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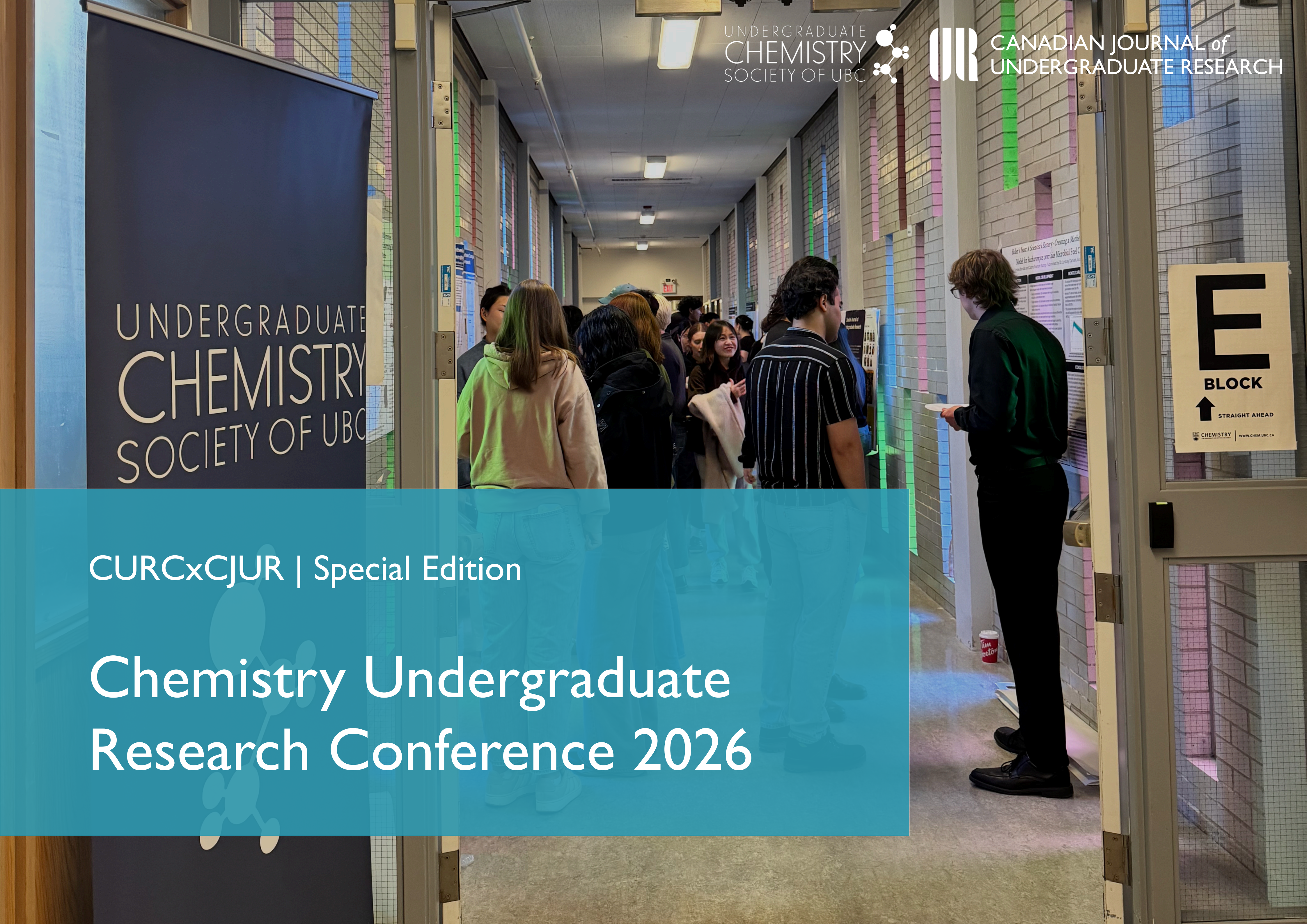

CURCxCJUR | Special Edition

Chemistry Undergraduate Research Conference 2026

CANADIAN JOURNAL *of* UNDERGRADUATE RESEARCH

UNDERGRADUATE CHEMISTRY SOCIETY OF UBC

CURCxCJUR: Chemistry Undergraduate Research Conference 2026

Special Edition

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This issue is published on the traditional, ancestral, and unceded territory of the Coast Salish Nations, including xʷməθkʷəy̓əm (Musqueam), Sḵwx̱wú7mesh (Squamish), and səlilwətaɬ (Tsleil-Waututh).

For inquiries about the Chemistry Undergraduate Research Conference, please address correspondence to undergraduatechemistrysociety@gmail.com. For inquiries about the Canadian Journal of Undergraduate Research, please contact cjur.uro@gmail.com.

