CQMF QCAM

COLLOQUE ÉTUDIANT
STUDENT SYMPOSIUM

LUNDI 10 NOVEMBRE 2025
MONDAY NOVEMBER 10th 2025

CARNET DE RÉSUMÉS
ABSTRACT BOOKLET

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1. Commanditaires/Sponsors

2. Mot de bienvenue/Welcoming remarks

C’est avec un immense plaisir que le comité étudiant du CQMF vous accueille à l’École de technologie supérieure (ÉTS) pour le Symposium étudiant 2025 du CQMF, ce 10 novembre 2025. Cet événement représente une occasion privilégiée de mettre en valeur les travaux de recherche de notre communauté étudiante et de stimuler le dialogue entre professeur·e·s, professionnel·le·s de l’industrie et étudiant·e·s.

Ce carnet de résumés présente l’horaire de la journée, les résumés des présentations orales étudiantes (classés par séance), les titres des présentations par affiche, ainsi qu’un aperçu du panel consacré aux opportunités de carrière dans les matériaux.

Nous encourageons les échanges et discussions entre étudiant·e·s diplômé·e·s, postdoctorant·e·s et professeur·e·s afin de renforcer la collaboration et la recherche au Québec. Nous vous invitons également à rester jusqu’à la fin de la journée pour célébrer les lauréat·e·s des présentations orales et par affiche.

Enfin, avez-vous déjà envisagé de rejoindre le comité étudiant du CQMF ?
C’est une belle occasion d’apporter de nouvelles perspectives, d’enrichir votre parcours et de contribuer à un environnement dynamique et collaboratif. Si vous êtes passionné·e par la recherche et le développement académique, nous vous invitons à vous impliquer pour façonner les prochains événements inspirants du CQMF.

Le comité étudiant du CQMF

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It is with great pleasure that the CQMF Student Committee welcomes you to the 2025 CQMF Student Symposium, held at the École de technologie supérieure (ÉTS) on November 10, 2025. This event provides a valuable opportunity to highlight the research achievements of our student community and to foster dialogue among professors, industry professionals, and students.

This abstract booklet includes the day’s schedule, the student oral presentation abstracts (organized by session), the titles of poster presentations, and an overview of the panel on career opportunities in the field of materials.

We encourage discussion and collaboration among graduate students, postdoctoral fellows, and professors to strengthen research and innovation across Quebec. We also invite you to stay until the end of the day to celebrate the winners of the oral and poster presentations.

Have you ever considered joining the QCAM Student Committee?
It’s a great opportunity to bring fresh perspectives, enhance your experience, and contribute to a dynamic, collaborative environment. If you are passionate about research and academic development, we invite you to get involved and help shape the future inspiring events of the QCAM.

The QCAM student committee

3. Programme du colloque/ Symposium Schedule

Time		Presenter	Supervisor	Research	
9:00 AM	**Opening Remarks**				
9:15 AM	OP 1	Tristan Perodeau	Audrey Laventure	Polymer/Energy	Oral Presentations [9:15 – 11:30 AM]
9:30 AM	OP 2	Thomas Jacquemin	Ali Nazemi	Polymer/Sustainability	
9:45 AM	OP 3	Camilo Garcia Henao	John A. Capobianco	Nanosciences	
10:00 AM	OP 4	Hanine Zakaria	Amy Blum	Nanosciences	
10:15 AM	OP 5	Lindsay Thomas	Ashlee Howarth	Self-Assembly	
10:30 AM	OP 6	Erick Daniel	Alejandro Rey	Biomedical	
10:45 AM	OP 7	Sanjeet Kumar	Armand Soldera	Sustainability/Energy	
11:00 AM	OP 8	Anees Babar	Jean-François Morin	Biomedical/Sustainability	
11:15 AM	OP 9	Sarah Yassine	Janine Mauzeroll	Sustainability	
11:30 AM	FT 1	Tiam Mahmoudian	Alain Cloutier	Sustainability	Flash Talks [11:30 AM – 12:00 PM]
11:33 AM	FT 2	Oumayma Tajir	Said Elkoun	Sustainability	
11:36 AM	FT 3	Djoussie Ngatsing Chivarol	Claudiene Ouellet-Plamondon	Sustainability	
11:39 AM	FT 4	Jumana Mahmud	Monique Lacroix	Sustainability	
11:42 AM	FT 5	Marc-Antoine Campeau	Corinne Hoesli	Biomedical	
11:45 AM	FT 6	Ahmed Ba Amer	Joshua Byers	Nanosciences, Energy	
11:48 AM	FT 7	Sirirat Khemasiri	Mohamed Siaj	Biomedical	
11:51 AM	FT 8	Javier Vargas	Audrey Laventure	Polymer	
12:00 - 1:30 PM	**Lunch | Posters [12:00 - 1:30 PM]**				
1:30 PM	OP 10	Jeremie Ouellette	Jean-François Morin	Energy	Oral Presentations [1:30 – 3:45 PM]
1:45 PM	OP 11	Mohamed Fatahine	Mohamed Mohamedi	Energy	
2:00 PM	OP 12	Saloua Merazga	Mohamed Mohamedi	Energy	
2:15 PM	OP 13	Ilyes Oubaha	Garry Hanan	Energy	
2:30 PM	OP 14	Zujhar Singh	Steen Schougaard	Energy	
2:45 PM	OP 15	Thomas Boulanger	Mickaël Dollé	Energy	
3:00 PM	OP 16	Chenier Charles	Mickaël Dollé	Energy	
3:15 PM	OP 17	Nasim Afzali	Jesse Greener	Energy	
3:30 PM	OP 18	Galal Nasser	Jan Kopyscinski	Energy	
3:45 - 4:45 PM	**Panel Discussion [3:45 - 4:45 PM]**				
4:45 PM	**Closing Remarks**				
5:00 PM	End time				

4. Nos panéllistes/Our Panelists

Fadwa Ben Amara, Conseillère technique en brevets | Technical Patent Advisor ROBIC

Fadwa specializes in drafting and prosecuting patent applications in the field of battery, chemistry and functional materials. Her expertise spans surface chemistry, electrochemistry, spectroscopy, polymer physical chemistry and analytical chemistry.

Ehsan Hamzehpoor, Professeur adjoint | Assistant Professor UdeM

Dr. Ehsan is an Assistant Professor of Organic Chemistry and Materials at the University of Montréal. His research expertise is in organic materials, particularly in designing covalent organic frameworks and engineering molecular solids to control properties like phosphorescence and semiconducting behavior.

Ngoc Duc Trinh, Directeur général adjoint | Deputy General Manager I-CI

Ngoc holds the position of Deputy General Manager at the Institute in graphic communications and printability (ICI), a non-profit college technology transfer center associated with Collège Ahuntsic. In this role, he is part of a team that supports businesses in the graphic communications industry through innovation, research, and training.

Yiwen Chen, Fondatrice et directrice de la R&D | Founder and Head of R&D ChillSkyn

Yiwen is a materials scientist with a PhD in Materials Engineering from McGill University. As Head of R&D and Co-Founder at ChillSkyn, she leads the development and commercialization of next-generation passive cooling coatings—leveraging cutting-edge science to deliver real-world environmental and commercial impact.

5. Résumés des présentations/Talks abstracts

Séance/Session 1 – Polymères, durabilité et auto-assemblage/Polymers, sustainability and self-assembly

Unveiling the role of Crystallinity in Solid Polymer Electrolyte's ion transport: A combinatorial Polarized Optical Microscopy – Electrochemical Impedance Spectroscopy approach

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The development of solid polymer electrolyte (SPE) for different electrochemical applications such as energy storage devices and electrochromic devices enables a safer and denser energy storage solution to the ones currently available. However, SPE systems demonstrate sub- par ionic conductivity for applications. In order to ameliorate the ion transport properties of these systems, it is necessary to properly characterize the impact of the multiphase microstructure. Polymer crystallinity as long been identified as an ionic transport hinderance in SPE applications. Considering the amorphous phase as the conducting phase and the crystalline phase as a non-conducting phase, the impact of crystallinity on the ionic transport behavior can be studied through Electrochemical Impedance Spectroscopy (EIS). However, these measurements only reveal the ionic character of the sample without shedding light on the microstructure.

In this study, two polymeric systems with different crystallization behaviors were chosen to highlight the impact of the crystalline phase on the EIS spectrums. Poly(ε-caprolactone) (PCL) and Poly(lactic acid) (PLA) respectively mixed at controlled molar ratios (r = 40 & r = 15) with Lithium bis(trifluoromethane)sulfonimide (LiTFSI) were used to form SPEs. SPEs are known to present a singular phase response in EIS measurements compared to the ceramic electrolyte counterpart where a grain boundary contribution is noticeable. Intriguingly, the crystalline PCL:LiTFSI system shows a similar two-phase EIS response to a ceramic electrolyte.

To adequately understand the role of crystallinity in the ionic transport behavior of thissystem, we developed an electrochemical cell allowing EIS measurements while simultaneously observing the polymer's microstructure evolution. Simultaneous optical observation through Polarized Optical Microscopy (POM) and Electrochemical Impedance Spectroscopy (EIS) allowed to properly characterize the hinderance of crystallinity in these systems. Atomic force microscopy (AFM) and Differential Scanning Calorimetry (DSC) were employed to elucidate the impact of the rigid amorphous fraction (RAF) on the ion transport behavior in SPE materials. The amorphous phase being spatially constrained by the growing crystalline phase, leads to diminished ionic transport properties through difficult polymer chain mobility at the interphase.

Development of Organic-Inorganic PN Cage-Containing Polymers as Degradable Coatings

Thomas Jacquemin [1], Maryam F. Abdollahi [2], Anjali N. Nambidiyattil [2], Anthony Olivier [3], Yasmine Rassi [1], Audrey Laventure [3], Saurabh S. Chitnis [2], Ali Nazemi [1]*

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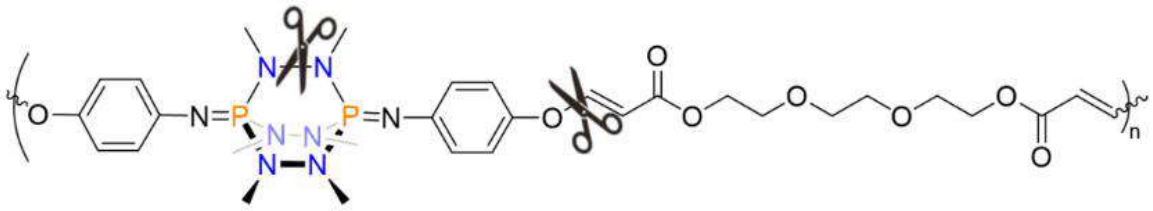
The development of durable materials is a key challenge in modern materials science, particularly when controlled degradation and minimization of persistent waste are considered essential for sustainability. The conception of degradable polymeric materials able to fragment at the end of their lives constitutes a promising route in sustainable materials design. In this presentation, we will highlight our recent work on a polymer system based on an activated alkyne-hydroxyl "click chemistry"[1] between an organic monomer and a phosphorus–nitrogen inorganic cage.[2] The results include the successful synthesis of different polymers, characterization primarily by ^{1}H and ^{31}P NMR spectroscopy, FTIR, thermogravimetric analysis and differential scanning calorimetry. Molecular weight estimation was performed using gel permeation chromatography but also 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.



(1) Maity, A.; Chen, J.; Wilson-Faubert, N.; Laventure, A.; Nazemi, A. Harnessing Activated Alkyne-Hydroxyl "Click"
Chemistry for Degradable and Self-Healing Poly(Urea Vinyl Ether Ester)s. Macromolecules 2024, 57 (1), 305–316.
(2) Bedard, J.; Chitnis, S. S. Three-Dimensional Synthons for Cage-Dense Inorganic Polymers and Materials. Chem. Mater. 2023, 35 (20), 8338–8352.
(3) Ruzicka, E.; Pellechia, P.; Benicewicz, B. C. Polymer Molecular Weights via DOSY NMR. Anal. Chem. 2023, 95 (20), 7849–7854.

