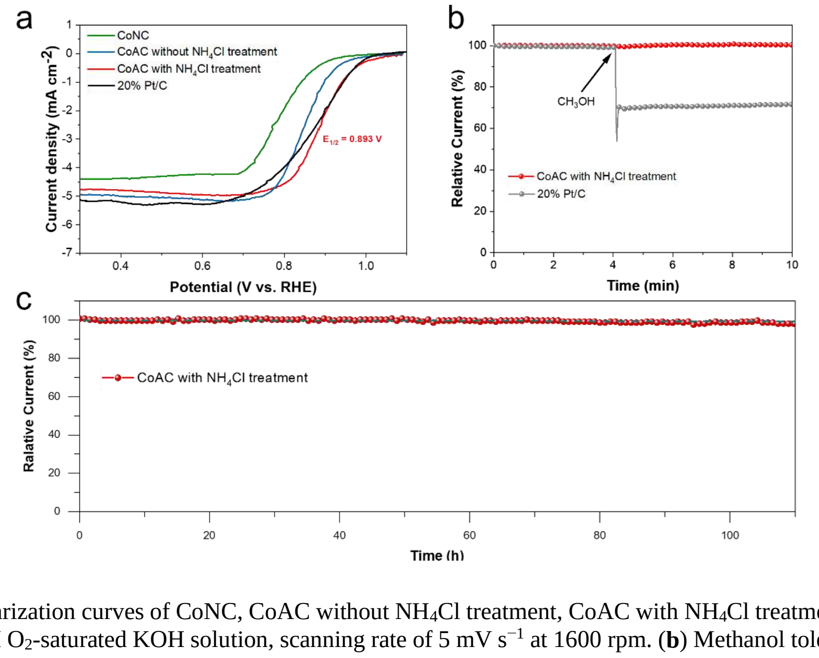

Figure 1. (**a**) ORR polarization curves of CoNC, CoAC without NH_4Cl treatment, CoAC with NH_4Cl treatment, and commercial Pt/C (20%) catalyst in 0.1 M O_2-saturated KOH solution, scanning rate of 5 mV s^{-1} at 1600 rpm. (**b**) Methanol tolerance test of CoAC with NH_4Cl treatment catalyst and commercial Pt/C (20%) catalyst at 0.5 V with a rotation rate of 1600 rpm. 20 µl methanol is injected into the 0.1 M O_2-saturated KOH electrolyte (200 mL) at 4 min. (**c**) The current-time chronoamperometric response in O_2-saturated 0.1 M KOH solution at 0.8 V with a rotation rate of 200 rpm.

COMBINATORIAL STUDY OF DEFORMABLE LITHIUM CHLOROBORACITE SOLID ELECTROLYTES

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In lithium-ion batteries, solid electrolytes are an attractive alternative to their liquid counterpart due to their potential for improved energy density, lifespan and safety. The major drawback is their lower ionic conductivity, which is worsened in the case of ceramic materials by the inability of these electrolytes to form efficient contacts with other components of the battery due to their lack of deformability. $Li_4B_7O_{12}Cl$ and $Li_4B_4Ga_3O_{12}Cl$-type chloroboracites are types of solid electrolytes that have received attention for their ability to be made in a deformable glassy state and then further crystallized into the conductive phase by heating to about 525 °C. This leads to a promising approach of designing a solid battery by first mixing the glassy material with the active cathode material and then heating the mixture to convert the electrolyte to the conductive phase while maintaining the intimate mixing. However, very few compositions have been studied, and no work includes determination of the effect of doping on the deformability of the material nor does previous work include the other necessary properties for solid electrolytes such as a large stability window. As such, we developed a combinatorial synthesis route to study these challenging materials. For the two target materials ($Li_4B_7O_{12}Cl$ and $Li_4B_4Ga_3O_{12}Cl$) we obtain phase pure materials after re-crystallization that match the results from literature. Our combinatorial approach also yields ionic conductivities in agreement with prior literature. We further identify challenges not reported previously such as poor stability against humidity leading to proton conduction, and a limited stability window. This thorough screening of these materials will dramatically accelerate our testing and development of these promising materials.

Exploring the Impact of Different 3D Cathode Structures on Li-S Battery Performance by Using 3D Printing Technology

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The cathode structure of lithium-sulfur (Li-S) batteries plays a crucial role in determining their performance. Compared to conventional laboratory doctor blade coating methods for cathode preparation, well-designed 3D cathode structures can significantly enhance battery performance. Moreover, 3D structures provide efficient Li^{+}/e^{-} transport pathways and mitigate structural degradation caused by the volumetric expansion of sulfur during charge–discharge cycles. In this study, various 3D-printed sulfur cathode architectures and patterns were designed and their performance differences were systematically analyzed. Additionally, in this study, the effects of filament thickness in 3D printing and sulfur loading on battery performance were investigated by controlling the linewidth of the printed structures. This poster will present the latest progress of the project along with some preliminary test results.

LES HUILES VÉGÉTALES EN IMPRESSION 3D

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La fabrication additive, ou impression 3D, permet de préparer des objets en superposant des couches de matière. Les polymères sont une classe de matériaux utilisés dans la fabrication additive. Leur production et leur utilisation ont considérablement augmenté au fil des décennies, entraînant des défis environnementaux majeurs, notamment en termes de gestion des déchets plastiques. En 2020, seulement 9 % des plastiques sont recyclés[1], alors que la majorité des polymères utilisés proviennent de ressources pétrolières et ne sont pas biodégradables.

Le groupe Laventure, spécialisé dans l'étude des relations entre structure, mise en forme et propriétés des matériaux, explore des alternatives plus durables pour l'impression 3D. Les huiles végétales s'avèrent être une ressource prometteuse pour la fabrication de polymères.[2] Nos travaux démontreront comment transformer ces huiles en matériaux avancés, notamment pour la conception de revêtements et de résines imprimables.

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OPTIMIZATION OF PHOTOACTIVE COATINGS FOR ENHANCED LIGHT-ASSISTED BATTERY CHARGING

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Meeting global energy demands through renewable sources is an urgent priority, with solar energy standing out due to its abundance, sustainability, and non-polluting nature. However, its variability and intermittency require efficient storage solutions to ensure consistent power availability. One promising approach is the development of photo-rechargeable batteries, which integrate solar harvesting and energy storage in a single system by storing energy at the molecular level.

This study focuses on the design of a photoactive polymer-based coating that facilitates light-assisted battery charging. By directly incorporating light-absorbing materials into the battery structure, these coatings eliminate the need for separate photovoltaic devices and improve overall system compactness and efficiency.

In this study, we focus on the development of a photoactive coating designed to facilitate light-assisted battery charging at the molecular scale. This study will assess the synthesis of the molecular components of the coating, which both absorb solar energy and efficiently transfer it into the electrochemical system of the battery.

Additionally, we will explore the methods of incorporating these photoactive materials into a functional coating, which encapsulates and interfaces with the active battery components. The research will also analyse the photophysical and electrochemical properties of these coatings, shedding light on how varying polymer loadings impact light absorption and charge storage capabilities. This work will provide crucial insights into optimizing the design of photoactive coatings for enhancing both the efficiency and compactness of solar energy storage systems, paving the way for more sustainable, high-performance solutions for on-demand electricity.

This work contributes to the advancement of integrated solar energy solutions, supporting sustainable, reliable electricity generation—particularly in regions lacking traditional power infrastructure.

QUANTIFICATION DE LA STRUCTURE DE MATÉRIAUX MOLÉCULAIRES

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Les verres moléculaires, des petites molécules organiques pouvant adopter une phase amorphe, sont des matériaux émergents dans plusieurs domaines tels que les industries alimentaire et pharmaceutique et l'optoélectronique. En effet, la phase amorphe possède des propriétés intéressantes qui sont absentes dans la phase cristalline, comme sa malléabilité, sa transparence et sa solubilité plus élevée. Cette phase de la matière est toutefois métastable et les verres moléculaires ont tendance à cristalliser à long terme. Dans ce contexte, le trempage (*dip-coating*) est une technique qui permettrait de préparer des films minces et ultraminces de verres moléculaires plus résistants à la cristallisation. Le trempage comporte plusieurs avantages par rapport à d'autres méthodes de dépôt de couches minces, tels que sa simplicité, sa versatilité et son faible coût, et permet d'avoir un bon contrôle sur l'épaisseur des films.

Dans ce travail, nous avons étudié la stabilité amorphe de films d'un verre connu pour être cinétiquement stable, possiblement grâce à des ponts H. Les films ont été préparés en vue d'obtenir différentes épaisseurs, soit en variant la vitesse de retrait du substrat, la volatilité du solvant et sa capacité à faire des ponts H ou interactions π-π avec le verre. L'application d'un modèle chimiométrique *Purity* sur les spectres infrarouges (IR) des films de verre a révélé une augmentation des ponts H avec l'épaisseur des films (de l'ordre du nanomètre), mesurée par ellipsométrie spectroscopique (SE), et l'atteinte d'un plateau aux épaisseurs élevées. Finalement, les solvants étudiés ont généré des résultats inattendus quant à la quantité de ponts H formés au sein des films de verre à épaisseur constante.

Optimisation des paramètres d'impression 3D de matériaux polymères à l'aide de l'apprentissage automatique : étude comparative de la profilométrie et de la stéréomicroscopie

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La fabrication additive, également connue sous le nom d'impression 3D, implique le dépôt robotisé de matériaux ou d'un mélange de matériaux suivant des mouvements cartésiens dans les directions X, Y et Z. Ces mouvements sont pré-calculés à partir d'une conception assistée par ordinateur (CAO), offrant ainsi à l'impression 3D une grande flexibilité tant au niveau de la forme que du matériau. Cette technique de fabrication ouvre de nouvelles voies pour étudier les relations structure–mise en forme–propriétés des matériaux, tels que les polymères. L'adoption généralisée et l'utilisation accrue de l'impression 3D ont donné lieu à de nouveaux défis, et avec l'augmentation de la demande, un intérêt croissant se manifeste pour le développement et l'utilisation de nouveaux matériaux. Trouver la méthode la plus optimale pour imprimer un nouveau matériau peut s'avérer être une tâche longue et complexe, reposant sur une approche par essais et erreurs. Ainsi, dans cette étude, nous explorons l'application des techniques d'apprentissage automatique pour optimiser les paramètres d'impression 3D d'un polymère imprimable. Plus précisément, nous utilisons le poly(caprolactone) (PCL), en exploitant un vaste ensemble de données, constituées de 800 échantillons caractérisés à la fois par la profilométrie et la stéréomicroscopie pour mesurer la fidélité d'impression comme données cibles. Notre objectif principal est de démontrer l'efficacité des modèles d'apprentissage automatique dans la prédiction des paramètres d'entrée les plus optimisés pour des exigences de fidélité d’impression spécifique. Ceci permet d'améliorer la rapidité et l'efficacité de l'innovation dans la fabrication additive. En utilisant des outils libres d’accès, nous évaluons les capacités prédictives des algorithmes en utilisant un ensemble diversifié de caractéristiques d'entrée et de cibles de sortie liées à la fidélité d'impression. Nos résultats révèlent que les données de stéréomicroscopie, bien qu'étant moins étendues que celles de la profilométrie, fournissent suffisamment d'information pour une optimisation efficace des paramètres. De plus, nous montrons que même avec un ensemble réduit de trois paramètres de sortie, les modèles maintiennent un niveau de précision prédictive satisfaisante. Cette recherche souligne le potentiel de l'intégration de l'apprentissage automatique avec l'impression 3D en chimie, offrant ainsi une approche rentable et extensible pour l'optimisation des paramètres.