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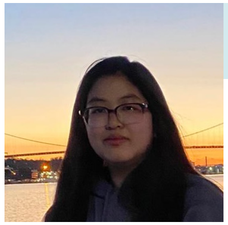

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Chemistry Undergraduate Research Conference 2026

The Chemistry Undergraduate Research Conference (CURC) is an annual event hosted by the Undergraduate Chemistry Society (UCS) at the University of British Columbia. Held each spring, the conference provides current and prospective Chemistry students with an opportunity to learn about undergraduate research in the Chemistry and related departments at UBC. It also offers CHEM 449 and 445 RLE students a valuable chance to practice their presentations and receive feedback from a graduate student panel before their defenses in April.

By bringing together undergraduate researchers, graduate panelists, and members of the Chemistry community, CURC highlights the diversity and quality of research taking place at the undergraduate level. The conference supports the development of scientific communication skills and fosters greater engagement with research across the department. In addition to research presentations, CURC also features a poster-making and presentation workshop to help students build confidence and strengthen their presentation skills. In 2026, the conference featured 15 undergraduate presenters with topics ranging from hydroaminoalkylation of polymers and living-cell alpha particle detection to mechanochemical porphyrin synthesis and the effect of mining pollution on atmospheric ice crystallization.

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Shifted-Excitation Raman Difference Spectroscopy (SERDS) and Machine Learning Measure Mineral Carbon Capture

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As global greenhouse gas emissions rise, the mining industry offers potential for CO_2 capture in mine tailings and industrial byproducts. Brucite ($Mg(OH)_2$), found in ultramafic mine tailings and industrial byproducts such as cement and magnesia, captures CO_2 in a stable mineral-forming reaction. Current methods to quantify inorganic carbon (i.e., acidification, combustion) are time-inefficient and destroy the sample, preventing further analysis. Efficient quantification of brucite carbon capture requires an automated, high-throughput technique. While existing Raman measurements of minerals can elucidate molecular structure and hydration level, they are challenged by non-uniform crystallinity, complex chemical composition, and background fluorescence. Here, we measure brucite carbon capture by correlating total inorganic carbon (TIC) from coulometric acidification with fluorescence-free shifted-excitation Raman differential spectroscopy (SERDS) features using machine learning multivariate regression. Overall, nonlinear models outperform linear models for carbonate prediction, particularly for single-output variable predictions. Univariate carbonate-band area-under-curve measurements correlate weakly with TIC due to significant nonlinearity at TIC > 6 wt% as a consequence of differences in crystallinity, hydration state, carbonate phase assemblage, and band overlap. Experiments testing the addition of simulated fluorescence further establish that nonlinear multi-parameter models outperform their linear counterparts. Mean absolute error increases by 0.76 and 0.46 for linear and nonlinear regression, respectively, with the addition of simulated fluorescence. Fluorescence-free Raman spectroscopy improves all machine learning models, especially complementing stronger baseline performance of nonlinear models. By refining and scaling, this approach yields an effective, high-throughput means to validate new industrial carbon capture methods.

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Keywords: Raman spectroscopy, machine learning, SERDS, mineral carbon capture, brucite, magnesium carbonates

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Development of Alpha Spectroscopy as a Diagnostic Tool for Targeted Alpha Therapy on Cancer Cells

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Targeted alpha therapy (TAT) is an emerging treatment for metastatic cancers. This radiotherapy technique uses alpha-emitting radiopharmaceuticals to deliver precise, localized alpha radiation to tumour tissue. Alpha particles have high linear energy transfer and cause double-strand DNA breakage in tumour cells, leading to cell death even in resistant cancers while minimizing harm to healthy tissue. Actinium-225 (Ac-225) is a promising radionuclide for TAT due to the four successive alpha emissions produced in its decay chain. We developed the Bio-Sample Alpha Detector (BAD), a silicon-based alpha particle detector operating under ambient conditions, that enables the collection of direct, real-time alpha spectroscopy data of live cells. The BAD setup allows radiolabeled cancer cell samples to be placed within 100 μm of the detector, accounting for the positional dependence of alpha particle detection and thus obtaining statistical uncertainties of < 1% in alpha count rates. Differences in alpha spectra of cells and control samples confirm the uptake of Ac-225 radiopharmaceuticals by A673 human tissue cancer cells. Geant4 Monte Carlo simulations confirmed that experimental data align with theoretical predictions. Uptake efficiencies measured by alpha spectroscopy align with those measured by gamma spectroscopy, confirming alpha-emission spectra results in anticipation of studies comparing other parameters of various cell lines. The BAD alpha spectroscopy technique is a novel tool for examining the behaviour of Ac-225 radionuclides in live cancer cells *in vitro*. The possibility of accurately and quantitatively measuring alpha radiation deposited in biological samples is promising for furthering the development of radiopharmaceuticals for TAT.