Shaping Traps, Shaping Light: Persistent Luminescence in Er^{3+}-Doped $NaLuF_4$ Nanoparticles

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Persistent luminescence has emerged as a promising platform for applications ranging from bioimaging to optical storage, where performance critically depends on the distribution and depth of charge carrier traps.[1] In this work, we systematically investigate trap engineering in β- NaLuF4:Er^{3+} nanoparticles through monovalent (Li^+, K^+) and trivalent (Fe^{3+}, La^{3+}) codoping strategies. Using a combination of structural (TEM, XRD) and spectroscopic techniques (radioluminescence, thermoluminescence, and afterglow kinetics), we probe the role of codopants in tuning both trap depth and trap density.[2] Thermoluminescence measurements reveal that codopant type and ionic radius exert a distinct influence on trap distributions. The introduction of larger dopant ions produces a shift toward deeper and more thermally stable traps, while smaller aliovalent ions preferentially enhance the concentration of shallow traps. Radioluminescence and afterglow decay analyses corroborate these findings, showing slower afterglow decay and improved temperature stability in systems dominated by deeper traps. Importantly, the results highlight that trap depth and trap concentration can be tuned independently through rational dopant selection, providing direct control over the balance between intensity, duration, and thermal stability of the afterglow. These insights establish codoping as a powerful design strategy for persistent luminescent nanomaterials, enabling the tailoring of optical performance for specific applications.

[1] L. Yang, S. Gai, H. Ding, D. Yang, L. Feng and P. Yang, Adv. Opt. Mater., 2023, 11, 1– 43.
[2] K. Van Den Eeckhout, A. J. J. Bos, D. Poelman and P. F. Smet, Phys. Rev. B - Condens. Matter Mater. Phys., 2013, 87, 1–11.

Advancing Functional Nanomaterials: Gadolinium-Doped Iron Oxide Nanoparticles

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Superparamagnetic iron oxide nanoparticles (IONPs) have gained significant attention in research due to their useful magnetic properties and versatile applications. The magnetic properties of IONPs can be tuned via nanoparticle morphology (size and shape); however, for applications that require a specific size or shape, chemical handles would be more useful. Controlling the magnetic properties by adding or subtracting unpaired spins via replacing iron with other elements is of great interest. Here, we present research on synthesizing and optimizing gadolinium (Gd)-doped iron oxide nanoparticles using a novel approach that emphasizes mild and eco-friendly conditions. Gd^{3+} has 7 unpaired f electrons, while Fe^{3+} has 5 unpaired d electrons. Doping nanoparticles with additional unpaired spins can significantly enhance MRI imaging contrast, facilitating earlier disease detection and improving treatment monitoring. There are very few systematic studies on rare earth dopants in IONPs, making it difficult to predict the material's properties in doped IONPs. My project addressed this gap. By utilizing low-cost, non-toxic precursors and avoiding the harsh environments often associated with traditional methods, this innovative synthesis technique ensures scalability, sustainability, and precise control over the physical and magnetic properties of the nanoparticles. Advanced characterization techniques such as X-ray diffraction, TEM, FTIR, and SQUID magnetometry are employed to analyze and fine-tune the structure and magnetic behavior of the nanoparticles. By systematically applying mild, eco-friendly conditions and advanced characterization techniques, my project aims to unlock the full potential of IONPs in both biomedical and materials applications. The anticipated outcomes promise to deliver a deeper understanding of magnetic properties in IONPs and to integrate them into materials, setting the stage for significant advancements in a range of advanced materials applications.

Laser-heated polymers as an alternative in catheter sterilization

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Catheters are ubiquitous in medical settings but are highly susceptible to bacterial colonization in the form of biofilms. Most existing strategies to prevent catheter-related infections are either costly or contribute to the development of bacterial resistance. Hyperthermia offers a promising alternative without these drawbacks; however, previously studied catheter heating methods often create hot spots that can damage surrounding tissue. This work presents a novel approach to catheter sterilization using laser heating of a thermo-chromic material layer surrounding the external catheter wall. This material helps regulate the temperature, limiting peak values and reducing the risk of tissue damage. A heat transfer model for the system is presented, and temperature profiles are calculated for various laser treatment conditions. Results show that thermochromic materials significantly reduce temperature gradients compared to non-thermochromic alternatives. Additionally, the maximum temperatures reached during laser heating remain within a moderate range above the material's optical properties' transition temperature. These findings suggest that the proposed method is a promising candidate for safe in vivo sterilization of catheters and other medical implants.

Sustainable Production of a Zirconium Metal–Organic Framework Through Optimization of Washing Steps

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Zirconium-based metal–organic frameworks (MOFs) are among the most thermally and chemically stable classes of MOFs. Due to their versatility and high stability, they have been studied for a diverse array of applications, including catalysis, gas storage, wastewater remediation, and more. The current synthetic process for the vast majority of zirconium MOFs are time-intensive and require large volumes of N,N-dimethylformamide (DMF) as a washing solvent, which poses environmental concerns. This study examines the effects of a greener washing method, as well as reduced solvent washing contact time, and the effects of systematic changes on the final physical properties of a zirconium-based MOF. Structural characterization is primarily performed using powder X-ray diffraction (PXRD) and nitrogen gas adsorption analysis. Replacing the DMF washing solvent with water, while also reducing both the intervals between washes and the number of washes, increased synthetic throughput without compromising the high surface area and structural integrity of the MOF, demonstrating an effective, sustainable, and efficient preparation method.

Extending Turbine Lifetimes: Linking Crack-Tip Plasticity and Microstructure to Localized Corrosion in Stainless Steel Using SECCM

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Metal alloys such as stainless steel degrade under the influence of mechanical loading and electrochemical corrosion, processes that often act synergistically to accelerate material failure. In critical infrastructure components, like hydraulic turbines, fatigue cracking introduces microstructural deformation near crack tips, altering the local electrochemistry of the surface and triggering localized corrosion. Despite the importance of the fatigue-corrosion interplay, the mechanisms linking stress-induced microstructural changes and corrosion at the microscale remain insufficiently understood.

Conventional electrochemical techniques measure the average corrosion behavior over large areas, overlooking the microscale variations and their corresponding impact. On the other hand, high-resolution scanning electrochemical cell microscopy (SECCM) provides a powerful tool for probing corrosion locally and identifying pitting initiation points through a direct correlation of localized electrochemical activity with microstructural features over the scanned area.

In this work, we cyclically load CA6NM stainless steel specimens to induce plastic (non-reversible) deformation around growing cracks and subsequently map the resulting corrosion variations using an oil-immersed SECCM. Results reveal a more active electrochemical activity closer to the crack, reflecting a more intense reactivity. A higher susceptibility to pitting corrosion is also observed in the cracked region, which declines progressively with distance from the crack. This work demonstrates a clear spatial dependence of localized corrosion on mechanically stressed microstructures, providing new insights into the coupled mechanisms of fatigue and corrosion that govern the durability of stainless steels.

Molecular Insights into the Protic Organic Ionic Plastic Crystal (POIPC): Effect of Dopants and Vacancies

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In recent years, significant research effort has been dedicated to the development of robust, high performance solid electrolyte batteries. A wide range of materials, including polymers, ceramics, and glasses, etc. have been tested and characterized as potential solid electrolyte candidates. In this respect, organic ionic plastic crystals (OIPCs) have attracted significant research attention owing to their promising properties. Herein, following our previous work on pure POIPC, we conduct extensive molecular dynamics simulations, in conjunction with experimental methods, to investigate the effect of dopants and vacancies on the structural, thermodynamic, and dynamical properties of POIPC [DBUH]-[FSI], consisting of the protic $[DBUH]^+$ cation with labile proton (H^+) on the nitrogen atom. Simulations have been performed for the LiFSI doping fraction of 1.31%, 2.52%, 5.39%, and 10.55%. Additionally, the effect of Schottky vacancies was examined at concentrations of 0.23% and 0.46% for the 1.31% and 2.52% doped systems. The simulated solid-solid and the solid-liquid phase transition temperatures is in very good agreement with the DSC data. Our findings indicate that the effect of vacancy is more pronounced at the lower doping levels. Hydrogen bonding analysis reveals that the protic N2-H1 site forms the strongest hydrogen bond in the system, with N2-H1--O being the most dominant hydrogen bond. Using rotational auto-correlation functions (RACFs), we identify distinct solid phases associated with different rotational modes in the systems, confirming the presence of at least three distinct solid phases across the doping range. Translational dynamics analysis affirms that the [FSI] anion is the most mobile component in the system. The activation energy (E_a) computed using the Arrhenius plot, is in considerable agreement with the experimental data. The lithium cation transference number (t^{Li+}) too agrees very well with the experimental analysis.

Asymmetrical Azulenoazulene Derivatives as Fluorescent Sensors

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Non-alternant, non-benzenoid π-conjugated hydrocarbons composed of fused five and seven membered rings have attracted considerable attention in recent decades due to their distinctive structural motifs, intriguing optoelectronic properties, and broad potential in fields ranging from materials science to biological applications, while simultaneously posing significant synthetic challenges.

Herein, we report a π-extended azulenoazulene based fluorescent probe that functions as a highly responsive singlet oxygen 1O2 sensor. The unique 5–7–5–7 fused topology promotes strong intramolecular charge transfer, yielding a remarkably large Stokes shift of approximately 195 nm (λ_abs = 440 nm, λ_em = 635 nm, Φ_F = 0.01 in CH2Cl2). Upon 1O2 generation, the probe exhibits a distinct fluorescence enhancement due to oxidative modulation of the azulene core. Our studies also support the hypothesis that the scaffolds can store singlet oxygen for extended periods and release it when required. Photophysical measurements, complemented by TD-DFT calculations, further confirm that the non-alternant electronic structure of the azulenoazulene core stabilizes the excited-state charge distribution. These findings establish azulenoazulene as a promising non-benzenoid scaffold for developing responsive fluorescent sensors with tunable photophysical properties, as well as a potential building block for the synthesis of longer π-conjugated azulenoazulene derivatives with low HOMO- LUMO band gap.

Development of Extended Azuleno[2,1,8-ija]azulene Derivatives

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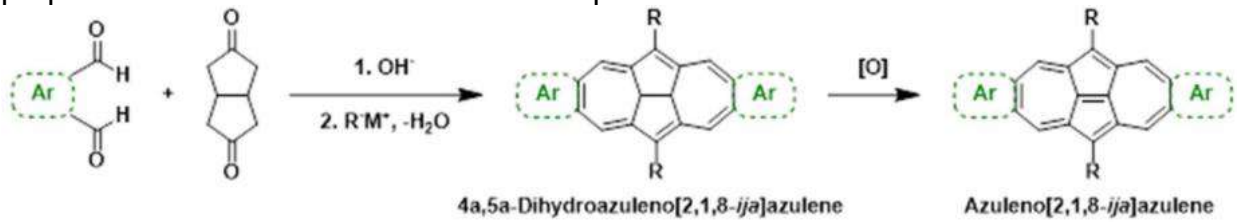
Over the past decades, non-alternant non-benzenoid hydrocarbons gained a lot of interest due to their unique optoelectronic properties.[1–3] Having a better knowledge of the structure-properties relationship is essential to further design semiconducting materials for optoelectronic applications. However, the synthesis of extended non-alternant, non-benzenoid -conjugated hydrocarbons remains a challenge.[4,5]
In 2023, we developed an efficient way to synthesize extended systems analogous to Vogel's azuleno[2,1,8-ija]azulene involving a four-fold aldol condensation between aromatic dialdehydes and commercially available tetrahydropentalene-2,5-(1H,3H)dione.[6] A problem arose from the transition from a fully conjugated closed-shell annulene to the diradical open-shell, which allowed dimerization of the phenyl derivative compound. Two approaches are explored to better understand the properties of such molecules. We first addressed this challenge by increasing the steric hinderance in proximity of the carbon where the radical is mainly located. Furthermore, stabilizing groups are added on the core to prevent dimerization. Upon the addition of sterically hindered groups, dimerization should be prevented, allowing a full characterization of the resulting product. Secondly, different aromatic moieties were added in the periphery of the azulenoazulene core. These modifications allow extending the π-conjugated system, resulting in a change of the optoelectronic properties. The synthesis and optoelectronic properties of these new molecules will be presented.