Bottlebrush Polymers for Advanced Energy and Display Applications

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Multifunctional polymers are key to advancing smart displays and energy storage technologies. Recent developments in these fields have led to the critical requirements of polymers, including multiple functionality. For example, redox-active and π-conjugated segments in the polymer enhance the optical contrast of the polymer and make them electrochromic. Whereas ionic conductivity leads to faster switching times between colored states and enhanced ionic or electronic conduction processes. These properties can further be enhanced by using bottlebrush polymers. Such side-chain engineering is a versatile means to modulate the physical and electronic properties of the polymer. This is possible by leveraging Ring-Opening Metathesis Polymerization (ROMP).

Toward enhancing polymer properties compared to their linear counterparts, bottlebrush copolymers consisting of both electronic and ionic conducting arms are of interest. Perylene diimide (PDI) is chosen as the conductive segment because of its well-known electron transport properties, fluorescence, reversibly electroactivity, and exceptional photostability. An ionically conductive side arm is further chosen for ionic conductivity. The strategies used for developing combined electro- and ionic conductive copolymers will be presented. Specifically, the synthetic approaches for developing electro- and ionic conductive monomers and their copolymerization by ROMP will be presented. This is to demonstrate that multiple functionalities can be achieved by combining synthetic control and functional design toward tuning mechanical and optical properties.

ELECTROLYTE ADDITIVE APPROACH FOR HIGH-ENERGY-DENSITY, LONG-LASTING LI-METAL BATTERIES

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Replacing the conventional graphite anode material in the rechargeable lithium-ion batteries with metallic lithium, which has the highest specific capacity and the lowest operation potential, significantly enhances the energy density of the batteries. However, the formation of the unstable solid electrolyte interphase (SEI) at the electrolyte/electrode interfaces reduces the coulombic efficiency (CE) and cycling life of the rechargeable lithium metal batteries (LMBs). Furthermore, the rapid formation and growth of dendritic lithium (Li) could penetrate the thin separator, leading to cell short-circuiting, eventual failure, and posing severe safety concerns. Therefore, there is an urgent need to develop new electrolytes or electrolyte additives to solve these challenges. In this presentation, I will introduce various effective electrolyte additives that we developed for practical LMBs applications. The additives were anchored preferentially on the Li surface to inhibit Li dendrite formation, to form a uniform cathode electrolyte interface (CEI) film to provide a fast Li+ ion pathway, as well as stabilize the electrolytes. The symmetric Li||Li, full Li/NCM and Li|LFP cells with electrolyte additives have small polarization and long cycling life, which demonstrates the importance of the additive to the application of the LMBs. This strategy is simple, low-cost, and compatible with the existing battery manufacturing process, therefore holds great potential for fast commercialization.

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NANOMATERIALS FOR NEXT-GENERATION FUEL CELLS AND BATTERIES

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The development of high-performance and low-cost clean energy conversion and storage technologies is essential to achieve carbon peak and neutrality targets. Hydrogen fuel cell has the advantages of high efficiency, high energy density, and zero emissions, which is a key frontier technology to achieve the above goals. However, the large-scale commercial application of hydrogen fuel cells is still facing bottlenecks such as high cost. The use of rare and expensive Pt-based catalysts is one of the key factors for the high cost of fuel cells. We developed some new strategies to design novel catalyst materials (including low-Pt and Pt-free catalysts) for fuel cells, to effectively control the material structures to further improve their catalytic activity and stability. On the other hand, the development of high energy density, safe, and long-life batteries is critical for their broad applications in smart grids, portable devices, and electric vehicles. Lithium metal and metal-air batteries are among the most promising next-generation energy storage technologies, beyond the lithium-ion battery. In this talk, I will introduce the latest research progress of our group in the rational design of key electrode/electrolyte materials for hydrogen fuel cells and batteries.

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UNUSUAL STRETCHING-INDUCED MOLECULAR ORIENTATION BEHAVIOR OF A SIDE-CHAIN LIQUID CRYSTAL ELASTOMER AND ITS REORIENTATION-ENABLED AUXETICITY

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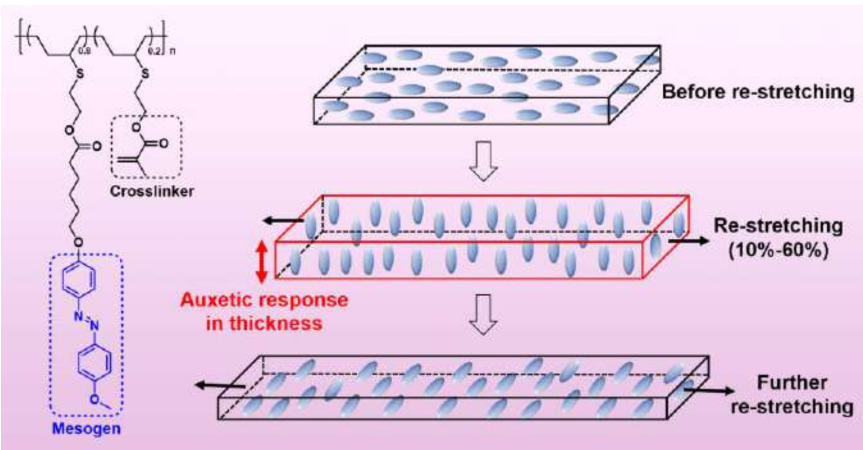
A liquid crystal polymer (LCP) is synthesized by the functionalization of polybutadiene with side-group mesogens and methacrylate cross-linker and is used to investigate the stretching-induced orientation of mesogens and chain backbone. Unusual orientation behaviors of the two constituents coupled through the spacer are revealed by X-ray diffraction (XRD) and polarized infrared spectroscopic measurements. When a polydomain LCP film is stretched in the nematic phase, the chain backbone and mesogenic side groups are oriented along and perpendicular to the stretching direction (SD), respectively; at a large strain (500%), the oriented mesogens are tilted in the plane. By contrast, when the polydomain LCP is stretched in the isotropic phase and cooled under strain into the nematic phase, a peculiar state is observed where both the mesogenic side groups and chain backbone are aligned perpendicular to the SD. By photocross-linking oriented LCP films under strain, the different macroscopic orientation states are locked in the resulting monodomain liquid crystal elastomer (LCE) films. Restretching such monodomain LCE films in the orientation direction of mesogens to induce their reorientation, an auxetic response is observed, with the thickness of the film increasing upon restretching over a small strain range. Polarized optical microscopic (POM) observation and UV−vis absorption measurement show unambiguously that the auxetic behavior is associated with a mechanically induced reorientation of the mesogens from in-plane homogeneous to out-of-plane homeotropic alignment. The onset and magnitude of the auxeticity as well as the strain range for its manifestation (increased film thickness with respect to the initial thickness before restretching) are affected by the relative orientational states of the side-group mesogens and chain backbone in the monodomain LCE film.



DÉVELOPPEMENT DE NOUVELLES MEMBRANES À PERMÉABILITÉ ACCRUE POUR L'AMMONIAC DANS LA SÉPARATION PAR DISTILLATION MEMBRANAIRE

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Produit par le processus d'Haber-Bosch, l'ammoniac est le second composé le plus synthétisé au monde. Son processus de fabrication, particulièrement polluant, est responsable d'environ 2% de la production mondiale de CO_2. L'ammoniac est un contaminant connu des eaux usées, qui participe à l'eutrophication des eaux et qui est toxique à la vie aquatique. De ce fait, l'intérêt de récupérer l'ammoniac présent dans les eaux usées semble évident, permettant à la fois d'éviter un processus de fabrication polluant et de retirer ce contaminant connu des eaux. La distillation membranaire est une technique permettant le passage de vapeur au travers d'une membrane hydrophobe, tout en empêchant le passage de liquide ou de sels, dû à une différence de pression de vapeur de part et autre de la membrane. La distillation membranaire a beaucoup été utilisée pour des applications dans la séparation d'eau de solutions salées mais demeure au stade exploratoire pour la capture de l'ammoniac en raison du manque de membrane spécifiquement pour ce procédé. Cette étude se base donc sur le design de membranes ayant une adsorption préférentielle de NH_3 afin d'augmenter le flux d'ammoniac au travers de la membrane. Différents additifs ont été sélectionné afin de fabriquer des membranes à matrices mixtes à partir de solutions de PVDF-HFP. Synthétisées par inversion de phase, l'hydrophobicité et l'épaisseur de ces membranes ont été caractérisées. Par leurs multiples sites d'adsorption, capacités à former des liaisons hydrogènes, et surfaces spécifiques augmentées, ces membranes devraient présenter des flux d'ammoniac plus important sans pour autant compromettre leurs autres caractéristiques.

FIGURE

(Optional / Facultative)

Development and Study of N,O-Bidentate Ligands for Photoactive Complexes of First-Row Transition Metals.

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Bidentate N,O ligands are promising for the development of photoactive first-row transition metal complexes. Among them, amidines *N*-oxide (AMOX) derivatives *(Figure*) are synthesized by *N*-oxidation of parent amidines using *m*-CPBA. Their corresponding complexes, such as Co(AMOX-Ph-CN)$_3$ (*Figure*), exhibit interesting photophysical properties for potential applications in catalysis and artificial photosynthesis. This study will focus on optimizing the synthesis of these ligands and their complexes, while providing detailed characterization through NMR and UV-vis spectroscopy, and X-ray diffraction analysis. Additionally, the potential to polymerize photoactive materials, incorporating first-row metal complexes, will be explored, targeting antenna effects or new magnetic properties for future applications.