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Keywords: alpha spectroscopy, targeted alpha therapy (TAT), actinium-225 (Ac-225), radiopharmaceuticals, radionuclides, nuclear medicine, cancer cells, alpha detector
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Synthesis and Characterization of Functionalizable Polyesters via Indium-Catalyzed Ring-Opening Polymerization

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Petroleum-based synthetic polymers have been linked to global environmental issues stemming from their manufacture, usage, and disposal processes. To address these concerns, research has been focused on bio-derived, functionalizable, and degradable polymers. Introducing heteroatoms into polymer backbones increases polymer degradability and makes them amenable to functionalization, which can be used to control physical and chemical properties of the polymer. Ring-opening polymerization (ROP) is an established method to synthesize such polymers. Adjusting monomer ring size can drive the polymerization by impacting thermodynamic parameters. However, maintaining control of the ROP to achieve targeted molecular weight with low dispersities is still a challenge. The Mehrkhodavandi group has previously reported the living ROP of lactide and beta-butyrolactone using a di-indium catalyst to form biodegradable linear polymers with high polymerization control and narrow dispersity. Depending on the monomer, the di-indium catalyst may remain di-nuclear during polymerization or dissociate into an active mono-nuclear form. In this study, we optimize the reaction conditions of various monomers with different ring sizes and heteroatoms such as nitrogen and oxygen in the ring. We also investigate the nuclearity of the catalyst with each monomer and whether that affects the polymerization control. Monomer ring strain and polymerization thermodynamic and kinetic parameters all impacted polymerization efficiency simultaneously, as monomers with greater ring strain required higher temperatures and longer reaction times. This work establishes the controlled polymerization of different lactones, affording more tailored properties which facilitate their use in a variety of applications.

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Keywords: ring-opening polymerization, lactone, lactide, biodegradable polymer, controlled polymerization, polyester

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Hydroaminoalkylation of Gaseous Alkenes

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Nitrogen-containing compounds are crucial components of natural products and pharmaceuticals. The methyl group is one of the most common functional groups in small-molecule drugs due to its effects on binding potency, leading to the so-called methyl effect. Methylation can be easily achieved through a variety of synthetic methods; however, accessing other small alkyl groups proves to be a challenge. Through previously established methods of hydroaminoalkylation, the alkylation of unprotected amines with gaseous substrates was explored. We report the alpha functionalization of commercially available amines with ethylene and propylene gas, with high regio- and diastereoselectivity. The success of gaseous hydroaminoalkylation provides a streamlined synthetic route to drug analogs using simple alkylation to expand upon the methyl effect.

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Keywords: hydroaminoalkylation, alkylation, propylene, ethylene, alkene, gas, amine

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Arduino-based Experiments as a Novel Addition to Undergraduate Chemistry Curriculum

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The Arduino Uno is an accessible and open-source microcontroller board commonly used in robotics projects for an introduction into electronics. Beginner-friendly Arduino kits are accompanied by various sensors, providing ample opportunities for students to explore the fundamentals of digital construction. Despite their appearance in chemical literature, the extent to which these tools can be fully integrated into existing chemistry laboratory experiments is limited. This project aims to explore the feasibility of student-built Arduino sensor systems and instruments to determine their potential for instructional use. By engaging in hands-on instrument construction, coding, and data collection, students can expand on guided inquiry projects in the CHEM 211 undergraduate analytical laboratory course. The first prototype was a drop counter designed with a KY-022 IR receiver module and a KY-005 IR transmitter as a detection system. Second, an Arduino-controlled Vernier pH probe was constructed to collect voltage signals in titration experiments. Lastly, an environmental sensor was constructed using a MQ135 Gas Sensor and DHT11 Temperature and Humidity Sensor for further environmental applications. All systems were coded using the Arduino IDE software. Measurable signals were obtained from both the Arduino-Vernier pH probe and environmental sensor, providing an implication that there is a potential for experimental application. However, the drop counter showed limited sensitivity for detecting coloured and colourless water droplets, demonstrating the need for further investigation. Overall, these results illustrate that Arduino-based instrumentation can be a creative, flexible, and innovative platform that students can use to hone their knowledge on analytical instruments during their guided inquiry projects.

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Keywords: Arduino, CHEM 211, pH, environment

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Iridescent and Hydrophobic Polymer Composite Cellulose Nanocrystal Films

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Cellulose nanocrystals (CNCs) are known for their ability to form iridescent films with structural colour via solidification of a chiral nematic liquid crystalline phase. However, the inherent brittleness and hydrophilicity of CNCs make them fragile and susceptible to moisture, limiting their versatility. To address these issues, an innovative strategy has been developed to overcome the incompatibility between hydrophilic CNCs and hydrophobic polycaprolactone (PCL), and a series of hydrophobic iridescent CNC-PCL composite films has been prepared. The soft PCL was homogeneously entrapped in the chiral nematic CNC matrix through film swelling, solvent exchange, and ambient drying, while the photonic structure of the assembled CNCs was well-retained. These composite materials are iridescent, flexible, and hydrophobic, making them promising candidates for waterproof photonic coatings. Furthermore, their structural colour, flexibility, and hydrophobicity were readily adjusted by tuning the proportion of PCL in the CNC matrix. It is expected that this new strategy will open the door for future researchers to develop water-resistant and flexible photonic materials by blending photonic crystals and hydrophobic polymers, as well as expanding their application scenarios.