Scheme 1 : General Synthesis of Azuleno[2,1,8-ija]azulene

References

(1) Konishi, A.; Yasuda, M. Breathing New Life into Nonalternant Hydrocarbon Chemistry: Syntheses and Properties of Polycyclic Hydrocarbons Containing Azulene, Pentalene, and Heptalene Frameworks. Chem. Lett. 2021, 50 (1), 195–212.
(2) Tobe, Y. Non-Alternant Non-Benzenoid Aromatic Compounds: Past, Present, and Future. Chem. Rec. 2015, 15 (1), 86–96.
(3) Miyoshi, H.; Nobusue, S.; Shimizu, A.; Tobe, Y. Non-Alternant Non-Benzenoid Kekulenes: The Birth of a New Kekulene Family. Chem. Soc. Rev. 2015, 44 (18), 6560–6577.
(4) Vogel, E.; Reel, H. Bent [14]Annulenes. Synthesis of 1,6:8,13-Ethanediylidene[14]Annulene. J. Am. Chem. Soc. 1972, 94 (12), 4388–4389.
(5) Reel, H.; Vogel, E. Dicyclohepta[Cd,Gh]Pentalene—A New Pyrene Isomer. Angew. Chem. Int. Ed. Engl. 1972, 11 (11), 1013–1014.
(6) Mathey, P.; Lirette, F.; Fernández, I.; Renn, L.; Weitz, R. T.; Morin, J.-F. Annulated Azuleno[2,1,8-lja]Azulenes: Synthesis and Properties. Angew. Chem. Int. Ed. 2023, 62 (11).

Electrodeposition Strategies for Stabilizing Zinc Anodes in Rechargeable Zinc–Air Batteries

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The rapid expansion of wearable electronics and IoT applications is fueling the search for energy storage systems that are cost-effective, sustainable, and safe. Rechargeable zinc–air batteries (ZABs) are strong candidates to meet these needs, owing to the abundance and recyclability of zinc and their inherently high energy density. Despite these advantages, the zinc anode remains the main barrier to long-term operation, as it is prone to dendrite growth, shape change, and parasitic hydrogen evolution. These issues accelerate corrosion and shorten battery lifespan.

To address these challenges, we investigated the use of electrodeposition techniques to engineer zinc anodes with improved stability. Electrodeposits were obtained on different substrates (zinc foil, carbon paper, and carbon nanotubes) from alkaline chloride-based electrolytes, using various electrochemical protocols including cyclic voltammetry, chronoamperometry, and chronopotentiometry. This approach provides control over deposit morphology while remaining simple, scalable, and cost-effective.

The electrochemical performance of homemade ZAB prototypes was then compared. Cells with polished zinc foils exhibited rapid dendrite formation and limited cycling stability, reaching a maximum power density of ~12 mW/cm2. In contrast, batteries employing electrodeposited zinc anodes achieved power densities up to ~45 mW/cm2 and sustained over 1500 charge–discharge cycles without dendritic failure. Scanning electron microscopy confirmed the enhanced structural integrity of the modified anodes.

These results highlight electrodeposition as a practical and versatile method for improving zinc anodes, offering a pathway toward more durable and high-performance zinc–air batteries suitable for next-generation electronic devices.

Enhanced Electrochemical performances of Li-ion battery- based Li4Ti5O12 /X (X= Si,V2O5) composite anodes

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Lithium titanate ($Li_4Ti_5O_{12}$) materials exhibit a range of remarkable properties that make them highly suitable for applications in lithium-ion batteries (LIBs). This study focuses on the synthesis of $Li_4Ti_5O_{12}$-based nanocomposites through a hydrothermal method. The structural and morphological characteristics of the $Li_4Ti_5O_{12}$, $Li_4Ti_5O_{12}$/Si, and $Li_4Ti_5O_{12}$/V2O5 nanocomposites were analyzed using X-ray diffraction (XRD), scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDX), and X-ray photoelectron spectroscopy (XPS). The results confirm the successful fabrication of $Li_4Ti_5O_{12}$-based composites with varying nanoscale dimensions. The electrochemical performance of the synthesized nanopowders, employed as active anode materials in LIBs, was assessed through galvanostatic techniques utilizing Li half-cells. The $Li_4Ti_5O_{12}/V_2O_5$ composite exhibited an initial reversible discharge capacity of 630.8 mAh g−1 at a rate of 0.1C, although this value decreased significantly to 24.5 mAhg−1 after 100 cycles. In contrast, the $Li_4Ti_5O_{12}$/Si composite demonstrated an initial discharge capacity of 517.5 mAh g−1, which mitigated to 189.50 mAh g−1 after 100 cycles. These results highlight the differences in cycling stability and electrochemical performance between the nanocomposites, providing valuable insights into their potential applications in advanced energy storage systems.

Highly efficient and photostable Ruthenium terpyridine complexes as photosensitizers for artificial photosynthesis

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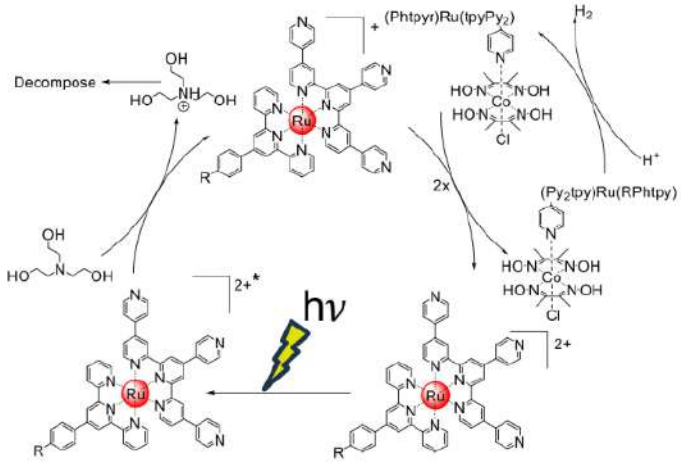
The recent climate crisis has focussed attention on the need for green and affordable energy; however, many avenues are available to produce green energy.[1] One of the most promising ways is the photocatalyzed production of hydrogen, as sunlight is the most abundant and widely available energy source on Earth.[2] Our first target is a novel molecular platform to harness energy emitted from the sun. Thus, a polytopic tridentate polypyridine-based ligand bearing three exterior pyridyl moieties, 4,4',4''-tris(4'''- pyridyl)-2,2':6',2''-terpyridine (Py3Tpy), allows for facile electron transfer to appended cobalt catalysts to complete the Hydrogen Evolution Reaction (HER).[3] Py3Tpy coupled with an electron-donating terpyridine yields highly stable and ruthenium heteroleptic complexes with exceptional hydrogen production (Figure). We present herein three new Ru(II) complexes as well as their incredible results in the HER surpassing any ruthenium-based photosensitizer in the current literature.[4]



References :

(1) Dincer, I. Renewable and Sustainable Energy Reviews 2000, 4
(2), 157-175. DOI: https://doi.org/10.1016/S1364-0321(99)00011-8.
(2) Kabir, E.; Kumar, P.; Kumar, S.; Adelodun, A. A.; Kim, K.-H. Renewable and Sustainable Energy Reviews 2018, 82, 894-900. DOI: https://doi.org/10.1016/j.rser.2017.09.094.
(3) Mercier, G. M.; Rousset, E.; Oubaha, I.; Bandyopadhyay, K.; Pal, A. K.; Ciofini, I.; Chamoreau, L.-M.; Marvaud, V.; Hanan, G. S. Chemical Communications 2025, 61 (77), 14911-14914, 10.1039/D5CC04303D. DOI: 10.1039/D5CC04303D.
(4) Rupp, M.; Auvray, T.; Rousset, E.; Mercier, G. M.; Marvaud, V.; Kurth, D. G.; Hanan, G. S. Inorganic Chemistry 2019, 58 (14), 9127-9134. DOI: 10.1021/acs.inorgchem.9b00698.

Structural-Property Investigation on Doped Hematite using Raman Spectroscopy

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Dopants, either intentionally or unintentionally incorporated, can alter defect concentrations and generate new types of lattice defects. In particular, ions such as Sn4+, or F− have been employed in hematite structure to tune its properties and enhance photoelectrochemical (PEC) performance. Owing to the strong vibrational response of iron oxides and hydroxides, Raman spectroscopy is a highly sensitive and accessible tool for quantifying lattice distortions and provides valuable insight into subtle structural variations. To extend its application in hematite structure analysis, we introduced secondary elements into the hematite lattice. In this study, we examine the structural influence of tin and fluorine dopants in hematite (α-Fe2O3) using Raman spectroscopy, X-ray absorption spectroscopy (XAS) and X-ray diffraction (XRD). Even though no subtle changes were seen in powder XRD and XAS spectra of doped hematite, we demonstrate that Raman spectroscopy effectively detects lattice distortions and dopant-induced structural variations. The incorporation of Sn^{4+} and F^{-} ions lead to lattice expansion and amplifies distortion-related vibrational modes. A linear relationship between Raman intensity ratios across undoped and doped samples reveals a consistent link between point defects and cation/anion doping.

Overall, this work presents a simple and reliable spectroscopic framework for identifying dopant types and assessing structural modifications in hematite-based materials for photoelectrochemical applications.

Lithium Metal – Solid Polymer Electrolyte Interface: a complete guide towards a full understanding of a fast-charging journey

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All-solid state lithium metal (LiM) batteries have attracted significant interest for use in electric vehicles over recent years, owing to their high specific energy density of ~ 450 Wh/kg. Consequently, solid polymer electrolytes (SPEs) have emerged as candidates for industrial and commercial applications due to their low cost and easy processing. PEO-LiTFSI based SPEs are among the most widely used in the community. The mechanical strength of these materials is too low to resist dendrite growth resulting in strategies such as polymer blending and crosslinking to produce more robust electrolytes. The Newman and Monroe criteria states that such mechanical properties are necessary to match the shear modulus of LiM. In addition to dendrite growth, LiM reactivity presents significant challenges for the formation of a stable surface electrolyte interface (SEI) layer. SEI formation consumes electrons and is responsible for uneven electroplating. X-Ray photoelectron spectroscopy (XPS) with depth sputtering was used to analyze passivation layers that form on the LiM surface, during LiM storage or cell preparation as a result of atmospheric contamination. The reactivity of the resultant SEI with common polymer electrolytes was analyzed by Raman spectroscopy. Complementary analysis of the surface of commercial lithium foils was performed via ultraviolet photoelectron spectroscopy and atomic force microscopy to determine the surface composition and the surface roughness respectively as both parameters have been shown to influence SEI formation and reactivity. The Sand equation was used to evaluate the threshold current density wherein dendrite formation and short circuiting occur in Li-Li symmetric cells containing crosslinked SPE. Plating failure at high current density can be used to determine the limiting current density of the electrolyte during use with real cathode materials, thus serving as a compatibility study for potential electrode materials. Operando and ex-situ scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS) was performed on a solid-state system with LiM-TPV at current densities as high as 1.2 mA/cm2. This was done to show how LiM morphology evolves during plating which is necessary to foresee the formation of irreversible dead Li which can cause loss of electrode-electrolyte contact and reduced coulombic efficiency under the critical conditions that are required for use in fast charging electric vehicles.

Formation of a Ge-doped γ-LiAlO2 structure within the Li2O-B2O3- Al2O3-GeO2 glass system

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This presentation focuses on the thorough structural characterization and study of ionic conduction mechanism of a new crystalline phase isostructural with γ-$LiAlO_2$, having the composition $Li_{0.77}Al_{0.77}Ge_{0.23}O_2$, discovered while exploring the Li_2O–B_2O_3–Al_2O_3–GeO_2 system using a glass synthesis-based approach. The activation energy of the ionic conduction of γ-$LiAlO_2$ was previously reported in the range of 0.7–0.9 eV, depending on the measurement method and the disorder present.[1, 2] In this work, we compare the activation energy for the ionic mobility of $Li_{0.77}Al_{0.77}Ge_{0.23}O_2$ with that of γ-$LiAlO_2$, using SoftBV analysis. Our results reveal a significant decrease in activation energy of 0.413 eV, attributed to a change in the ionic conduction pathway. It is likely that glass disordered structure, owing to glass synthesis and resulting from its thermal treatment, could impact the ionic conductivity.[2] Experimental and computational evidence for the formation and properties of this new material is then provided through in situ X-ray diffraction and thermal analysis during crystallization and further supported by single-crystal X-ray diffraction, and simulations of ionic conduction in order to understand the origin such improvement.