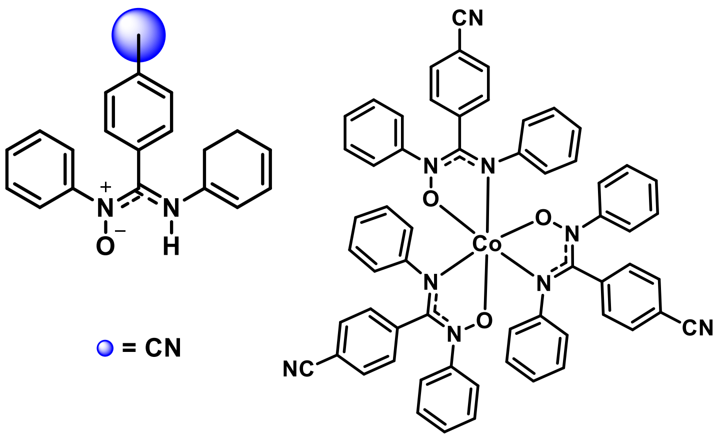

Figure : Chemical structures of AMOX-CN ligand and its Co(III) complex

COLORIMETRIC DETECTION METHODS OF PH-SENSING BANDAGE FOR POINT-OF-CARE WOUND DIAGNOSTICS

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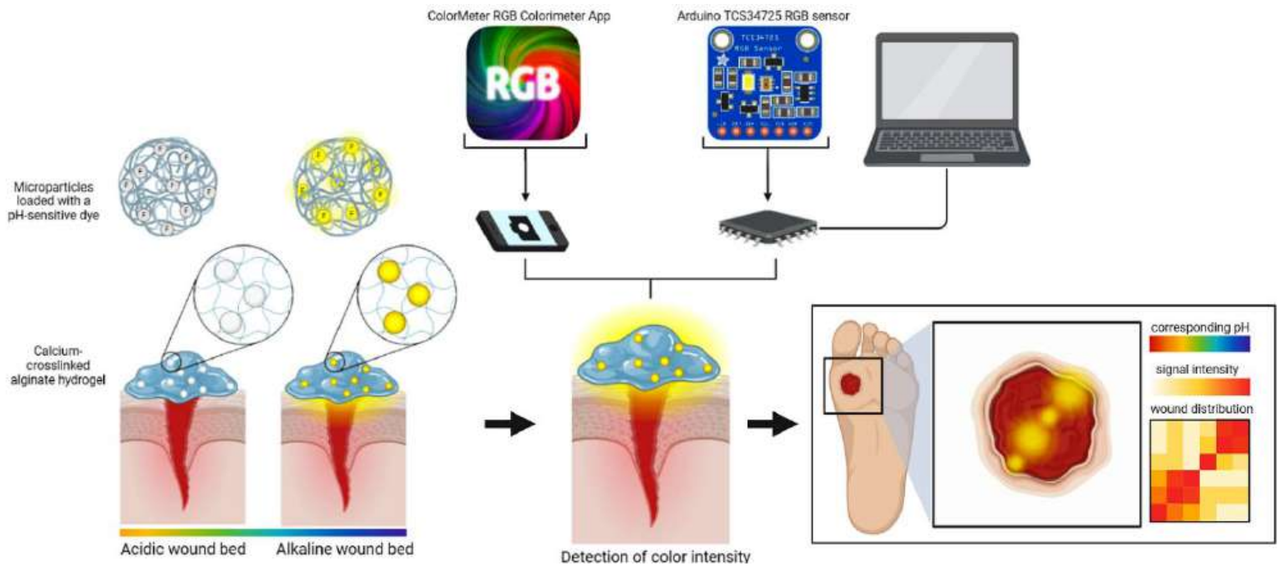
Chronic lower extremity wounds like diabetic foot ulcers (DFUs) are a major complication of diabetes and the leading cause of lower limb amputations worldwide. Currently, DFUs are diagnosed through macroscopic evaluation, and molecular diagnostics are lacking for the disease staging, treatment selection, and evaluation of treatment success. There is a need for new diagnostic technologies combined with detection methods for point-of-care use. Preclinical and clinical data support the importance of wound pH as a biomarker in chronic wound healing, with DFUs typically exhibiting more alkaline pH values when compared to normal healing wounds. In a previous study, we developed a pH-sensing fluorescent bandage based on pyranine-loaded microparticles that were physically immobilized in an alginate hydrogel. Here, we present a second-generation pH-sensing bandage for colorimetric wound diagnostics. Pyranine was adsorbed at high concentrations onto microparticles to enable colorimetric signal detection. This approach leverages pyranine's ability to change color in response to pH variations through proton exchange properties with the wound fluid. The colorimetric properties of our bandage enable signal detection by two methods suited for point-of-care use: a smartphone camera and a cost-effective homebuilt RGB detector. Analyzing the color intensity of the bandage with red, green and blue absorbance values, it is possible to correlate the RGB absorbance to a pH value in the clinically-relevant range to 6.0 to 9.0 *in vitro* and *ex vivo*, as the B values decreased with the increase in pH levels, as associated with DFUs. These findings indicate the potential of colorimetric detection using smartphone cameras or home-built absorbance detectors for rapid wound diagnostics at the point-of-care.



GRAPHENE-BASED FIBER SENSORS

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Graphene-based materials have garnered interest as efficient gas sensitive materials for sensors, demonstrating significant potential in medical applications for detecting biomarkers and serving as advanced tools for health monitoring and disease diagnosis. The distinct two-dimensional morphology of graphene, with its high surface area and continuous conductive network, is known to enhance the sensitivity of sensors by providing abundant active sites for adsorption and facilitating rapid electron transfer. Graphene fibers, formed by assemblies of graphene sheets into fibrous structures, have emerged as promising materials for sensor fabrication due to their exceptional electrical, chemical, and mechanical properties. Advantages of graphene fibers include their stability and tunability, allowing them to detect a broad spectrum of gases and making them highly versatile as sensing materials in gas-sensing applications. These graphene fibers leverage the exceptional sensitivity and selectivity of graphene with mechanical flexibility of fiber materials, enabling integration into wearable electronics and miniaturization of sensing devices.

This work investigates graphene fibers for sensing applications and focuses on the preparation of these graphene-based composite fibers through fiber spinning techniques. The incorporation of graphene into polymeric or hybrid matrices provides sensing materials that can be easily processable with enhanced electronic properties. Electrospinning enables the formation of ultrafine, uniform fibers, while wet-spinning offers control over fiber alignment and supports scalable production, enhancing the functional properties of the composite material. By tailoring the graphene dispersion, fiber morphology, and material composition, the resulting fiber sensors achieve improved stability, sensitivity, and selectivity. This study further presents the characterization of graphene-based composite fibers, emphasizing their electronical properties and structural morphology, which are critical to their performance in sensing applications. This presentation also highlights the real-world practicality of graphene-based fiber sensors as advanced gas-sensing technologies, showcasing their ability to detect diverse biomarker gases and their potential in healthcare management for real-time monitoring.

DEVELOPMENT OF HEA-BASED PROTECTIVE COATINGS FOR THERMAL PROBES USED IN AL PRODUCTION

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The control of the cryolithic bath temperature is crucial for the operation of aluminium electrolysis cells. At present, it is measured punctually, as the thermal probes protected by a 446 steel sheath corrode rapidly in the cryolithic bath at 950°C, making them unsuitable for continuous operation. In this context, we have studied various high entropy alloys (HEAs) with a view to their use as protective coatings for thermal probes used in aluminium electrolysis cells.

High entropy alloys (HEAs) are currently the focus of particular attention, as some of them exhibit outstanding properties that far exceed those of conventional alloys (e.g. exceptional wear resistance, good structural stability, high resistance to corrosion and oxidation), making them of interest in many fields [1]. Their high-temperature stability further broadens their spectrum of applications. In addition, HEAs can be processed into coatings using existing equipment and technologies [2].

Based on the thermodynamic modelling work of Senkov et al [3], we pre-selected different families of HEAs likely to be single-phase at 1000°C. In particular, we studied alloys based on Co-Cr-Fe-Ni. These alloys were synthesized by melting and characterized (XRD, SEM-EDX…) before and after oxidation in air at 1000°C and after immersion in cryolite at 1000°C (Fig. 1). We were thus able to establish their oxidation and corrosion mechanisms as a function of their composition and compare them with those of 446 steel.

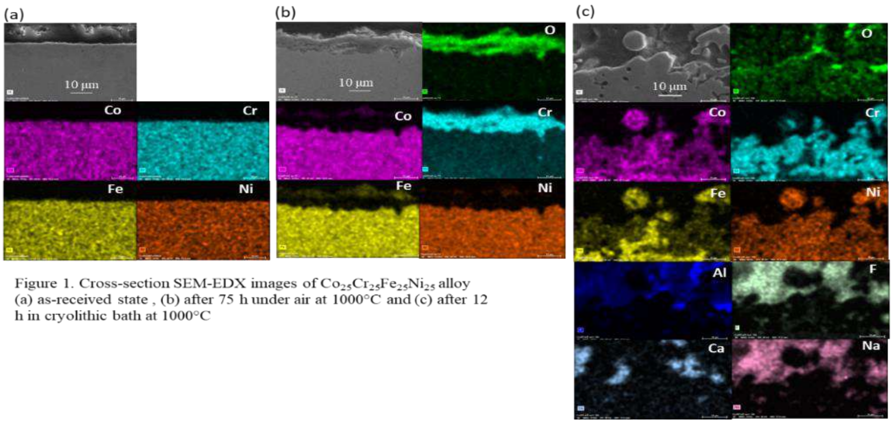

Figure 1. Cross-section SEM-EDX images of $Co_{25}Cr_{25}Fe_{25}Ni_{25}$ alloy (a) as-received state , (b) after 75 h under air at 1000°C and (c) after 12 h in cryolithic bath at 1000°C

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SOLVENT-DETERMINED MORPHOLOGY, ACTUATION AND SENSING OF SEMI-INTERPENETRATING LIQUID CRYSTAL ELASTOMER AND POLY(IONIC LIQUID)

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Liquid crystal elastomers (LCEs) are promising materials for many applications such as soft actuators, artificial muscle and soft robotics. In this study, we used a soliton processing method to prepare semi-interpenetrating polymer networks (semi-IPNs) comprising an LCE and a poly(ionic liquid) (PIL). We found that the solvent could affect the phase separation and thus the morphology, which, in turn, determines the actuation behaviors of the resulting semi-IPNs, Using tetrahydrofuran (THF) as the solvent, a “bilayer” morphology was formed due to concentration gradients in the thickness direction, resulting in actuator strip with one side rich on LCE and the other side rich on PIL. Reversible bending/unbending is the main actuation deformation for this self-assembled bilayer actuator. In contrast, when N,N-dimethylformamide (DMF) was used as solvent, a homogeneous, phase-separated morphology was obtained, and the resulting actuator displays contraction/elongation. On the other hand, the semi-IPNs act as an elastomeric sensor to sense mechanical deformations or movements, like finger and wrist bent, through electrical resistance variations. This work has unveiled the importance of the solvent used in solution processing LCE and PIL composite materials.