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Opening Rings, Closing the Loops: A Novel Aluminum Catalyst for the Polymerization of Cyclic Poly(lactide)

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Synthetic polymers are integral parts of our world today. However, their convenience, demand, ubiquity, and majority petrochemical basis have propagated the ongoing plastic problem, and thus environmentally friendlier alternatives are needed. Poly(lactide) (PLA) is a renewable, biocompostable, and biocompatible polymer that has the potential to replace many commercial petrochemical polymers. While linear PLA has generally acceptable mechanical qualities, it has poor thermal resistance. However, the cyclic analogue, cyclic PLA (c-PLA), provides superior crystallinity, thermal resistance, and mechanical strength. It furthermore combines biodegradability and better material characteristics, presenting a powerful approach to plastic alternatives with enhanced material properties. Thus, understanding c-PLA synthesis and catalysis is crucial, as cyclic polymer synthesis remains challenging. While c-PLA synthesis has been reported using indium catalysts, further understanding of the various factors that impact catalyst performance is needed. Aluminum is an abundant green metal that is commonly used in catalysis, possessing higher Lewis acidity and a smaller ionic radius than indium. We aim to investigate and understand the effects of a different metal centre, with respect to Lewis acidity and ionic radius, on c-PLA synthesis using aluminum, with the expectation of also producing high molecular weight polymers. We will synthesize a novel aluminum catalyst and measure the initiation efficiency, monomer conversion, and polymer molecular weight. The catalyst will be characterized by nuclear magnetic resonance spectroscopy, X-ray crystallography, and elemental analysis, and the polymers will be analyzed via mass spectrometry and size exclusion chromatography.

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Keywords: aluminum, polylactide, ring opening polymerization, Lewis acidity, biodegradable polymer

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Baker's Yeast: A Scientist's Battery - Creating a Mathematical Model for *Saccharomyces cerevisiae* Microbial Fuel Cells

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Microbial fuel cells (MFCs) are a promising technology offering a low-cost, sustainable option for generating renewable energy from organic matter and efficient wastewater treatment. While MFCs have been well-studied, those powered by *Saccharomyces cerevisiae*, commonly known as baker's yeast, remain less explored, especially regarding accurate predictive modelling of their electrical output. This study investigated the voltage produced by MFCs comprised of baker's yeast, sugar, and graphite rods and developed a mathematical model of the voltage over time. The voltage output of an MFC was recorded over time using various concentrations of yeast and sugar. To interpret the behaviour of the system, several mathematical models were combined, including Monod kinetics and ordinary differential equations (ODEs) for yeast growth and sugar depletion. A Monte Carlo simulation was used to estimate the uncertainty and to account for biological variability and electrical noise in the system. The combined experimental and modelling results confirmed that yeast MFCs can reliably sustain a low voltage and that the voltage over time produced can be effectively modelled using a system of biological and electrochemical equations. This approach provides insight into the properties and viability of yeast-based MFCs.

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Synthesis of a New Bimetallic Platinum Complex Within a Phenylpyridine-Based Ligand Framework

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Over the past few decades, the development of luminescent metal complexes has gained popularity due to their applications in sensors, catalysis, bioimaging, and organic light-emitting diodes (OLEDs). In particular, Pt(II) complexes with cyclometallating ligands have garnered attention for their emissive properties and high stability. This project aims to synthesize a novel bimetallic Pt(II) complex featuring a macrocyclic ligand framework synthesized by bridging two phenylpyridine-based scaffolds with nitrogen. This compound is expected to demonstrate increased photophysical properties and stability thanks to its tetradentate rigid structure and strong σ-donor atoms. Furthermore, intramolecular Pt-Pt communication and the synergistic effect of the second Pt(II) centre on emission will be investigated by comparing the photophysical properties of the mononuclear and bimetallic Pt(II) complex. In this work, we provide synthetic pathways for the phenylpyridine-based ligand framework and Pt(II) complexes, overcoming synthesis challenges such as undesired polymerization during the macrocyclization step. Characterization and analysis of the photophysical properties of the mononuclear Pt(II) complex will also be discussed, expanding the library of emissive compounds for functional materials.

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Keywords: Pt(II) complexes, luminescent metal complexes, OLEDs, macrocycles, phenylpyridine-based ligands, cyclometallation, photophysical properties

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