References:

(1) Wiedemann, D.; Nakhal, S.; Rahn, J.; Witt, E.; Islam, M. M.; Zander, S.; Heitjans, P.; Schmidt, H.; Bredow, T.; Wilkening, M.; et al. Unravelling Ultraslow Lithium-Ion Diffusion in γ-LiAlO2: Experiments with Tracers, Neutrons, and Charge Carriers. Chemistry of Materials 2016, 28 (3), 915-924. DOI: 10.1021/acs.chemmater.5b04608.
(2) Wohlmuth, D.; Epp, V.; Bottke, P.; Hanzu, I.; Bitschnau, B.; Letofsky-Papst, I.; Kriechbaum, M.; Amenitsch, H.; Hofer, F.; Wilkening, M. Order vs. disorder—a huge increase in ionic conductivity of nanocrystalline LiAlO2 embedded in an amorphous-like matrix of lithium aluminate. Journal of Materials Chemistry A 2014, 2 (47), 20295-20306, 10.1039/C4TA02923B. DOI: 10.1039/C4TA02923B.

Liquid metal-based electrocatalytic system for CO_2 conversion to graphite

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Electrochemical reduction of CO_2 presents a promising approach to address environmental concerns by converting CO_2 into valuable carbon-based materials. This study focuses on the production of graphite using liquid metals as working electrode (WE) and ionic liquid as electrolyte, offering a novel pathway to overcome challenges such as low CO_2 solubility and electrode degradation. Ionic liquids, with their high CO_2 solubility and electrochemical stability, further enhance the efficiency of the reaction. A three-electrode electrochemical cell was employed, incorporating liquid metal-cerium (LMCe) as the WE-catalyst and ionic liquid-based electrolyte. The graphite was successfully produced with a high purity of more than 80 wt%. Additionally, the use of ionic liquids allowed for a reduction in the applied potential for this process, achieving a faradaic efficiency (FE) higher than 80% for graphite production. This demonstrates that the process was made highly efficient, enabling the production of high-purity graphite at lower potentials with enhanced FE, marking significant advancements in CO_2 utilization. This work highlights the synergistic role of liquid metal and ionic liquid in enabling efficient CO_2 electrochemical reduction. The findings provide a scalable and effective solution for producing valuable carbon materials, presenting a breakthrough in the development of sustainable CO_2 conversion technologies.

Development of Zeolite-based Dual Function Materials (DFMs) for CO2 Capture and Methanation

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Achieving net-zero by 2050 requires carbon management that can capture CO_2 and reuse it within a closed carbon cycle. Dual-Function Materials (DFMs) integrate a CO_2 sorbent with a hydrogenation catalyst, enabling capture from flue gas or diluted streams and in-situ conversion to renewable natural gas (RNG) under the same conditions. This concept resembles pressure swing or temperature swing adsorption; however, hydrogen is introduced for catalytic conversion of the adsorbed CO_2 instead of raising pressure or temperature to regenerate the sorbent. Zeolites, with ordered microporosity and tunable acidity/basicity, are promising DFM that can simultaneously provide strong CO_2 affinity and a robust support for metal catalysts. This study introduces zeolites as potential DFMs for CO_2 capture and in-situ methanation for the first time, focusing on the role of zeolite framework structures.

Three zeolite frameworks were synthesized: Chabazite (CHA) with small pores, MFI (ZSM-5) with medium pores, and Faujasite (zeolite Y) with large pores, using a hydrothermal synthesis without organic structure-directing (OSDA) agents. The zeolite gel recipe was crystallized at 160-180 °C for up to 4 days, after which the product is dried. Ru was added at 1 wt%, along with 5 wt% Mg, via post-modification. The zeolite's phase purity was characterized using X-ray diffraction, while CO_2 uptake, surface area, and metal interaction with the zeolite were studied using TGA, BET, and H2-TPR, respectively. The DFM's performance was examined using a TGA and a fixed-bed reactor in a cyclic operation of CO_2 capture and methanation.

CHA and Y zeolites were successfully synthesized using a cost-effective and eco-friendly route. Post-modification with 5 wt% MgO and 1 wt% Ru produced effective DFMs that couple CO_2 capture and methanation under the same conditions. At 40 °C, the small-pore CHA exhibited superior CO_2 adsorption, while at 200 °C, the large-pore Y outperformed CHA and ZSM-5. Across 200–325 °C, weakly bound CO_2 diminished while strongly bound species increasingly drove CH_4 formation, with an optimum near 275 °C showing a methane formation of ~300 µmol g-1. This work supports Canada’s aim for a 5% and 10% RNG blend by 2025 and 2030, respectively, potentially eliminating 7.2 and 96 million tons of GHGs annually. Success in this area could position Quebec and Canada as leaders in the carbon circular economy and support net-zero objectives.

6. Résumés des présentations rapides/Flash Talks abstracts

Modeling of Moisture Transfer in Particleboards and MDF Panels Intended for Exterior Use

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This study aims to investigate the durability and hygroscopic behavior of wood-based composite panels designed for exterior applications, focusing on two types of particleboards for siding (single-layer and three-layer structures) and one medium-density fiberboard (MDF) intended for outdoor furniture. While most previous studies have concentrated on interior-grade products, there is still a lack of scientific data regarding exterior panels under severe climatic conditions. The project will address this knowledge gap through a series of complementary experimental and modeling approaches. Mechanical performance will be evaluated by measuring the modulus of elasticity (MOE), modulus of rupture (MOR), and internal bond (IB) strength before and after accelerated aging cycles (immersion, steaming, freezing, and drying) designed to simulate long-term outdoor exposure. Dimensional stability will be assessed by examining thickness swelling and linear expansion under controlled variations of temperature and relative humidity. In addition, water vapor transmission rates and diffusion coefficients will be determined at different temperature–humidity conditions, while sorption and desorption isotherms will be established at three reference temperatures over a wide range of relative humidity (0–95%). The experimental data will be used to develop a multiphysics model describing coupled heat transfer, moisture diffusion, and dimensional variations. This model, based on Fick's law, will be validated through numerical simulations and compared with laboratory observations. The expected outcomes are to provide new knowledge on the hygrothermal performance and durability of exterior-grade panels, to offer tools for optimizing their design and manufacturing, and to contribute to the development of more durable and sustainable construction materials. Ultimately, the project is expected to contribute to international objectives related to clean energy, industrial innovation, sustainable urban development, and climate change mitigation.

UV-C-Activated Riboflavin Crosslinked Gelatin Film with Bioactive Nanoemulsion for Enhanced Preservation of Fresh Beef in Modified Atmosphere Packaging

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This study explores a new eco-friendly approach for developing bioactive gelatin films using UV-C irradiation-induced photo-crosslinking. Riboflavin, a food-grade photoinitiator, was selected at an optimal concentration of 1.25% (w/w) for crosslinking gelatin under UV-C exposure for 4 to 22 min. Physicochemical analyses revealed enhanced tensile strength, reduced water vapor permeability, and lower water solubility in films crosslinked for up to 13 min. FTIR analysis demonstrated significant molecular changes, confirming the formation of crosslinking connections in gelatin–riboflavin films. Antimicrobial nanoemulsion (NE) (0.5, 0.75, 1% v/v) was incorporated into crosslinked films and applied to fresh beef. The 1% NE film exhibited the strongest antimicrobial effect, extending shelf-life by 20 days. In vitro release study confirmed Fickian diffusion behavior in the 1% NE film. This study also investigated the synergy between 1% NE film and three different types of modified atmosphere packaging (MAP) on the microbiological and physicochemical properties of beef for 26 days. The best results were achieved with 1% NE film under MAP1 and MAP2, which preserved meat redness and prevented lipid oxidation, extending the shelf-life up to 26 days. Therefore, UV-C irradiation-induced crosslinked bioactive film combined with high-oxygen MAP offers a promising solution for prolonging the shelf-life of beef.

Développement de modèles d'intelligence artificielle explicable et générative pour la formulation, la prédiction et l'optimisation multi-échelles des propriétés mécaniques des mélanges polymères recyclés

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Face à la nécessité de réduire l'empreinte environnementale des matériaux polymères, l'intégration de matières recyclées dans des produits à haute valeur ajoutée représente un levier stratégique pour l'industrie. Toutefois, la variabilité des flux de déchets plastiques, les incertitudes liées à leur composition et les effets de dégradation limitent leur utilisation, notamment lorsque la reproductibilité et la performance sont critiques. Ce projet de recherche propose de surmonter ces barrières en combinant intelligence artificielle explicable (XAI) et modèles génératifs dans un cadre robuste de prédiction, d'interprétation et de formulation des mélanges de polymères recyclés.

La méthodologie repose sur le développement de modèles prédictifs entraînés sur des données expérimentales issues de tests industriels. Des réseaux de neurones physiquement contraints permettent de modéliser des propriétés clés telles que la résistance mécanique, la stabilité thermique et l'indice de fluidité. L'intégration de méthodes d'explicabilité met en évidence les facteurs déterminants—type de polymères, proportions, additifs, paramètres de transformation—et fournit aux ingénieurs des outils concrets d'optimisation.

En parallèle, des modèles génératifs orientés reverse design proposent automatiquement des formulations—monocomposant ou multicomposants—en fonction d'objectifs prédéfinis (performance, coût, durabilité, recyclabilité). Ces formulations candidates sont synthétisées, testées et intégrées dans une boucle d'apprentissage continu, assurant l'amélioration progressive des modèles.

Cette approche duale, à la fois explicable et générative, transforme les incertitudes liées aux matériaux recyclés en opportunités d'innovation. Elle garantit performance, traçabilité et adaptabilité industrielle, tout en s'inscrivant dans une dynamique d'économie circulaire et de transition vers des procédés industriels plus durables.

Designing Photoactive Coatings for Light-Assisted Battery Charging

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Harvesting solar energy offers a sustainable and eco-friendly solution to the world's growing energy demands, as sunlight is abundant, renewable, and clean. However, one of the major challenges in solar energy utilization lies in its intermittency — electricity generation is limited to periods of sunlight, leaving gaps during nighttime or cloudy conditions. Developing technologies that can efficiently store solar energy and release it on demand is therefore a key step toward achieving reliable and continuous power generation.

A promising approach to address this challenge involves photo-rechargeable batteries , which can directly capture, convert, and store solar energy within a single integrated system. Unlike conventional solar cells coupled with external batteries, these systems eliminate the need for separate components, allowing for a more compact and efficient energy conversion and storage process at the molecular level.

In this study, we present the design and development of a photoactive molecular coating engineered for light-assisted battery charging. The synthesized photoactive material not only absorbs sunlight but also facilitates efficient photo-induced charge transfer to the electrochemical components of a conventional battery. The coating is designed to interface seamlessly with the electrode materials, enabling direct energy flow from light absorption to charge storage without intermediate devices.

We further detail the fabrication process used to convert the photoactive molecular compound into a stable and functional thin-film coating capable of operating under realistic battery conditions. Comprehensive photophysical, spectroscopic, and electrochemical characterizations were performed to evaluate its light-harvesting efficiency, charge separation dynamics, and energy transfer behaviour.

The resulting opto-electroactive coating demonstrates enhanced light absorption, improved photo-charge generation, and superior charge storage capacity compared to unmodified electrodes. These findings highlight the potential of integrating molecular-level photoactivity into battery architectures, paving the way for the development of compact, efficient, and sustainable solar energy storage systems that operate seamlessly across light and dark cycles.

Etude du Revêtement photocatalytiques TiO_2/g-C_3N_4 appliqué comme traitement de surface sur du mortier

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La pollution de l'air et de l'eau par les colorants organiques et les composés chimiques issus des activités humaines constitue un défi environnemental majeur. Dans ce contexte, la photocatalyse apparaît comme une solution prometteuse, capable d'utiliser la lumière pour dégrader les polluants. Ce projet explore la conception et l'application de revêtements à base d'un composite de dioxyde de titane (TiO_2) et de nitrure de carbone graphitique (g-C_3N_4) sur des surfaces de mortier. Ces matériaux, lorsqu'ils sont exposés à la lumière, activent des réactions qui décomposent les molécules nocives telles que le méthyl orange, un colorant modèle. Deux modes d'application ont été comparés dans ce projet : par peinture et par pulvérisation. Les résultats montrent que la pulvérisation offre un revêtement plus homogène et améliore l'efficacité de dégradation, atteignant jusqu'à 80 % (contre 65 % par peinture) de disparition du colorant (polluant methyl orange) après 24 heures. Ce projet contribue à démontrer le potentiel des revêtements photocatalytiques dans la dépollution des environnements bâtis et ouvre la voie à des surfaces « autonettoyantes » et respectueuses de l'environnement.