AMIDINE OXIDE (AMOX) LIGANDS AND THEIR FIRST ROW TRANSITION METAL COMPLEXES

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The photophysical, redox, and structural properties of amidine oxide (AMOX) coordination complexes make them interesting candidates as components (photosensitizers and/or catalysts) in artificial photosynthetic systems and optoelectronic devices. Ligand design is used to circumvent the limitations usually encountered for photoluminescent complexes with first-row transition metals, such as limited absorption in the visible part of the electromagnetic spectrum, short lifetimes of excited states, and the preponderance of their non-radiative decay mechanisms. The ligands were synthesized by N-oxidation of amidines containing anthracene or 4-tert-butyl phenyl on the central carbon, using m-CPBA. The complexes were then formed from salts of Ni(II) and Zn(II). Both the ligands and the complexes were characterized by NMR, IR and UV-vis spectroscopy, and mass spectrometry. The crystal structures of both the ligands and the complexes were also elucidated by X-ray diffraction analysis; an example is shown in Figure 1, below.

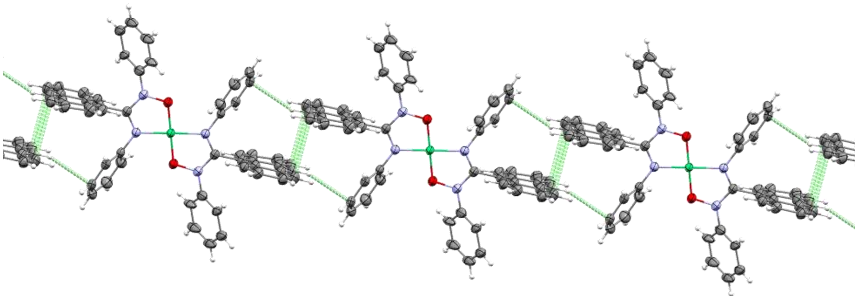

FIGURE 1. The solid-state structure of a $Ni(AMOX)_2$ complex.

Phase Stability and Hydrogen Storage Performance of Hf-Ti-Nb-V-Zr High-Entropy Alloys Understanding Laves Phase Formation

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High-entropy alloys (HEAs) are gaining attention as promising materials for hydrogen storage, thanks to their structural flexibility and capacity to form metal hydrides with adjustable properties. In this work, we explore the hydrogen storage behavior of the alloy $Hf_{13}Ti_3Nb_{18}V_{51}Zr_{15}$, designed to offer a balance of elements favorable for Laves phase formation.

Although this composition was initially thought to crystallize in a hexagonal close-packed (HCP) structure, experimental results revealed the predominant formation of a C15 cubic Laves phase. This was confirmed through X-ray diffraction (XRD) and scanning electron microscopy (SEM) combined with energy-dispersive X-ray spectroscopy (EDX). The microstructural analysis showed a multiphase material, relatively homogeneous overall, but with some segregation zones rich in Hf, Nb, and Zr.

Hydrogen absorption measurements were performed using a custom Sievert-type apparatus. During the first activation at room temperature, the alloy showed limited hydrogen uptake. However, a significant improvement was observed when the temperature was increased, indicating that the absorption is thermally activated and governed by diffusion mechanisms.

These findings highlight the crucial role of temperature in enhancing hydrogenation kinetics. They also confirm that Laves phase–forming HEAs like $Hf_{13}Ti_3Nb_{18}V_{51}Zr_{15}$ can be fine-tuned to optimize hydrogen storage performance.

By deepening our understanding of phase formation and diffusion behavior in multi-component systems, this study contributes to the design of next-generation hydrogen storage materials. The C15 Laves phase identified here shows promise for reversible hydrogen storage under moderate conditions, opening up new directions in alloy design for energy applications.

METAL–ORGANIC FRAMEWORKS (MOFS) FOR DIRECT AIR CAPTURE OF CARBON DIOXIDE

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The levels of atmospheric CO_2 have reached a critical threshold. Direct Air Capture (DAC) is a promising technology that can help remove CO_2 from the air, but it relies on effective sorbents. Metal–organic frameworks (MOFs) have gained attention as potential sorbents due to their high surface area, tunable chemistry, and porosity. To accelerate the discovery of MOFs for DAC, Meta AI developed *The Open DAC 2023 Dataset.*[1] This dataset is a powerful computational tool that evaluates MOFs based on their predicted CO_2 and H_2O adsorption energies, with a focus on adsorbing CO_2 in humid conditions. The study also provides the most comprehensive density functional theory (DFT) dataset of CO_2 and H_2O adsorption in MOFs to date, correcting previous limitations found in force-field (FF)-based studies. This study predicts the top 10 MOFs recommended for DAC based on Meta AI's screening criteria. In this work, the MOFs predicted by Meta AI were synthesized and tested for their CO_2 and H_2O adsorption, alongside several well-known MOFs with reported uptake values as a benchmark for comparison. The selected MOFs from *The Open DAC 2023 Dataset* were synthesized, characterized using powder X-ray diffraction, thermogravimetric analysis, N_2 and H_2O isotherms, and tested for CO_2 uptake from 0 to 1 atm, specifically focusing on CO_2 uptake at 400ppm, most relevant to DAC.

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DEVELOPMENT OF APTASENSORS FOR COSTIMULATORY PROTEIN RECEPTORS DETECTION

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Rheumatoid arthritis (RA) is a chronic autoimmune disorder affecting approximately 1% of the global population, characterized by persistent synovial inflammation and progressive joint destruction. Early symptoms, such as pain and stiffness in small joints, are often subtle and overlooked. Although RA is not fatal, delayed diagnosis can lead to irreversible disability, making early detection critical for effective treatment and prevention of joint damage. Current diagnostic methods rely on biomarkers that correlate with disease presence and progression, but these markers still have limitations. Recently, costimulatory proteins of the CD28-B7 pathway, namely CD28, CD86, and CTLA-4, have emerged as promising biomarkers due to their roles in modulating T-cell activation and immune regulation, making them crucial for RA pathogenesis. This study aims to develop a reliable, sensitive, and cost-effective electrochemical aptasensor for detecting these proteins. Aptamers specific to each target protein are selected through the in vitro Systematic Evolution of Ligands by Exponential Enrichment (SELEX) process and integrated into a DNA-based biosensor platform utilizing electrochemical impedance spectroscopy (EIS) for signal transduction. Currently, the focus is on CTLA-4, with an aptamer from a previous study used to create a sensor for its detection. To enhance sensitivity, the sensor is constructed on gold nanoparticles (AuNP) electrodeposited onto carbon screen-printed electrodes (CSPE) to increase surface area, rather than using gold screen-printed electrodes (AuSPE). The resulting sensor is expected to enable accurate and selective detection of CTLA-4 in complex biological matrices, advancing early immunodiagnostic applications.

CARACTERISATION DE LA RECUPERATION DU LITHIUM AVEC UN MATERIAU A TAMIS IONIQUE

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De nos jours, le lithium est un élément essentiel pour l'industrie des batteries. Le lithium est abondant dans les eaux salines et elles peuvent représenter un approvisionnement durable de cet élément ; cependant, la capture de cet élément par des processus d'adsorption est entravée par des concentrations élevées d'ions compétiteurs qui se trouvent dans ces eaux. La récupération sélective du lithium des eaux salines avec un matériau à tamis ionique synthétisé à partir d'un matériau d'oxyde de lithium à base de titane (LTO) est le sujet principal de cette étude. Du LTO commercial et du LTO qui a été délithié pour former une structure à tamis ionique en mesure de distinguer le lithium des ions compétiteurs ont été utilisés afin de tester la capacité d'adsorption du lithium. Différents matériaux de LTO délithiés, c'est-à-dire d'oxyde d'hydrogène à base de titane (HTO), ont été produits en exposant la poudre de LTO à de l'acide chlorhydrique pour différents intervalles de temps dans le but d'identifier les propriétés optimales du matériau pour l'adsorption sélective. Afin d'établir une relation entre le degré de délithiation et la capacité d'adsorption dans les eaux salines, ces matériaux ont été caractérisés et par la suite évalués au niveau de leur performance pour l'adsorption du lithium. Il est possible d'envisager le développement de nouveaux adsorbants sélectifs pour la capture du lithium avec ces résultats.