Mots clés: photocatalytique, revêtement, TiO2/g-C3N4, dépollution, matériau de construction

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 joint pain and stiffness are often subtle, and delayed diagnosis can lead to irreversible disability, underscoring the importance of early detection for effective treatment. Current diagnostic methods rely on conventional biomarkers that, despite clinical utility, have limited specificity and sensitivity. Recently, costimulatory proteins of the CD28–B7 pathway—CD28, CD86, and CTLA-4—have emerged as promising biomarkers due to their key roles in T-cell activation and immune regulation, central to RA pathogenesis. This research aims to develop a sensitive, reliable, and cost-effective electrochemical aptasensor for their detection. Aptamers specific to each target are selected via the Systematic Evolution of Ligands by Exponential Enrichment (SELEX) process and integrated into a DNA-based biosensor platform using electrochemical impedance spectroscopy (EIS) for signal transduction. The current focus is on CTLA-4, employing a previously reported aptamer to construct and validate the sensor. The developed aptasensor demonstrates high selectivity and accuracy in detecting CTLA-4 in complex biological matrices. Among the tested configurations, the gold screen-printed electrode (AuSPE) exhibited a lower limit of detection than the gold nanoparticle-modified carbon electrode (CSPE),making it more suitable for early-stage RA diagnosis.

Comparaison des mélanges physiques et covalentes à base de carbazoles pour l'impression 3D

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La fonctionnalisation de systèmes imprimés en 3D présente la possibilité d'introduire la mise en forme de dispositifs intelligents. Les types de dispositifs peuvent varier amplement selon leur domaine et leur utilisation souhaitée. En conséquence, diverses techniques d'impression seront favorisées selon le type d'architecture souhaité. Dans ce projet, la méthode de mise en forme privilégiée est le traitement numérique de la lumière, soit « Digital light processing (DLP) », en raison de la résolution d'impression pouvant mettre en forme des architectures avec une fidélité d'impression de l'ordre des microns à un faible coût. Cette méthode requiert un système photopolymérisable à des longueurs d'onde de ~405 nm. La majorité des résines commerciales imprimables par cette méthode présentent un monomère et un photoamorceur permettant de déclencher la polymérisation menant à la formation des liaisons covalentes. Cela dit, la fonctionnalisation de ce type de systèmes requiert l'ajout d'un troisième composé, soit une molécule fonctionnelle. Dans cette étude, les dérivés de carbazole ont été employés pour leurs propriétés optoélectroniques. Une étude comparative entre un mélange physique (non covalent) et un mélange impliquant des liaisons covalentes, est importante pour comprendre l'impact de ces deux stratégies sur les propriétés résultantes des dérivés de carbazole. Une compréhension approfondie des effets influençant la fonctionnalisation de ce type de systèmes permettrait également la mise en place d'une approche systématique pour le développement de nouveaux matériaux fonctionnels imprimables en 3D.

L’étude sur le comportement électrochimique sur l’électrodéposition de l’argent en utilisant SECCM

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La déposition électrochimique contrôlée des nanoparticules (NPs) représente une approche clé pour la fabrication de nanomatériaux fonctionnels, notamment dans les domaines de la catalyse, de la détection et de la plasmonique. Parmi les différentes méthodes de dépôt, la microscopie électrochimique à cellule de balayage (SECCM) s’est imposée comme une technique de pointe permettant l’étude et la synthèse de nanoparticules à l’échelle locale. Cette approche repose sur l’utilisation d’une micropipette remplie d’électrolyte, qui crée une cellule électrochimique confinée au niveau du ménisque, offrant ainsi un contrôle spatial précis du dépôt. Dans cette étude, la SECCM est exploitée pour la synthèse localisée et ordonnée de nanoparticules d’argent (Ag NPs) par électrodéposition à partir de solutions contenant des précurseurs métalliques. En ajustant des paramètres tels que le potentiel appliqué, la charge transférée et la composition de l’électrolyte, il est possible de contrôler la taille, la forme et la distribution spatiale des nanoparticules formées. Cette méthode permet la croissance directe d’Ag NPs sur des substrats conducteurs, assurant une excellente adhérence et une connexion électrique stable, tout en éliminant la nécessité de surfactants stabilisants. L’analyse cinétique des processus de nucléation et croissance, combinée à des modèles cinétiques dépendant du temps et à des simulations par éléments finis, permet d’extraire des paramètres physico-chimiques essentiels tels que les énergies de surface et les constantes de vitesse. Par ailleurs, la SECCM offre la possibilité d’étudier séparément l’activité des plans basaux et des bords de marche (step edges), apportant une compréhension approfondie du rôle des défauts de surface dans la nucléation des NPs. Ainsi, la SECCM se révèle être un outil puissant et polyvalent pour la nanofabrication électrochimique localisée et l’analyse mécanistique de la croissance des nanoparticules d’argent, ouvrant la voie à une conception rationnelle de matériaux nanostructurés à propriétés contrôlées.

Fonctionnalisation par traitement plasma du polytétrafluoroéthylène expansé pour le recrutement de cellules progénitrices endothéliales sur prototype de prothèse vasculaire

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Les prothèses vasculaires de petit diamètre (<6 mm) en polytétrafluoroéthylène expansé (ePTFE) sont largement utilisées pour le remplacement artériel, en particulier dans le traitement de l'artériopathie oblitérante des membres inférieurs, lorsque les vaisseaux autologues ne sont pas disponibles. Cependant, leurs performances à long terme restent limitées, avec seulement 68 % des prothèses restant perméables sans réintervention après deux ans, et moins de 50 % après cinq ans chez les patients ayant subi un pontage chirurgical sous le genou. L'hydrophobicité et les interactions incontrôlées entre la surface du ePTFE et les cellules sanguines sont à l'origine de ce problème, limitant l'endothélialisation des prothèses. Une approche biomimétique par le greffage de molécules à la surface du matériau constitue une solution prometteuse pour favoriser l'endothélialisation et ainsi l'homéostasie vasculaire. Nous émettons l'hypothèse qu'un greffage d'anticorps et de peptides dérivés de la matrice extracellulaire permettrait le recrutement de cellules régénératives de la circulation sanguine et l'endothélialisation de prothèses. Pour permettre la fonctionnalisation du PTFE et ePTFE, des groupements aminés (NH2) ont été introduits par décharge plasma à pression atmosphérique (barrière diélectrique; N2/H2) et basse pression (radio fréquence; NH3), respectivement. La caractérisation des surfaces traitées par spectroscopie à rayons X et tests immuno-enzymatiques ont permis de déterminer les conditions d'opérations optimales maximisant la densité des groupements aminés en surface. Suivant un protocole de greffage peptidique établi, l'application d'une stratégie de bifonctionnalisation, employant un peptide biomimétique avec motif RGD et un peptide d'interaction de la région Fc d'anticorps IgG (RRGW) a été validée. La quantité relative de peptide et d'anticorps immobilisés en surface a été quantifiée sur PTFE/ePTFE. La fonctionnalité de la surface à divers ratio peptidique (RRGW:RGD) a été testée à l'aide de cellules endothéliales formatrices de colonies (CEFC) isolées de sang périphérique humain. L'inclusion de RGD a induit l'étalement cellulaire et a augmenté le nombre de cellules capturées sous agitation, avec un recouvrement maximal à 75:25 RRGW:RGD sur PTFE. Intégrant une stérilisation par éthylène oxide, le protocole de fonctionnalisation a été adapté à des segments de prothèses vasculaires commerciales. La capture cellulaire sous écoulement laminaire a été testée en exposant une prothèse fonctionnalisée à une suspension cellulaire pendant 2h. La capture et adhésion cellulaire a été confirmé par le marquage de l'actine et des noyaux (Figure 1). Les travaux futurs viseront à caractériser la cinétique d'endothélialisation et le phénotype des cellules capturées pour divers ratios peptidiques pour définir un prototype qui sera ultimement testé dans un modèle animal de pontage vasculaire.

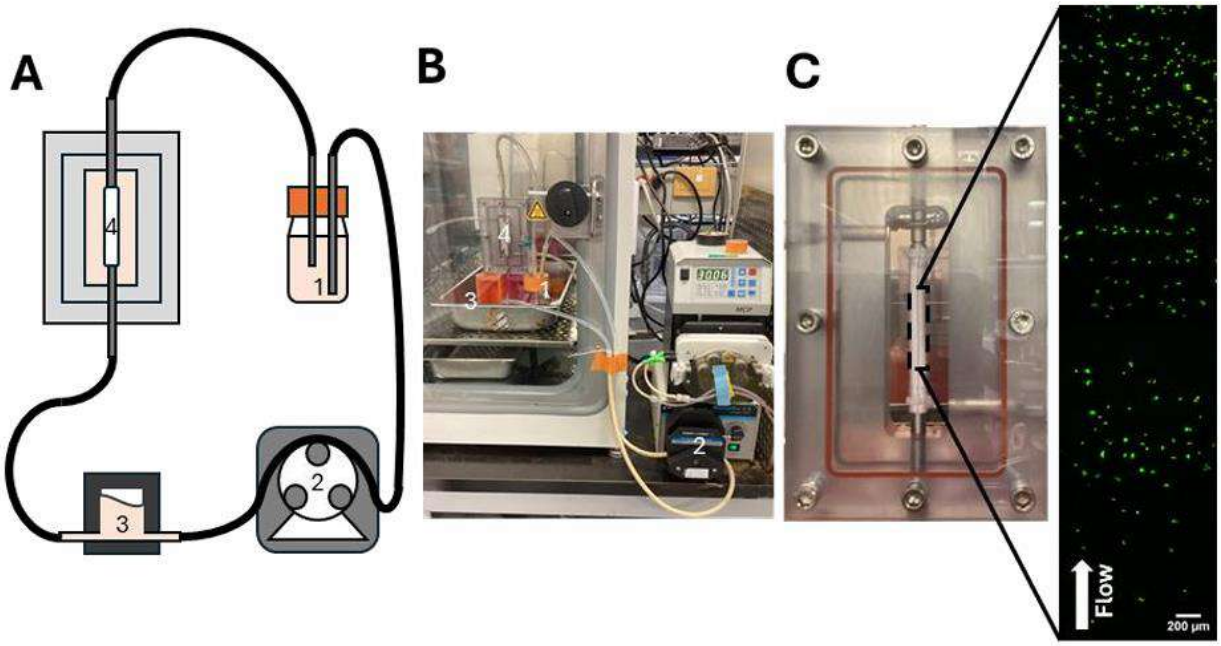

Figure 1. Montage expérimental en circuit fermé de capture cellulaire sous flux. (A) Schéma et (B) système de circulation expérimentale utilisé pour perfuser une suspension de CEFC à travers la prothèse fonctionnalisée de ePTFE. La pompe péristaltique (2) fait circuler la suspension cellulaire depuis le réservoir (1), à travers le régulateur de flux (3) et l'échantillon de prothèse (4), à un débit de 63 mL/min, produisant une contrainte de cisaillement de 0.5 dyne/cm² à la surface luminale de la prothèse. La capture cellulaire a été démontrée après 2 heures de circulation. La prothèse a été rincée puis fixée avant l'imagerie (actine: vert, noyau: rouge), confirmant la présence de cellules capturées (C).

7. Résumés des présentations posters/Poster abstracts

Screen-Printed CuO-Based Thin Films for Enhanced Visible-Light Photocatalysis

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CuO-based thin films were fabricated using a simple screen-printing method. A nanometer-scale Pt layer was deposited to enhance photocatalytic efficiency. The resulting films were characterized, and a possible photocatalytic mechanism was proposed. The thin films exhibited excellent visible- light-driven photocatalytic activity.

Keywords: CuO nanoparticles; Thin films; Screen printing; Photocatalysis

Development of Noble-Less Manganese Oxide Nanorod Catalysts for Direct Glucose Fuel Cells

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Direct glucose fuel cells (DGFCs) are a promising power source for low-power and sustainable energy applications, particularly in biomedical devices, biosensors, and portable electronics. By directly oxidizing glucose, a renewable and biologically abundant fuel, these systems can convert chemical energy into electricity under mild operating conditions. However, their widespread application remains limited by the dependence on noble-metal catalysts such as platinum, gold, and palladium, which provide high catalytic activity but are costly and scarce. To overcome this limitation, we developed a noble-less composite anode composed of carbon nanotubes (CNTs) decorated with manganese oxide (MnO_2) nanorods. CNTs were synthesized via chemical vapor deposition (CVD), followed by hydrothermal growth of MnO_2 nanorods to enhance surface activity and electron transport. The CNT/ MnO_2 nanorods were evaluated using cyclic voltammetry and chronoamperometry in NaOH and PBS electrolytes at different glucose concentrations. The optimized electrode exhibited high catalytic activity and stability, which was further validated in an air-breathing DGFC using Pt/C as the cathode. These results highlight the potential of MnO_2 -based nanostructures as efficient, low-cost alternatives to noble-metal catalysts for next-generation glucose fuel cells.

Photocathodes organiques à base de polymères π-conjugués pour la photoreduction de l'eau et la production d'hydrogène

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La production d'hydrogène à partir d'énergie solaire est une solution prometteuse pour répondre aux besoins énergétiques de façon durable. Toutefois, la conception de photocathodes organiques stables reste un défi majeur. Pour concevoir des dispositifs permettant de transformer l'énergie solaire en potentiel électrique, de nouveaux polymers π-conjugués sont développés à partir de dérivés d'azulèno[2,1,8-ija]azulène, de colorants VAT orange 1, VAT orange 3 et de vanilline, qui sont des composés peu dispendieux et facilement fonctionnalisables afin d'explorer leur potentiel comme matériaux actifs pour la réduction de l'eau (Figure 1). Les polymères sont synthétisés par des couplages de Suzuki et de Sonogashira, puis déposés en films minces sur des substrats conducteurs. Les méthodes de caractérisation de spectroscopie UV-Vis, voltampérométrie cyclique, TGA, GPC, DSC seront utilisés afin d'évaluer si les matériaux possèdent une largeur de bande interdite de 1,23 eV, une bonne stabilité, des propriétés optoélectronique convenables et de grandes masses molaires. Les premiers résultats révèlent une forte absorption dans le visible et un alignement énergétique favorable pour la génération d'hydrogène. Ces travaux démontrent la faisabilité d'utiliser des polymères organiques comme photocathodes et ouvrent de nouvelles perspectives pour la conversion de l'énergie solaire en énergie propre.

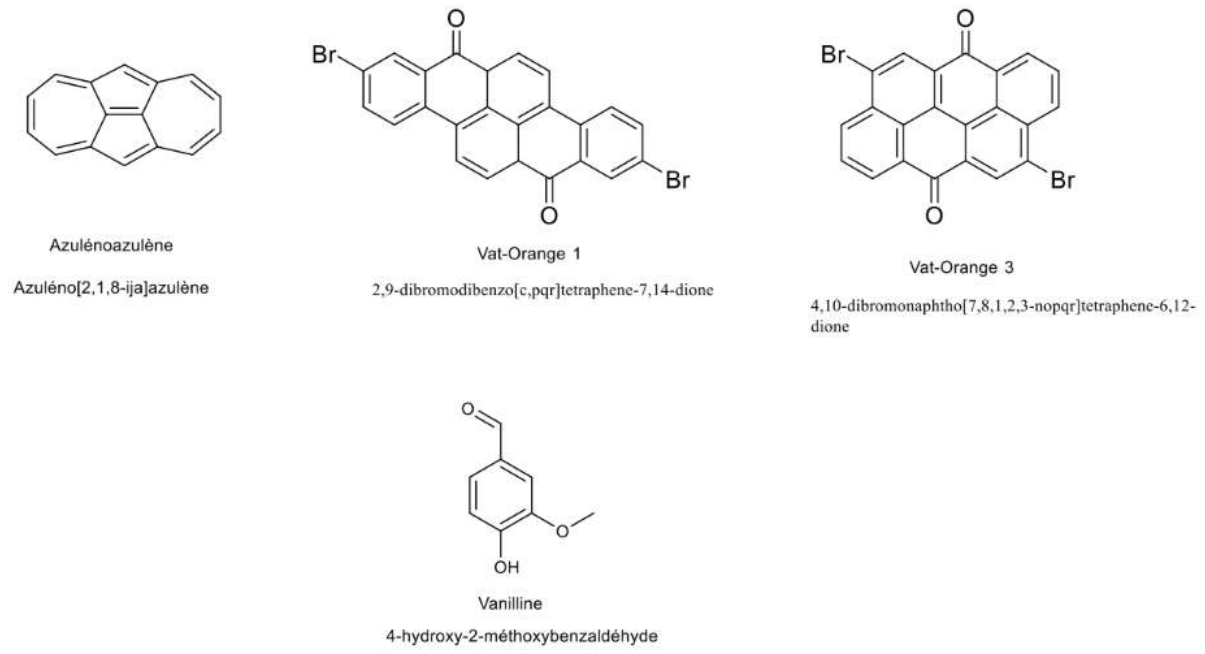

Figure 1. Molécule cibles

Design and Demonstration of Mixed-Reactant Air-Breathing Microfluidic Fuel Cells for Portable Electronics

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The increasing demand for compact and sustainable power sources for portable electronics and biomedical devices drives the development of micro-energy systems with high power density, long operational life, and minimal footprint. Mixed-reactant air-breathing micro fuel cells provide a promising solution by combining fuel and oxidant (ambient oxygen) in a single stream while employing a selective cathode that avoids fuel crossover. This membraneless design eliminates the need for polymer electrolytes and external pumps, reducing weight, volume, and system complexity, while offering scalable and cost-effective architectures.

Integration of microfluidic control with electrochemical reactions further enhances performance by optimizing mass transport and minimizing diffusion limitations. These systems are therefore highly suitable for applications where conventional power sources are impractical. However, challenges remain in scaling prototype devices, integrating complex components, and ensuring reliable operation under real-world conditions.

This work presents the design, modeling, and experimental validation of several air-breathing membraneless microfluidic fuel cell architectures. Computational models based on finite element analysis were developed to simulate mass transport, electrode reactions (fuel oxidation and oxygen reduction), species distribution, electrode porosity, and cathode air-breathing behavior. Model predictions showed good agreement with experimental measurements, accurately capturing cell polarization, power output, and fuel utilization under varying flow rates and current densities.

Proof-of-concept demonstrations include: (i) a stack of three U-shaped microfluidic fuel cells (0.5 M HCOOH) with a total volume of 10.6 cm^3 powering four green LEDs for 20 hours at a flow rate of 16.7 µL/min; (ii) a paper-based microfluidic fuel cell utilizing methanol vapor and passive capillary-driven flow; and (iii) a four-cell stacked system tested in series and parallel, achieving up to 0.69 V and 4.14 mW in parallel, and 2.39 V and 3.57 mW in series, successfully powering a 3-LED array for 3 hours.

These results demonstrate the potential of mixed-reactant air-breathing microfluidic fuel cells as reliable, low-power energy sources for portable electronics, advancing the development of compact and sustainable micro-energy systems.

Langmuir Monolayers as Model Membranes of the Tear Film Lipid Layer

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The tear film lipid layer is the outermost layer of the eye, in direct contact with the air at the air- water interface. It plays a crucial role in maintaining the integrity of the ocular surface by creating a hydrophobic barrier to prevent evaporation of the aqueous layer. Dry eye syndrome can be linked to meibum compositional changes whether due to meibomian gland dysfunction or other risk factors such as exposure to airborne species. The meibum lipid composition also varies significantly between individuals and as a function of age. Thus, it is important to study and

understand the roles of the different lipid classes that make up this duplex membrane and to develop a model membrane that accurately represent the biophysical properties of the tear film.

In this study a lipid mixture mimicking the tear film lipid layer composition was employed that comprises combinations of phosphatidylcholine, glyceryl trioleate, oleyl oleate, cholesteryl oleate, palmitic acid, and oleic acid. Langmuir-Blodgett trough experiments were performed to generate surface pressure-area isotherms, while Brewster angle and atomic force microscopy provided insights into lipid layer morphology at the micron- and nano- scales, respectively. Preliminary results demonstrate that the model membrane recreates the pressure-area isotherms of extracted human meibum. Future work will use the model to evaluate changes to the membrane functional properties upon exposure to airborne pollutants.

Synthèse de polymères conjugués pour la dispersion du graphène

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De nos jours, les technologies reposent sur une consommation importante et croissante d'énergie notamment de l'énergie électrique. Afin de répondre à cette forte demande énergétique, il est nécessaire de trouver des sources d'énergies renouvelables, constantes et respectueuses de l'environnement. Du point de vue utilisation à longue durée, les batteries rechargeables, particulièrement les batteries aux Li-ions, restent les mieux adaptées à cette forte demande énergétique mondiale. Elles ont fait l'objet de nombreux travaux de recherche et sont aujourd'hui commercialisées à grande échelle. Leur tension élevée en circuit ouvert, leur capacité, leur densité d'énergie élevée, leur longue durée de vie, leur puissance et leur efficacité élevée en font des dispositifs de stockage idéal.

Néanmoins, malgré qu'elles soient très prisées de nos jours, les batteries Li-ions n'échappent pas aux inconvénients liés à ses impacts environnementaux. Elles sont composées de produits chimiques pouvant être toxiques et une biodégradabilité très faible. On peut en citer le NMP (N méthylpyrrolidone) qui est très toxique et peut nuire à la fertilité, le PVDF (polyfluorure de vinylidène) qui fait partie de la famille des polyfluoroalkyliques qui sont en cours de bannissement aux États-Unis, au Canada et en Europe à cause de sa persistance dans l'environnement. Actuellement, le couple NMP/PVDF est mélangé à de la poudre de carbone conducteur pour produire une pâte (ou encre) pour une utilisation dans les batteries Li-ions en tant que liant. Cette encre contient les différents matériaux de la batterie Li-ion principalement les matériaux actifs et le carbone conducteur de la cathode.

Dans cette étude, nous allons synthétiser des polymères pi-conjugués pour remplacer le PVDF dans les batteries et ces polymères devront être solubles dans des solvants respectueux de l'environnement comme l'eau. Pour cela, mon choix se porte sur les pigments de cuves 1 et 3 tout simplement parce qu'ils sont des molécules fortement conjuguées, facilement fonctionalisables. Leur conjugaison leur confère une facilité à faire des interactions π-π avec les matériaux de carbone ; ce qui une des principales propriétés pour être un bon agent dispersant des matériaux de carbone.

Exploring N,O-Bidentate Ligands in the Creation of 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 1*) are synthesized by *N* oxidation of parent amidines using *m*-CPBA. Their corresponding complexes, such as Co(AMOX-Ph CN)$_3$ (*Figure 1*), 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.

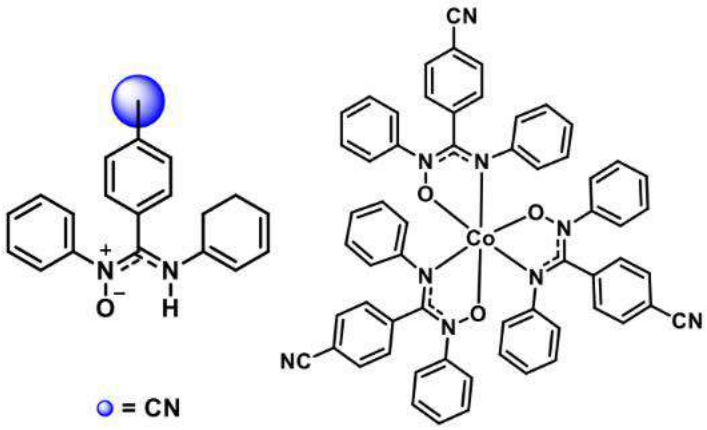

Figure 1. Chemical structures of AMOX-CN ligand and its Co(III) complex.