Délithiation

$Li_4Ti_5O_{12} + 4\,H^+ \rightarrow H_4Ti_5O_{12} + 4\,Li^+$

$Li_4Ti_5O_{12}$

Adsorption

$H_4Ti_5O_{12} + 4\,Li^+ \rightarrow Li_4Ti_5O_{12} + 4\,H^+$

$H_4Ti_5O_{12}$

SURFACE ANISOTROPY-DRIVEN POLARIZED REFLECTANCE MODULATION IN POLYOXYMETHYLENE

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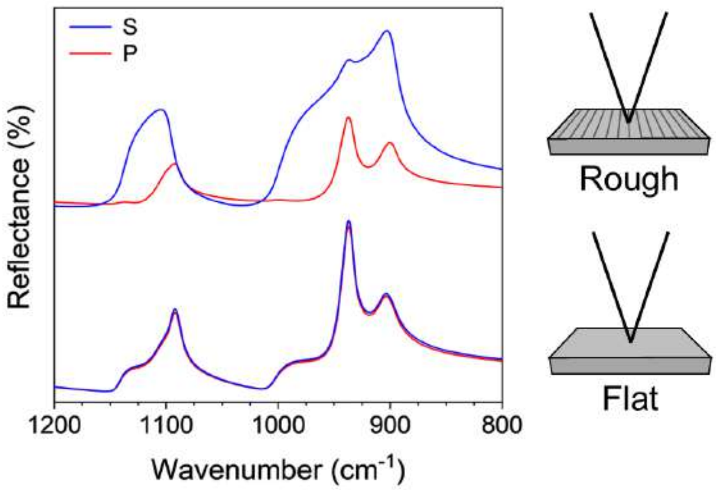
Active polarimetric sensing requires robust materials with tailored optical anisotropy and high reflectivity in the mid-infrared range (MIR, 8 to 14 µm) for field applications.[1] Polyoxymethylene (POM) exhibits uncommon high reflectance modes in the MIR range, making this polymer a strong candidate for such applications. Our polarized specular reflection measurements and analysis of the complex dielectric function reveal that these highly reflective bands arise from surface-active polariton-type modes. The topological sensitivity of these modes suggests that optical anisotropy can be tuned by generating micro and nanoscopic surface features.[2]

Based on this assumption, we prepared POM samples with varied surface features by directionally sanding isotropic bulk POM materials using a range of grits. Polarized MIR reflectance exceeding 50 %, with a corresponding degree of linear polarization over 0.3, was achieved through these simple surface modifications, without compromising the overall reflectance compared to the untreated melt. Topography analysis enabled characterization of the size, density and aspect ratio of surface features. No evidence of molecular orientation changes was detected, confirming that the polarization contrast arises solely from surface anisotropy. The optical anisotropy achieved through these simple surface treatments was compared to that induced by molecular orientation when stretching POM films. Generating highly polarized response from these topologically anisotropic materials serves as both a practical method for tailoring optical properties and a means to advance our understanding of the structure-optical properties relations in polaritonic-like polymer materials.



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A SPRAYABLE H-BONDING COUMARIN-CONTAINING COMPOUND FOR PHOTOALIGNMENT OF LIQUID CRYSTALS ON A CURVED SURFACE

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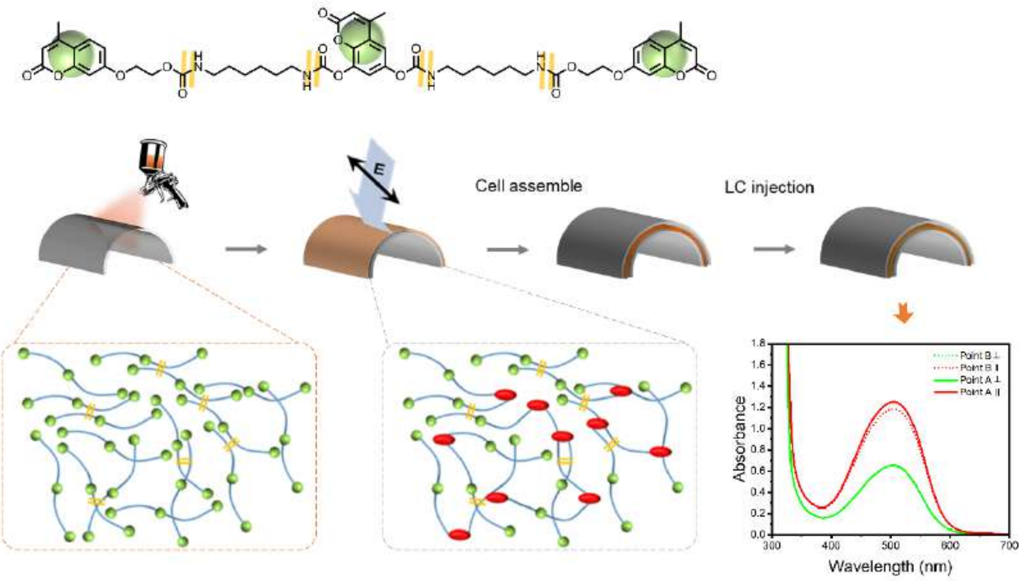
Abstract:

The success of the photoalignment of liquid crystals provides displays and other optical applications with more possibilities, compared with the surface rubbing technique. Especially, it is highly required for applications requiring liquid crystal alignment on curved surfaces, for which surface rubbing is hard to apply. Photodimerization of photoactive species coated on the substrate under linearly polarized light irradiation is one of the photoalignment methods. In this work, we present a study on the photoalignment behaviors of a novel low-molecular-weight, H-bond donor, acceptor, and coumarin-containing compound that can be spray-coated on curved surfaces. The photoalignment of liquid crystals using this coumarin-containing compound is investigated by monitoring the polarized absorption of a dichroic dye-doped nematic liquid crystal. It is found that the order parameter can reach about 0.5 by adjusting the thickness of the spray-coated layer and the polarized light intensity. In addition to liquid crystal alignment on a curved surface, the reversible photoreaction of coumarin is explored to reprogram the photoalignment layer to achieve control in either the degree or direction of the liquid crystal alignment. The results show that the novel structure of the coumarin-containing compound is promising for photoalignment of liquid crystals.



ÉTUDE DE LA RÉTICULATION DU POLY(DIMÉTHYLSILOXANE) : UNE APPROCHE PAR CARACTÉRISATION THERMIQUE, MÉCANIQUE ET SPECTROSCOPIQUE.

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Dans le cadre des méthodes de mise en forme des matériaux réticulés, telles que l'impression 3D, il est crucial de comprendre leurs mécanismes de réticulation. L'étude de la cinétique de réticulation implique l'analyse des constantes de vitesse, des ordres de réaction et de leur énergie d'activation. Ces analyses sont souvent réalisées à l'aide de techniques complémentaires, mais non simultanées. Dans ce contexte, une méthode d'analyse combinée est présentée pour obtenir plusieurs types d'information simultanément à partir d'un seul échantillon. La réticulation d'un système modèle de polymère thermodurcissable, le poly(diméthylsiloxane) (PDMS), est d'abord étudiée sous différents angles à l'aide de diverses méthodes telles que la calorimétrie différentielle à balayage (DSC), la rhéologie et la spectroscopie infrarouge (IR). La DSC permet d'identifier la température de réticulation et sa cinétique pour divers échantillons de PDMS. La rhéologie permet de suivre les caractéristiques viscoélastiques des échantillons en utilisant les modules de perte et de stockage pour analyser l'impact de la réticulation sur leurs propriétés mécaniques. L'IR est utilisé pour comprendre le mécanisme réactionnel du point de vue des liaisons chimiques impliquées dans la réticulation. Ces trois techniques permettent d'obtenir des informations découplées des points de vue macroscopique et moléculaire sur ce processus de réticulation. Ces données ouvriront la voie à une meilleure compréhension et un meilleur contrôle de la réticulation pour les applications en impression 3D, ainsi que dans le traitement général des matériaux thermodurcissables.

SUBSTITUTIONAL EFFECT OF ZR BY TI, ON HYDROGEN STORAGE AND MICROSTRUCTURE OF $ZR_{1-X}TI_XMO_2$ (X=0, 0.25, 0.5, 0.75 & 1) ALLOYS.

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Abstract

In this study we determined the effect of substitution of Zr by Ti in the AB_2-types alloy were $Zr_{1-x}Ti_xMo_2$ where x = 0, 0.25, 0.5, 0.75, and 1. The crystal structure, microstructure, and initial hydrogenation has been examined. The samples were synthesized by arc-melting and characterized by scanning electron microscopy, X-ray diffraction and energy-dispersive spectroscopy. The hydrogenation capacity was measured using a home-made Sieverts equipment. Pure-$ZrMo_2$ crystallizes in two phase: a primary C15 Laves phase with abundance 95 wt.% and a secondary body-centered cubic structure (BCC) phase. Substitution of Zr by Ti led to a significant change in the C15/BCC phase abundance ratio. The substitution of Zr by Ti changes the lattice parameters of both phases for all samples. Increasing Ti content made the first hydrogenation faster and increase the hydrogen storage capacity for x = 1, 0.25 and 0.5. Further substitution lead to a decrease of hydrogen capacity.

TOWARDS A BETTER UNDERSTANDING OF THE POLYMER:SALT COORDINATION PHENOMENON IN SOLID POLYMER ELECTROLYTE

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The development of solid polymer electrolyte for different electrochemical applications such as energy storage devices enables a safer and denser energy storage solution to the ones currently available. Fundamental understanding of ionic transport through interaction strength and polymer chain relaxation in the solid and melted states is necessary to develop better electrolytes. In this work, we developed and applied a characterisation method through multiple techniques allowing us to interpret the impact of the salt coordination on the ionic transport of a solid polymer electrolyte's The polycaprolactone (PCL) / lithium bis(trifluomethane)sulfonimide (LiTFSI) system studied was analyzed by differential scanning calorimetry (DSC), variable temperature infrared spectroscopy (FT-IR), electrochemical impedance spectroscopy (EIS) and oscillatory rheology. Polyester electrolytes being less reported than their polyether counterparts, the phase diagram of the PCL / LiTFSI system was constructed from DSC results. The concentration gradient was then analysed by various techniques to obtain a better understanding of coordination throughout the gradient. Standard FT-IR spectroscopy allowed to probe the coordination environment of the lithium salt as a function of concentration while variable temperature FT-IR enabled a quantitative evaluation of an interaction strength between the lithium cation and the carbonyl moiety of PCL. Ionic conductivities of the prepared electrolytes were evaluated and linked with interaction strength. Finally, the use of oscillatory rheology enabled the determination of relaxation times linked with the molecular structure of the system. Comparative analysis of the results obtained allowed a fundamental understanding of the impact of coordination strength on ionic transport in the solid and melted states.