First-Ever Integration of Ionic Liquid Crystal Elastomers (iLCEs) into Soft MEMS Transducers for Multifunctional Electro-Skin Applications

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The advancement of microelectromechanical systems (MEMS) toward flexible and multifunctional architectures is hindered by the rigidity of traditional materials such as silicon and ceramics. This limitation restricts the development of next generation devices capable of adaptive deformation, low-voltage operation, and multifunctional performance essential for wearable electronics, soft robotics, and biomedical applications. To overcome these challenges, this research introduces the first-ever integration of ionic liquid crystal elastomers (iLCEs) into soft MEMS transducers. iLCEs combine the molecular order of liquid crystals with the elasticity of polymers and the ionic conductivity of liquid electrolytes, enabling reversible, programmable actuation and sensing under low electrical stimuli (~1 V).

The study is structured into three main objectives: (1) the development of an aligned LCE as a reference system for iLCE synthesis, (2) the fabrication and integration of iLCEs into MEMS microcantilevers, and (3) the realization of a multifunctional iLCE-based MEMS electro-skin capable of selective actuation, sensing, and energy harvesting. The iLCEs developed in this work exhibit substantial strain (>50%), rapid response, and high flexo-ionic sensitivity (~220 μC/m), making them ideal candidates for soft microsystems that operate efficiently under small or low-frequency mechanical inputs.

This research establishes a foundation for a new class of soft, intelligent MEMS that can dynamically interact with their environment while maintaining mechanical flexibility, electrical responsiveness, and scalability. The resulting iLCE-based electro-skin paves the way for next-generation biomedical interfaces, adaptive wearable sensors, and shape-morphing electronics, representing a significant step toward fully integrated multifunctional microsystems.

Analyzing the Piezoelectric Properties of an Aromatic Diamine for Organic Crystal-Based Energy Harvester Devices

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Piezoelectric crystalline materials can produce an electric field upon application of mechanical stress, causing changes in charge distribution within the distorted crystal lattice. The aromatic diamine crystal, N,N'-bis(4-nitrophenyl)methanediamine (BPNA), has piezoelectric properties due to its non-centrosymmetric supramolecular crystal structure. Voltage and current outputs were measured to study the piezoelectric effect as a function of the stress applied by repetitively tapping BPNA embedded in paper or in a polyvinyl alcohol (PVA) polymer matrix. A possible application of interest is an organic crystal-based energy harvester device, which can be used to power LEDs and other small electronics. Although BPNA is achiral, it crystallizes as a conglomerate to give chiral crystals. Attrition-enhanced deracemization (a.k.a. Viedma ripening) of BPNA was investigated using solid-state circular dichroism to obtain homochiral BPNA. Ultimately, homochiral BPNA crystals will be used to investigate the possibility of spin-dependent piezoelectric properties based on the chiral-induced spin selectivity (CISS) effect.

Synergie d'hydrogénation dans un alliage à haute entropie biphasé CC-C14

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Les Alliages à Haute Entropie (AHEs) constituent une nouvelle classe d'hydrures métalliques. La majorité de ces matériaux nécessitent un traitement préliminaire avant leur première hydrogénation à la température ambiante. Cependant, des études ont montré que les HEAs présentant une structure biphasée CC/C14 peuvent absorber l'hydrogène à température ambiante sans traitement préalable, une propriété attribuée à la synergie entre les phases. Cette étude se concentre sur l'analyse comparative des propriétés de première hydrogénation dans un AHE biphasé. Deux approches sont étudiées, l'une où les phases de l'alliage sont coulées ensemble, et l'autre où elles sont mélangées par broyage mécanique. Lorsque les phases CC et C14, de compositions respectives **Ti8.6V51.1Cr20.9Ni2.5Mn16.9** et **Ti24.1Zr7.9V18.8Cr8.2Ni18.6Mn22.4**, sont coulées ensemble, le système obtenu absorbe l'hydrogène à température ambiante, atteignant une capacité de 1.9 % en poids en deux heures. Lorsque les deux phases sont mesurées séparément, aucune d'elles n'absorbe l'hydrogène. Lorsqu'elles sont mélangées par broyage mécanique, le nouveau système ainsi obtenu absorbe l'hydrogène à température ambiante, atteignant une capacité de 1.8 % en poids après 10 heures de réaction. La synergie entre les phases BCC et C14, lorsqu'elles sont coulées ensemble, offre une meilleure cinétique d'hydrogénation. Cette étude apporte une nouvelle compréhension de l'influence du type de synergie entre deux phases sur les propriétés d'hydrogénation des systèmes biphasés.

Homoleptic cobalt(III) bisguanidylpyridine complexes for photocatalytic and photoredox processes

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There is a great need to replace precious metals in photochemical reactions. In this regard we prepared room-temperature luminescent Co^{III}(dGPy)2(X)3 (dGPy = 2,6-bis(1,5,7- triazabicyclo[4.4.0]dec-5-ene)pyridine , X = BF^{4-}or PF^{6-}) complexes that show LMCT (Ligand to Metal Charge Transfer) and LLCT (Ligand to Ligand Charge Transfer) transitions in the relatively low-energy UV region (λabs≈360–400 nm) and quasi-reversible reductions (E1/2(red)= −0.58 V vs. SCE) in their electrochemistry. A blue emission from the excited state of Co^{III}(dGPy)2(X)3 can be linked to the large bite angle and strong δ donation of the guanidine moieties. The combination of these effects helps separate the emissive ^{3}LMCT state and the non-emissive ^{3}MC state. Herein we present a new photoredox catalyst for the regioselective mono trifluoromethylation of polyarene but also for the photosynthesis of H^2.

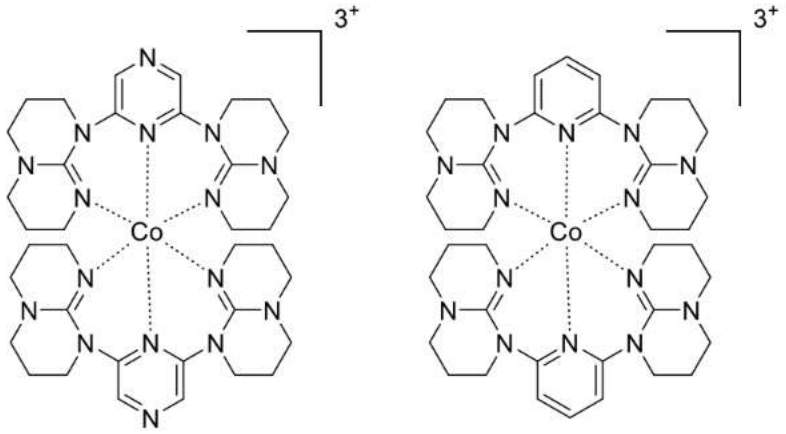

Figure: Structure of the presented compound $[Co(dgpz)2]^{3+}$ et $[Co(dgpy)2]^{3+}$

Résumé du poster : « Synthèse d'une nouvelle famille d'Organic Framework : Les IOFs ».

Iness Boubadjou, équipe M.E.E du Professeur Olivier Fontaine.

La transition énergétique stimule la découverte de nouveaux matériaux. Dans ce contexte, le choix des stratégies d'assemblage devient déterminant pour la conception de nouveaux matériaux. La chimie réticulaire et la chimie supramoléculaire sont aujourd'hui deux approches essentielles pour imaginer et construire de nouveaux matériaux.

La première, illustrée par les MOFs (Metal Organic Framework) ou les COFs (Covalent Organic Framework), s'appuie sur des liaisons fortes et permanentes pour créer des réseaux cristallins ordonnés et poreux. La seconde, la chimie supramoléculaire, se base plutôt sur des interactions plus faibles mais réversibles, permettant alors un auto-assemblage de blocs moléculaires de manière contrôlée.

C'est dans ce contexte que s'inscrivent les Ionic Organic Frameworks (IOFs) : une toute nouvelle famille de matériaux encore en développement, qui pourrait représenter la "première génération" de réseaux organisés uniquement grâce à des interactions ioniques. Ici, les blocs anioniques et cationiques s'assemblent autour de cœurs aromatiques symétriques comme le benzène, le pyrène ou le triphénylbenzène, et sont fonctionnalisés, par exemple, avec des groupements imidazolium pour la partie cationique et TFSI pour la partie anionique. Cette symétrie facilite leur organisation dans l'espace et permettrait de créer des structures supramoléculaires régulières. L'objectif à terme est de pouvoir maîtriser ces assemblages et leur organisation, afin de concevoir des réseaux supramoléculaires parfaitement ordonnés.

Streamlining the purification of microencapsulated pancreatic islets using density gradient centrifugation

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Islet transplantation has emerged as a sustained alternative to daily insulin injection for type 1 diabetes therapy, but access remains limited by the need for lifelong immunosuppression to avoid autoimmune and allogeneic graft rejection. Microencapsulation in hydrogel beads has been broadly investigated to protect islets from the immune system. Microencapsulation either by nozzle-based devices or emulsification methods often produces by products such as unencapsulated islets and empty beads. These by-products compromise transplant success, as non-encapsulated islets increase immune rejection risk and empty beads add to transplant volume. In preclinical studies, handpicking is often applied to remove these impurities, but this method is not readily scaled to clinical doses. The goal of this project was to adapt a published density gradient centrifugation separation method to stem cell-derived islets encapsulated in high-density alginate beads. As a first step, pancreatic islet sized MIN6 cell aggregates (density: 1.065 g/mL) were encapsulated, while empty 5% alginate beads (density: 1.047 g/mL) were generated by emulsification and internal gelation. Separation was achieved in two steps: first, a continuous density gradient (1.056 -1.061 g/mL) of MIN6 media and polysucrose with sodium diatrizoate (Histopaque-1077) containing calcium chloride recovered ~95% of encapsulated islets, with some unencapsulated aggregates. Second, an individual gradient of 1.063 g/mL was used to isolate free aggregates, completing the separation process. Future work aims to further automate the process, optimize separation efficiency, and apply these methods to microencapsulated stem cell-derived islets. This approach could be broadly applied for translational research on microencapsulated cellular therapies.

N-Heterocyclic carbene-containing polymers as precursors for plasmonic nanomaterials

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Normal and mesoionic *N*-heterocyclic carbenes (*n*NHC and *m*NHC, respectively) 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 functionalized *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 nor catalysis activity.[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 sensitive metallic nanoparticles, with great catalytic and economic interest. Our approach begins with the product of our click reaction, which we polymerize under controlled conditions to obtain a precisely defined number of repeat units through an efficient and straightforward synthetic route. Building on this well-defined structure, the subsequent synthesis and reduction of metal– NHC complexes proceed smoothly under mild conditions, as no free NHC intermediates are involved. Moreover, we plan to expand this work by tuning the polymerization techniques to generate polymer networks with various topologies, enabling fine control over the shape and overall properties of the resulting nanomaterials.

Keywords: Polymer chemistry, plasmonic materials, nanoparticles, *N*-Heterocyclic carbene, Organometallic chemistry.

Electrodeposition of lead halide perovskites

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Halide perovskites have attracted considerable interest due to their remarkable optoelectronic properties, which can be easily tuned by adjusting their composition. In this work, we focus on $CsPbBr_3$, a composition that exhibits notable stability combined with a suitably positioned bandgap for carrying out photoelectrocatalytic reactions such as oxygen and hydrogen evolution, as well as carbon dioxide reduction. A key step toward their advancement lies in developing scalable synthesis methods.

This study explores the electrodeposition of PbO_2 followed by two chemical conversion steps to synthesize $CsPbBr_3$. The influence of two distinct intermediates, $PbBr_2$ and $PbCl_2$, is compared to evaluate their impact on the final $CsPbBr_3$ quality. X-ray diffraction (XRD) and scanning electron microscopy (SEM) were employed to analyze the structural and morphological transformations occurring during the conversion of PbO_2 into $PbCl_2$ and $PbBr_2$, and their subsequent evolution into the $CsPbBr_3$ perovskite structure. The analyses reveal that converting PbO_2 into $CsPbBr_3$ via the $PbCl_2$ intermediate yields a perovskite with optimized surface coverage, resulting in a higher photocurrent during photoelectrochemical evaluations.

Exploration d'architectures supramoléculaires fonctionnelles : coordination de ligands bis AMOX avec des métaux de première rangée

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Les *N*-oxydes d'amidine *N,N'*-disubstituées (AMOXs), ligands bidentates *N*,O anioniques, forment des complexes métalliques stables qui se distinguent par leurs propriétés photophysiques, rédox et magnétiques. Leur forte modularité structurale, liée à la variabilité des substituants sur la fonction amidine, permet un contrôle précis de l'environnement stérique et électronique, influençant la liaison métal–ligand et, de facto, les propriétés des complexes formés.

L'auto-assemblage dirigé par coordination entre ligands et centres métalliques constitue une approche puissante pour la conception d'architectures métallosupramoléculaires. La réversibilité et la directionnalité des interactions métal–ligand favorisent la formation de systèmes adaptatifs et dynamiques, ouvrant la voie à la création de matériaux intelligents capables d'auto-régénération, d'auto protection et de réactivité programmée.

Dans cette optique, l'extension de la chimie de coordination des AMOXs à la dimension supramoléculaire constitue une approche pertinente pour explorer le potentiel de leurs assemblages. Pour ce faire, le pontage de deux unités AMOX a été envisagé, menant à des ligands ditopiques bis-AMOX. Leur coordination avec des métaux de transition de première rangée a conduit à diverses architectures supramoléculaires multimétalliques, telles que des complexes de coordination supramoléculaires (SCCs) et des polymères de coordination (CPs). Les résultats préliminaires confirment la formation de métallacycles avec Ni(II) et Cu(II), ainsi que d'un polymère 1D luminescent avec Zn(II). Les stratégies de synthèse, la caractérisation structurale ainsi que l'étude des propriétés de ces assemblages seront présentées. Ces résultats mettent en évidence la pertinence et la versatilité des ligands bis-AMOX pour la conception d'architectures métallosupramoléculaires, constituant une plateforme prometteuse pour le développement de systèmes photofonctionnels ou catalytiques.

Mots clés: Chimie métallosupramoléculaire, auto-assemblage dirigé par coordination**,** ligands bis-AMOX, métaux de première rangée, architectures multimétalliques, métallacycles, polymères luminescents, matériaux intelligents, propriétés photophysiques et rédox.

Orientation Quantification of Electrospun Fibers with PLS Models

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Electrospun polymer fibers form an emerging class of materials for applications that include selective filtration, energy storage, electronics, and biomedical engineering.[1] Their growing potential partially comes from the exponential improvement of their properties with a reduction of the fiber diameter, a phenomenon often associated with a higher molecular orientation. Current techniques to quantify the orientation of fibers in Raman microscopy, via the order parameter $\langle P_2 \rangle$, are the depolarization constant (DC) and the Most Probable Distribution (MPD) methods.[2] However, they exhibit some limitations, such as requiring extensive measurement time, and simple calibration models using the band ratio are not always an option.

Herein, we propose a calibration method based on *Partial Least Squares* (PLS) regressions, which can make the quantification significantly faster, and analyze subtle spectral variations and overlapping bands. We have developed PLS models for polymers exhibiting contrasting properties, namely the polystyrene (PS), the poly(ethylene oxide) (PEO) and the polyoxymethylene (POM). The calibration and validation standards used to build the models were Raman spectra of films or fibers of the polymers covering the complete range of $\langle P_2 \rangle$ as previously determined with the DC or MPD methods. The PLS models for the three polymers demonstrated good calibration accuracy and predictive performance. The latter was further investigated by comparing the $\langle P_2 \rangle$ vs *Fiber diameter* plots with predicted $\langle P_2 \rangle$ from our models with those from our earlier published works. For all the polymers studied, the predicted and actual values followed similar trends with the diameter, confirming the robustness of our models.

(1) Papkov, D.; et al. Quantifying Polymer Chain Orientation in Strong and Tough Nanofibers with Low Crystallinity: Toward Next Generation Nanostructured Superfibers. *ACS Nano* **2019**, *13* (5), 4893–4927. https://doi.org/10.1021/acsnano.8b08725.

(2) Richard-Lacroix, M.; Pellerin, C. Accurate New Method for Molecular Orientation Quantification Using Polarized Raman Spectroscopy. *Macromolecules* **2013**, *46* (14), 5561– 5569. https://doi.org/10.1021/ma400955u.

N-Heterocyclic carbene-stabilized SiNP@AuNP as active and recyclable hybrid catalysts for environmental depollution

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Silica nanoparticles(SiNPs) have been widely used as heterogeneous supports to immobilize catalysts due to the many advantages they offer. Furthermore, this immobilization enables easy separation, purification and reusability of the catalyst which is in agreement with green chemistry principles. A catalyst that can be used in these types of systems are metallic nanoparticles, more specifically, gold nanoparticles (AuNPs).In fact, AuNPs are versatile materials with applications across numerous fields; however, their exceptional activity and multifunctional nature make them particularly attractive as catalysts. However, extremely small size of conventional AuNPs renders their recyclability challenging.

To circumvent this issue, we propose the immobilization of AuNPs on SiNPs via mesoionic *N* heterocyclic carbenes (*m*NHCs) as they have established themselves as strong ligands to stabilize metal nanoparticles due to the NHC-M bond strenght that is 2 times stronger than the S-M bond leading to higher stability of the AuNPs. The catalytic activity of the SiNP@AuNP material is characterized by the reduction of 4-Nitrophenol, as an example of a common environmental pollutant, highlighting their use in environmental remediation. Our approach stands out as every reaction is doneat the SiNP surface enabling easy separation and purification.

Absorption d'hydrogène dans les alliages à haute entropie TiZrVCr, TiZr($Al_{0.25}V_{0.75}$)Cr et TiZr($Al_{0.45}Cr_{0.55}$)V

René Exaucée Binichou Kinzonzi Ngongot

Les alliages à éléments multiples ont récemment été identifiés comme étant de bons candidats pour l'absorption d'hydrogène pour des applications pratiques. Nous présentons ici les propriétés d'absorption des alliages TiZrVCr, TiZr(Al0.25V0.75)Cr et TiZr(Al0.45Cr0.55)V. Pour ces trois alliages, la microscopie électronique montre une structure composée de régions ayant des compositions chimiques différentes. La diffraction X confirme la présence de deux phases : une phase cubique à corps centré et une phase cubique de type Laves. La première hydrogénation à la température de la pièce de l'alliage TiZrVCr est rapide et montre une capacité de plus de 2.75% massique d'hydrogène. Lorsque Cr ou V est remplacé par l'aluminium, la capacité décroit et il y a apparition d'un temps d'incubation pouvant aller jusqu'à 5 minutes. La diffraction X des poudres hydrurées montre que les deux phases ont absorbé l'hydrogène.

L'énergie d'activation de déhydrogénation des alliages a été mesurée avec un calorimètre sous pression d'hydrogène en utilisant la méthode de Kissinger. Les résultats indiquent que l'énergie d'activation du TiZrVCr (E_a = 60 ± 6 kJ/mol) légèrement plus élevé que celle du TiZr($Al_{0.25}V_{0.75}$)Cr (E_a = 52 ± 2 kJ/mol), mais beaucoup plus élevée que celle du TiZr($Al_{0.45}Cr_{0.55}$)V (E_a = 34.7 ± 0.6 kJ/mol). Il semble y avoir une corrélation inverse entre le temps d'incubation et l'énergie d'activation, ce qui est contre-intuitif.

Synthesis of Novel Ni/Fe/V-Based Materials for Supercapacitor Electrodes

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Supercapacitors have emerged as promising energy storage devices owing to their high power density, rapid charge–discharge capability, and long cycle life, bridging the gap between conventional capacitors and batteries. In this work, we report the development of advanced CP/NixFeyVz electrodes for supercapacitors synthesized on a carbon paper (CP) substrate via a simple hydrothermal method, with temperature and reaction time systematically varied as key parameters.

The resulting materials were characterized using scanning electron microscopy (SEM) and X-ray photoelectron spectroscopy (XPS). The electrochemical behavior of the CP/NixFeyVz electrode was investigated through cyclic voltammetry (CV), galvanostatic charge–discharge (GCD), and electrochemical impedance spectroscopy (EIS) in a three-electrode configuration.

The CP/NixFeyVz electrode demonstrated remarkable electrochemical properties, delivering a high specific capacitance of 480 $F \cdot g^{-1}$ at a scan rate of 0.01 $mV \cdot s^{-1}$. This cost-effective synthesis route yields electrodes with excellent capacitive characteristics and holds strong promise for next generation energy storage applications.

Architecturally Controlled Bottlebrush Polymers for Advanced Energy and Display Applications

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One of the major problems in material sciences is developing a single component material that can do more than one job, i.e. multifunctionality. 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. Different ionically conductive side arms can be further chosen for ionic conductivity. Using ROMP provides excellent control in architecture, composition and solubility control etc. 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. The goal is to develop a library of polymers to establish a structure property relationship to directly applying them for device applications. This will demonstrate that multiple functionalities can be achieved by combining synthetic control and functional design toward tuning mechanical and optical properties.

Electrochemical reduction of carbon dioxide to solid carbonaceous products on a ceria-liquid metal alloy

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With the continuous rise of greenhouse gas emissions, carbon capture and utilization (CCU) has emerged as a promising strategy to mitigate global warming while promoting a circular carbon economy. Captured CO_2, particularly from fossil fuel-based power plants, can be electrochemically converted into value-added products such as CO, methanol, and ethylene. Synthetic graphite, valued for its high purity, constitutes approximately 45% of global graphite production, primarily serving as a key material for lithium-ion battery anodes. The increasing demand for graphite underscores the urgent need for more sustainable production methods. In this work, we demonstrate a reliable electrochemical approach for the synthesis of layered graphite directly from CO_2 using an upgraded *2.0 experimental system* based on a Galinstan (Ga–In–Sn) liquid metal substrate alloyed with a cerium catalyst. This next-generation system offers enhanced control of reaction parameters and improved electrode stability. The use of liquid metal electrodes provides distinct advantages, including resistance to carbon coking due to weak van der Waals adhesion at the liquid–solid interface and a high overpotential for the hydrogen evolution reaction. Our results reveal the formation of crystalline graphite layers under ambient conditions, highlighting a scalable, low-energy pathway for sustainable carbon utilization and synthetic graphite production.

Optimized Battery Design for High-Performance Rechargeable Zinc–Air Systems

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Abstract: The growing demand for efficient and sustainable energy storage in portable electronics, electric vehicles, and stationary applications highlights the limitations of conventional lithium-ion batteries and the need for alternative technologies. Zinc–air batteries (ZABs) are among the most promising candidates to address these challenges. Compared to lithium, zinc is less hazardous, inexpensive (US$2/kg vs. US$8/kg for Li) [1–2], and widely available, with global reserves estimated at 250 million tonnes in 2020 (U.S. Geological Survey).

Because only the zinc anode is stored in the cell while oxygen is absorbed from the ambient air, ZABs offer a high theoretical energy density of 1350 Wh/kg (excluding oxygen), a theoretical operating voltage of 1.65 V, and potentially low manufacturing costs. The use of atmospheric oxygen also contributes to compact, recyclable designs [3].

This research focuses on improving ZABs through device design optimization, aiming to enhance charge–discharge efficiency, power density, and cycle life. Electrochemical testing of different cell configurations is complemented by postmortem analyses of the zinc anode and air cathode to identify degradation pathways that limit long-term operation. In parallel, preliminary results are presented on gel polymer electrolytes (GPEs) fabricated via electrospinning, showing potential for future solid-state ZAB designs. Collectively, these findings underscore the importance of battery design in advancing the practical deployment of next-generation rechargeable ZABs.

References

[1] E. Davari, D.G. Ivey, Bifunctional electrocatalysts for Zn–air batteries. *Sustain. Energy Fuels*, 2 (2018) 39.
[2] V. Caramia, B. Bozzini, Materials science aspects of zinc–air batteries: a review. *Mater. Renew. Sustain. Energy*, 3 (2014) 28.
[3] P. Gu, M. Zheng, Q. Zhao, X. Xiao, H. Xue, H. Pang, Rechargeable zinc–air batteries: a promising way to green energy. *J. Mater. Chem. A*, 5 (2017) 651.

THANK YOU !