$Co(fAMOX)_2X$ Complexes: Synthesis, Characterization and Structural Properties

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Transition metal coordination complexes are fundamental in modern inorganic chemistry, due to their broad range of applications, such as catalysis and energy storage. [1] In this context, cobalt complexes stand out for their ability to adopt multiple oxidation states and their versatility in coordination geometries. This study focuses on the synthesis and structural characterization of cobalt complexes with N, N'-disubstituted formamidine N-oxide (fAMOX) ligands of the $Co(fAMOX)_2X$ type (X = Cl, Br, I). The fAMOX ligands are bidentate, having a nucleophilic N-oxide fragment and an electrophilic imine group, thus combining σ-donating, π-donating and π-accepting character. In addition, their structures allow steric modularity by-providing notable flexibility in term of functionalization of the amidine moiety. These unique features of fAMOX ligands offer special properties to their complexes, upon coordination with metal ions. [2, 3]

The complexes reported here in were synthesized in very good yields (> 80%) and exhibit stability under ambient conditions. HRMS and C/H/N elemental analysis confirmed the identity and the purity of the compounds, together with spectroscopic characterization (e.g., FTIR, ^1H NMR). Their solid-state structures highlight the formation of pentacoordinated complexes, where the fAMOX ligands coordinate bidentately with cobalt, while the halogen acts as a monodentate ligand. The electronic and steric properties of the fAMOX ligands are key for directing the structures of the complexes and their characteristics. These findings expand the understanding of coordination complexes of fAMOX ligands and their remarkable properties. [3]

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Multifunctional Biopolymer Film Incorporating Phycocyanin-Loaded Mesoporous Silica for Superhydrophobic and UV-Protective Food Packaging Applications

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This research focuses on the extraction, stabilization, and application of phycocyanin (PC), a natural fluorescent pigment derived from Spirulina platensis, known for its excellent antioxidant activities. While PC holds great promise for use in food, cosmetic, and pharmaceutical industries, its practical applications are significantly limited due to its high sensitivity to environmental conditions, including heat, light, and pH changes. To address these limitations, PC was extracted using a green solvent method, ensuring a sustainable and environmentally friendly approach. The extracted pigment was subsequently encapsulated within mesoporous silica nanoparticles (MSN) formed with the microemulsion-assisted sol-gel method, which acts as a protective matrix. FTIR, SEM, and UV-Vis analyses confirmed the successful encapsulation process (CP-MSN). MSN has a high surface area and tunable pore size, allowing for efficient loading and shielding of sensitive bioactive compounds. Encapsulation greatly enhanced the thermal and photostability of PC, preserving its structural integrity and functionality over extended periods.

Following stabilization, CP-MSN was incorporated into biodegradable biopolymer-based films containing cellulose and chitosan. In the next step, the prepared films were coated with stearic acid (SA) as a superhydrophobic coating material. The effects of PC-MSN addition and post-modification with SA on the morphological and physico-chemical properties of the fabricated films were investigated.

The findings revealed that the films were uniform in appearance, suggesting strong compatibility between the various components. Incorporating PC-MSN led to a reduction in both water vapor and oxygen permeability, while also resulting in increased film thickness. Moreover, the resulting composite fluorescent films exhibited desirable UV-blocking capacity and superhydrophobic surface behavior, which collectively contribute to better protection of packaged goods, particularly moisture-sensitive products. This study demonstrates a novel and eco-friendly approach to functional food packaging design by combining natural pigments, nanostructured carriers, and biodegradable polymers. The findings suggest strong potential for commercial applications in the food industry, promoting both product safety and sustainability.

Plateforme de diffraction des rayons-X de l'Université de Montréal

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La plateforme rayon-X offrent plusieurs services :

1. Résolution de structure pour monocristal avec source Metaljet (Ga)
a. Basse température et température variable.
b. Détermination de conformation absolue des molécules chirales.

2. Mesures sur poudre:
a. 4 sources disponible Co, Cu, Mo et Ag, pour tout type d'échantillons.
b. Mesures *in-situ*, sous atmosphère et température contrôlé.
c. Mesures à angle rasante (source Cu seulement).
d. Mesure en transmission avec capillaire ou direct (source Mo ou Ag).
e. Analyse d'échantillons par méthode de Rietveld et autres techniques.

The X-ray platform offers several services:

1. Single-crystal structure resolution with a Metaljet (Ga) source
a. Low and variable temperature.
b. Absolute conformation determination of chiral molecules.

2. Powder measurements:
a. 4 sources available: Co, Cu, Mo, and Ag, for all sample types.
b. In-situ measurements, under controlled atmosphere and temperature.
c. Grazing angle measurements (Cu source only).
d. Transmission measurements with capillary or direct (Mo or Ag source)
e. Analysis of samples by Rietveld method and other techniques.

Synthèse et caractérisation de structures organiques microporeuses à base de thiophène pour l'extraction sélective de l'or issu des déchets électroniques

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Avec l'augmentation des déchets électroniques, la récupération de l'or suscite un intérêt croissant. Les réseaux organiques covalents (COFs) ou les structures organiques microporeuses (MON), une nouvelle classe de matériaux microporeux, présentent des avantages remarquables pour la récupération de l'or (Au) grâce à leur grande surface spécifique, leurs groupes fonctionnels sélectifs, leurs canaux réguliers et leur synthèse modulable. Dans cette étude, un MON à base de thiophène a été synthétisé en utilisant le 1,8-dibromobenzo(b,d)thiophène et le 1,4-diéthynylbenzène pour des applications de récupération de l'or. Le MON obtenu a été caractérisé à l'aide de diverses techniques, notamment la diffraction des rayons X sur poudre (PXRD), la méthode de Brunauer-Emmett-Teller (BET), la microscopie électronique en transmission (TEM), la microscopie électronique à balayage (MEB) et la spectroscopie photoélectronique X (XPS). Le Fe_3O_4@MON a montré une excellente capacité d'adsorption de l'or, avec une grande sélectivité et une cinétique rapide. Ses performances surpassent celles de nombreux COFs aux structures plus complexes et dotées de multiples groupes fonctionnels. Ces résultats mettent en évidence le potentiel du Fe_3O_4@MON pour une récupération pratique de l'or à partir des déchets électroniques.

Mots clés: les structures organiques microporeuses, déchets électroniques, réseaux organiques covalents, récupération de l'or.

SCANNING PROBE MICROSCOPY (SPM) AT THE LABORATORY OF CHARACTERIZATION OF MATERIALS (LCM)

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Since January 2001, the Laboratory for the Characterisation of Materials (LCM) has offered the research community in Quebec access to a variety of state-of-the-art instruments. Our research professionals provide training and technical support. Here, we describe the various scanning probe microscopy (SPM) options available at the LCM. In addition to imaging topography, SPM can use a variety of forces to measure variations in nanomechanical, chemical and physical properties. As a technique, SPM is not bound to specific environmental conditions; it can be performed in a vacuum, in air or in a fluid, and at a variety of temperatures. Thanks to the expertise available at the LCM, our infrastructure is one of the most specialised platform in Quebec for imaging nanostructured materials and thin films on length scales ranging from the nanometre to the micron. More than 100 scientists use our SPM installation every year. Our facility is open to researchers from all sectors (academia, government and industry) at affordable rates.

SELF-ASSEMBLED ORGANIC MOLECULAR FILMS: FROM REDOX-RESPONSIVE SURFACES TO BIOMEMBRANES

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The self-assembly of organic molecules on solid substrates and at the air/water interface offers unprecedented opportunities to create organized monolayer films that impart specific surface properties or facilitate the investigation and manipulation of interactions between molecules or particles and interfaces. One research thrust employs self-assembled monolayers (SAMs) of ferrocene-terminated alkanethiolates chemisorbed onto gold to drive the charge transfer-induced assembly of amphiphilic materials at solid/aqueous interfaces and to enable nanomechanical actuation. To fully harness the capabilities of these redox-active SAMs, we are investigating how their (supra)molecular organization and intermolecular interactions influence their macroscopic properties. In parallel, Langmuir monolayers composed of phospholipids and phospholipid–protein model mixtures of pulmonary surfactant are used to assess the potential of inhaled molecular and nanoparticulate matter to impair respiratory function and to guide the design of carbon-based nanoparticles for pulmonary drug delivery. The ultimate goal is to engineer functional films for technological, environmental or biomedical applications.

LAYER BY LAYER MODIFIED LIPID NANOPARTICLES FOR MIR181A A DELIVERY IN GLIOBLASTOMA TREATMENT

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Glioblastoma multiforme (GBM) is the most common and lethal primary brain cancer. Current pharmacological interventions marginally increase the 12-month overall survival of patients with GBM. Among the novel therapeutic strategies being pursued, micro-RNAs, a class of non-coding RNAs, are receiving considerable attention for their regulation of several pathways implicated in tumorigenesis and survival. Notably, microRNA-181a-5p (miR-181a) has consistently been reported to be downregulated in GBM clinical samples, and its overexpression negatively affects tumor growth both in vitro and in vivo.

To improve the delivery of miR-181a to GBM cells, we sought to develop a modified lipid-based nanocarrier capable of encapsulating and delivering miR-181a to GBM cells in vitro and in vivo.

Lipid Nanoparticles (LNPs) containing miR181a were modified using the layer-by-layer strategy where hyaluronic acid composed the outermost layer. Hyaluronan-decorated LNPs (HA-LNP) were characterized by DLS, encapsulation efficiency, and AFM. Glioblastoma cells targeting was identified by Flow Cytometry and Confocal Microscopy. Transfection efficiency was evaluated in vitro after incubation of HA-LNPs/siGFP with HeLa and U251 GFP cells. The effect of miR-181a on GBM cells was assessed in vitro (viability assay) and in vivo (tumor growth).

The resulting HA-LNPs targeted GBM cells more efficiently than non-modified LNPs and mediated siRNA and miRNA transfection in vitro. Finally, delivery of miR-181a by HA-LNPs induced significant cellular death of U87 GBM cells in vitro and delayed tumor growth in the subcutaneous tumor model.

In summary, we report on the surface modification of lipid nanoparticles using the LbL process for improved siRNA and miRNA delivery. We add more evidence that rescuing the expression of miR-181a by exogenous gene transfer impairs tumor development in vivo. A better understanding of the miR-181a intracellular mechanism in GBM context will help researchers and clinicians to propose a combined strategy to alleviate the yet dismal prognosis of this malignancy.

Préparation et caractérisation de cristaux liquides imprimés en 3D

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L'impression 3D est une méthode de mise en forme additive employée dans divers domaines pour concevoir des architectures complexes. Ces domaines peuvent varier allant du domaine aérospatial, médical et même à des usages en conversion et en stockage d'énergie. Or, une compréhension approfondie du contrôle de la microstructure en impression 3D est encore peu abordé, contrairement à l'attention qui a été portée aux films minces et aux objets de faible dimension. Par exemple, il est connu que l'électrofilage est une technique permettant d'aligner des molécules dans une fibre suite à l'application d'un potentiel électrique lors de sa fabrication. Dans cette étude, un système spécifique est examiné dans le but d'approfondir notre compréhension des phénomènes d'organisation moléculaire durant l'impression 3D, car dans le cas des polymères, leurs propriétés et leurs fonctions dépendent directement de leur organisation.

Le système examiné est un élastomère à cristaux liquides thermosensible. Ce polymère est choisi pour son imprimabilité due à ses transitions thermiques : une basse transition vitreuse (T_g) et une transition nématique-isotopique (T_{NI}), phase où les molécules sont orientées de manière aléatoire, permettant un domaine d'imprimabilité se situant entre ces transitions menant à l'impression de structures comportant une anisotropie. Ce système a été étudié au moyen de diverses méthodes de caractérisation, telles que : la photo-rhéologie infrarouge (Photo rhéo-IR), la calorimétrie différentielle à balayage (DSC), la microscopie optique polarisée (POM), ce qui nous permet de conclure que la contrainte exercée par la buse lors de la mise en forme influence l'alignement de la matière, comme ce qui a été observé pour les méthodes de mise en forme des films minces. Cette méthode offre un contrôle supplémentaire sur les microstructures du système choisi.

277 mots

N-HETEROCYCLIC CARBENES CONTAINING POLYMERS FOR PLASMONIC NANOMATERIAL

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Normal and mesoionic *N*-heterocyclic carbenes (*m*NHCs) are constituting a well-established ligand class for the stabilization of metal complexes and nanoparticles thanks to their extensively investigated strong metal-ligand interactions. The development of *m*NHCs through the simple and accessible click chemistry and bottom-up approach is leading to the improvement of plasmonic nanomaterials stability and the preservation of their optoelectronic properties. Polymerized NHCs on the surface of the plasmonic nanoparticles are already showing highly stable networks under various conditions without disrupting plasmonic behavior.[1,2] By combining the proprieties of these NHCs and our expertise in polymer chemistry, we are targeting the synthesis of metallic nanoparticles with enhanced stability and properties, with the goal of stabilizing extremely air-sensible metallic nanoparticles, with great catalytic interest. Our approach is starting from the product of our click reaction that we are polymerizing under controlled conditions, reaching precise repeat unit number. Continuing with this defined moiety, synthesis of metal-NHCs complexes and their reduction is soft and moderated as no free NHCs are present as intermediates. Furthermore, we are planning to extend our work by forming different sort of shapes of our polymer networks by adjusting the polymerization techniques, leading to the fine tuning of nanomaterial shapes and overall properties.

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Advancing Sustainable Wood Adhesives: A Green Chemistry and Wood Engineering Approach to Tannin Extraction

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Abstract

Engineered wood panels are widely manufactured using petrochemical adhesives such as urea-formaldehyde (UF), phenol-formaldehyde (PF), and melamine-formaldehyde (MF) resins, all of which release formaldehyde, a known hazardous volatile organic compound. As awareness grows around the health and environmental impacts of formaldehyde emissions, the wood industry is under increasing pressure to find bio-based, non-toxic alternatives that maintain performance while reducing ecological footprint.

This project explores the potential of tannin-rich bark from Quebec's softwood species; Jack Pine (Pinus banksiana), Black Spruce (Picea mariana), and White Spruce (Picea glauca), as a source for formaldehyde-free adhesives. These bark residues, currently underutilized or burned by sawmills, represent a promising raw material in the transition toward greener adhesive technologies.

Our research integrates wood engineering and green chemistry to optimize tannin extraction methods and develop novel adhesive formulations. This approach prioritizes key performance criteria such as bond strength, moisture resistance, dimensional stability, and cost-effectiveness, while drastically reducing the presence of allergens and volatile organic compounds. The project also aims to reduce industrial waste and valorize local forest resources in line with sustainable development goals.

By combining academic expertise with industrial collaboration, this initiative contributes to Quebec's leadership in renewable material innovation. The outcomes of this work are expected to support the creation of new composite panels using bio-based adhesives that meet market standards without relying on synthetic chemicals.

Keywords : Bio-adhesives, Tannins, Formaldehyde- free, Boréal Forest, softwood

PLASMA-MODIFIED MICROPATTERNS ON FLUOROPOLYMER FOR CELL ADHESION

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This study explores the use of plasma-enhanced chemical vapor deposition (PECVD) to create functionalized micro-patterned fluorinated ethylene propylene (FEP) films for biomanufacturing applications. Micropatterns of 100 and 150 microns were fabricated using plasma polymer deposition following ammonia pre-treatment. The films were treated with gas mixtures of ethylene, ammonia, and carbon dioxide under optimized RF power and time conditions.

The resulting surfaces were characterized using Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS), confirming the presence of oxygen- and nitrogen-rich functional groups. These modified FEP surfaces promoted the adsorption of extracellular matrix (ECM) proteins, enabling improved cell adhesion and viability.

Mouse insulinoma cells (MIN6) and human pluripotent stem cells were cultured on the modified surfaces. Live/dead analysis confirmed high viability of MIN6 cells after five days, and immunostaining showed robust expression of pancreatic differentiation markers (PDX1, NKX6.1) in stem-cell-derived posterior foregut cells cultured on the patterned substrates.

The micropatterns supported localized clustering, a feature known to influence differentiation outcomes. This platform offers a scalable, biocompatible, and clinically relevant system for culturing cells in regenerative medicine and stem-cell-based therapies.

Our results highlight PECVD as a powerful tool for engineering fluoropolymer surfaces that support advanced biomanufacturing needs. The platform holds promise for closed, GMP-compatible systems designed to maintain cell viability and guide differentiation, especially in pancreatic lineage development.

Terpyridine-based Ruthenium (II) Complexes for Hydrogen Production and Artificial Photosynthesis

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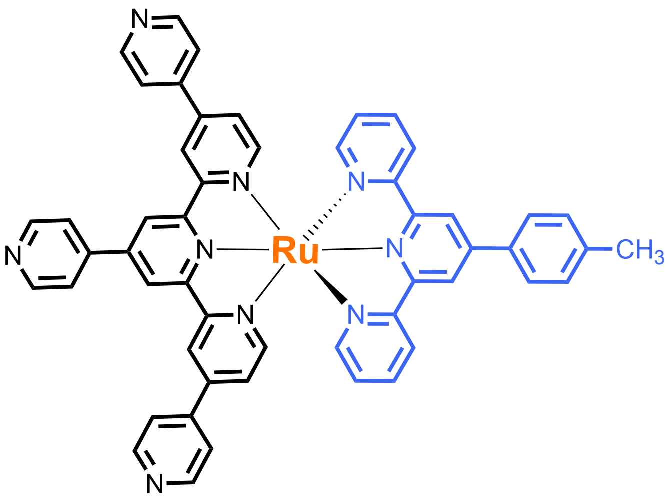
With a growing global need for alternative forms of energy, the development of novel complexes to photochemically produce hydrogen from water is of high interest. This project aims to convert solar energy into chemical energy using new Ruthenium polypyridine complexes.[1] This work involves the design, synthesis, and characterisation of substituted terpyridine ligands using different functionalities such as *(*Methoxy/ Bromo/ Cyano /Carboxamide or Methyl*)*-Phenyl to assess their stability and light-harvesting efficiency. The synthetized ligands can then be complexed with ruthenium along with *4,4',4''-(4'''-pyridyl)-2,2':6',2''-terpyridine (py$_3$tpy)* in a two-step approach to form heteroleptic complexes.[2,3] These complexes can be further used in supramolecular architectures for heterogeneous catalysis or photovoltaics applications.



Heteroleptic complex Ru(py$_3$tpy)(tpy-Ph-Me)$^{2+}$

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HYDROGEL CONTAINING LIPOSOMAL ENZYME MICROREACTORS FOR MOLECULAR DIAGNOSIS IN DIABETIC FOOT ULCERS

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Diabetic foot ulcers (DFU) are a serious diabetes complication linked to high rates of amputation and mortality. Current DFU diagnostics rely on visual assessments such as wound depth and signs of infection. However, this visual assessment does not consider the complexity of the ulcer and is rather subjective. Overexpression of hydrogen peroxide (H_2O_2) contributes to chronic inflammation and the non-healing state of DFUs. Therefore, we are developing a hydrogel with liposomal microreactors to monitor H_2O_2 levels in wounds.

The methodology involves the development of liposomal microreactors via the thin-film rehydration method. These liposomes are loaded with horseradish peroxidase (HRP) and fluorescent dye sulfo-cyanine 7 (S7) and integrated into an alginate-based hydrogel. Upon application, wound fluids diffuse into the hydrogel, where they encounter liposome microreactors. Inside the liposomes, S7 reacts with HRP and H_2O_2, resulting in a measurable loss of fluorescence proportional to H2O2 levels. The system will be tested on animal models of DFUs to assess overall performance (Fig 1A).

The development and characterization of liposomal microreactors were achieved. S7 fluorescence decreases within 40 seconds in a hydrogen peroxide-dependent manner, showing a 60% reduction at the highest H_2O_2 concentration after 20 minutes. The quantity of HRP loaded in the liposomes was optimized for detecting H_2O_2 within a clinically relevant range of 1 to 10 µM (Fig 1B). Additionally, prototypes of alginate hydrogels have been developed and are being evaluated for their H_2O_2 sensing capability. The next steps include optimization and characterizing hydrogels, testing in biologically relevant media, and in vivo tests in diabetic wound mouse models.

DFUs remain challenging due to the lack of objective diagnostics. The proposed hydrogel system enables sensitive in situ H_2O_2 detection within clinically relevant ranges. Initial results are promising, with further optimization and validation in animal models required for clinical translation.

ADSORPTION D'UN ANTIDÉPRESSEUR DANS UNE COLONNE A LIT FIXE UTILISANT UN CRYOGEL HYBRIDE A BASE D'ACRYLATE DE SODIUM ET DE CARBOXYMÉTHYLCHITOSANE

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Résumé

Les antidépresseurs sont une classe de produits pharmaceutiques psychotropes considérés comme des contaminants émergents. Ils suscitent des inquiétudes à l'échelle mondiale en raison de leur faible biodégradabilité, leur persistance et leur bioaccumulation dans l'environnement. Leurs résidus ont été détectés à l'état de trace (de l'ordre du ng/L) et leurs effets néfastes sur les organismes aquatiques vivant dans les milieux récepteurs sont répertoriés. L'augmentation constante de la consommation de ces médicaments par les humains contribue au rejet d'une proportion croissante de ces derniers et de leurs métabolites dans les égouts. Malheureusement, les stations d'épuration urbaines présentent une efficacité limitée pour détecter et éliminer ces contaminants des eaux usées avant leur rejet dans les cours d'eau environnants [1]. Il est donc impératif de mettre au point des technologies de traitement avancés simples, efficaces, peu onéreuses, et qui génèrent peu de sous-produits toxiques. L'adsorption constitue une technologie attrayante. Dans un contexte de développement durable, nous proposons de concevoir des biomatériaux adsorbants à partir de déchets de la biomasse. Plus spécifiquement, l'étude vise à développer un cryogel hybride à base d'acrylate de sodium et de carboxyméthylchitosane pour l'adsorption continue en lit fixe de la fluoxétine, à prédire et à modéliser les courbes de percée en mode opérationnel simple, facilement transposable à l'échelle industrielle. Une étude de l'effet des paramètres de fonctionnement (pH, débit, concentration initiale, hauteur du lit) sur la dynamique d'adsorption a été complétée. Le cryogel a une capacité de gonflement rapide dans l'eau (10 secondes), une porosité très développée (98 %), un pH_{PZC} =7.5 et est très hydrophile comme l'a révélé l'analyse de l'angle de contact. Le pH= 8.5 est optimal pour l'adsorption avec un temps de percée plus long tandis que l'augmentation de la hauteur du lit augmente le temps de percée.

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COORDINATION DE LIGANDS BIS-AMOX AVEC DES MÉTAUX DE 1RE RANGÉE : CONCEPTION D'ARCHITECHTURES SUPRAMOLÉCULAIRES FONCTIONNELLES

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Les *N*-oxydes d'amidine (AMOX), ligands N,O anioniques et bidentates, forment des complexes de coordination stables et robustes *via* des cycles chélates à cinq atomes avec des ions métalliques. Ces composés présentent des propriétés photophysiques, rédox et magnétiques intéressantes, ce qui les rend pertinents pour le développement de matériaux fonctionnels, notamment dans les domaines de l'optoélectronique et de la catalyse. Leur capacité de chélation peut être modulée de manière contrôlée par la variation des substituants sur le squelette amidine, permettant d'influencer l'environnement stérique et électronique du complexe et, par conséquent, d'ajuster ses propriétés.

Compte tenu de l'intérêt des AMOXs en chimie de coordination, il nous est apparu pertinent d'étendre leur étude à la chimie supramoléculaire pour explorer leur potentiel comme matériaux fonctionnels. Dans cette optique, nous rapportons ici la formation de différentes architectures supramoléculaires multimétalliques obtenues par la coordination de ligands bis-AMOXs pontés par azote avec des métaux de transition de première rangée. La synthèse et la caractérisation de ces assemblages sont présentés, ainsi que leurs propriétés photophysiques et rédox. Les résultats préliminaires indiquent la formation d'assemblées dinucléaires discrets avec Ni(II) et Cu(II), ainsi que d'un polymère unidimensionnel luminescent avec Zn(II), illustrant, de ce fait, la polyvalence des ligands bis-AMOX dans la conception de systèmes supramoléculaires fonctionnels aux propriétés modulables.

McGill Chemistry Characterization (MC^2) Facility

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The McGill Chemistry Characterization (MC^2) facility is a multi-user facility that provides instrumentation and expertise on a wide variety of analytical and microscopy techniques. We serve both the experienced and novice investigators and our services include training for independent use, analytical services and full support from our experienced staff.

Our facilities are located in McGill's department of chemistry in Otto Maass and Pulp and Paper Research Centre. We serve over 100 researchers in both academia and industry.

In order to provide an open-access centralized facility equipped with cutting-edge research instrumentation, MC^2 is part of the Quebec Centre for Advanced Materials which receives funding from FRQNT.

TiO_2-Modified Pb Electrocatalysts for Electrochemical Conversion of Carbon Dioxide

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Lead (Pb) has attracted attention for the electrochemical production of formic acid/formate due to its low cost, chemical stability and high selectivity. Meanwhile, titanium dioxide (TiO_2) is well known for its applications in photodegradation and solar energy conversion. In order to improve the electrochemical performance of porous Pb electrodes for CO_2 reduction, TiO_2 was deposited on the porous Pb surface using atomic layer deposition (ALD). Afterwards, the prepared samples were characterized using a range of techniques, including Scanning Electron Microscopy (SEM), X-ray Diffraction (XRD), X-ray Photoelectron Spectroscopy (XPS), and Transmission Electron Microscopy (TEM).

Surprisingly, in the absence of light, electrochemical CO_2 reduction tests showed that TiO_2-modified electrodes exhibited a reduced onset potential for formate formation, from -0.65 V for porous Pb to -0.15 V *vs* RHE. This is accompanied by higher faradic efficiency at lower overpotential and improved energy efficiency in the absence of any light irradiation. Among the samples tested, the porous Pb electrode modified with 150 ALD cycles of TiO_2 showed exceptional performance, achieving a maximum faradaic efficiency of 100% and a maximum energy efficiency of 80% at an overpotential of 120 mV. These values exceed those of the unmodified electrode and are among the highest energy efficiencies reported in the literature.

The enhanced performance is attributed to the altered interaction between water molecules and the catalyst surface induced by the presence of TiO_2 at the electrode surface. This study highlights the potential of TiO_2-modified Pb electrocatalysts as highly efficient and selective materials for CO_2 electrochemical conversion. The findings pave the way for the development of high-performance and energy-efficient electrocatalysts for carbon utilization.

PERFORMANCE ANALYSIS OF P3HT:PCBM BASED ORGANIC PHOTOVOLTAIC ARCHITECTURES WITH AND WITHOUT LITHIUM FLUORIDE: A CROSS-INSTITUTIONAL STUDY OF ENVIRONMENTAL INFLUENCE AND STANDARDIZATION

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This study presents a comparative investigation of Organic Photovoltaic (OPV) devices fabricated at Concordia University and McMaster University, focusing on how fabrication environments influence key device performance parameters. Two commonly studied OPV architectures were selected for this work: ITO/PEDOT:PSS/P3HT:PCBM/Al and ITO/PEDOT:PSS/P3HT:PCBM/LiF/Al. These structures provide a reproducible platform for evaluating device behavior and material interactions in polymer-fullerene solar cells. Although matched fabrication protocols were used, including spin-coating of the active layer and thermal evaporation of the electrodes, differences in ambient humidity, glovebox atmosphere, substrate handling, and annealing conditions could contribute to performance variations.

Device characterization was carried out under standard AM 1.5G illumination to assess short-circuit current density (Jsc), open-circuit voltage (Voc), fill factor (FF), and power conversion efficiency (PCE). The role of a thin lithium fluoride (LiF) interlayer, which is often used to enhance electron extraction and reduce interfacial resistance, was specifically analyzed in both fabrication environments to determine its effect on performance consistency and stability. Comparative data reveal how small environmental differences can influence the morphology and electronic quality of both the active and interfacial layers, leading to measurable changes in device output.

By identifying trends and potential sources of variability, this work contributes to the broader goal of developing standardized OPV fabrication and testing protocols that enhance reproducibility across laboratories. These findings underscore the critical role of environmental control in OPV development and demonstrate the need for collaborative benchmarks across institutions. Ultimately, this study aims to promote best practices for scalable, high-efficiency organic solar cells and supports the ongoing efforts of the materials science community to bridge performance gaps caused by uncontrolled external variables. The insights gained may be particularly useful for multi-site research initiatives and industrial scaling of OPV technologies.

MECHANISTIC INSIGHT INTO THE GENERATION OF A MOLECULAR CRYPTID USING HYPERVALENT IODINE

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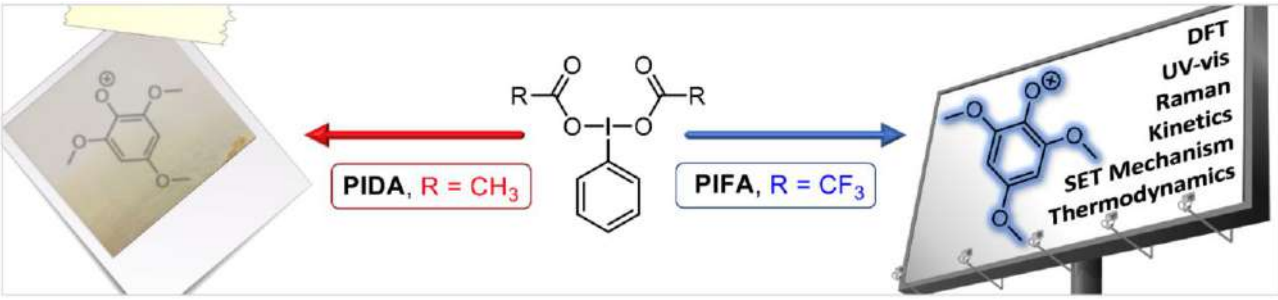
Hypervalent iodine compounds are widely used in organic synthesis as strong, yet selective oxidation reagents. Their use in phenol dearomatization have unlocked a new method to add nucleophiles on aromatic moiety using a greener and cheaper alternative to heavy metals. This reaction is well known and has been used in several total synthesis [1] and synthetic methodologies [2,3], but the mechanism behind this umpolung reactivity of phenols remains uncertain. Some researchers postulated an associative mechanism between the hypervalent iodine and the phenol, making a strong electrophilic complex. Others have postulated a peculiar and under-documented intermediate: the phenoxenium cation. This molecular cryptid, stabilized by fluorinated polar solvent like 1,1,1,3,3,3-hexafluoroisopropanol, helps explain several observed reactivity leading to dearomatized phenols. This phenoxenium is not a trivial intermediate and two mechanistic pathways have been proposed to explain its generation using hypervalent iodine: two subsequent outer-shell single electron transfer or a heterolytic cleavage of a phenol-iodine bond complex. Using a combined theoretical, kinetic, and spectroscopic approach, we present direct evidence for the existence of the titular molecular cryptid and evidence for its generation mechanism.[4]



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DEVELOPMENT OF ORGANIC-INORGANIC SELF-HEALABLE AND DEGRADABLE POLYMERS FOR ADVANCED APPLICATIONS.

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The development of durable materials is a key challenge in modern materials science, particularly when longevity and reduced material waste are considered essential for sustainability. Self-healing systems offer a promising route toward such goals by extending the functional lifetime of materials. Our research explores an unconventional intersection between self-healing polymers[1] and inorganic cages architecture[2]. In this presentation, we will highlight our recent work on a polymer system based on polyurea incorporating a phosphorus–nitrogen 3D inorganic cage. Preliminary results include the successful synthesis of polymers, characterized primarily by ^{1}H and ^{31}P NMR spectroscopy. Molecular weight estimation was performed using DOSY NMR : this provides information on molecular diffusion, allowing an indirect estimation of molecular weight in solution.[3] The resulting materials exhibit relatively rigid textures, likely influenced by the cage architecture. These early findings are promising yet offer substantial room for improvement.

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