## Undergraduate Poster Session
## Room Ballroom BC - Session UN-ThP

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**UN-ThP-1 Nitrogen Plasma Treated-Polylactic Acid: Examining pH Variations During Degradation***, **Imaandeep Bual**, Morgan Hawker,* California State University, Fresno

Polylactic acid (PLA) is a promising biodegradable polymer that degrades at a faster rate than conventional fossil fuel polymers and can combat the growing issue of plastic pollution. Moreover, it is an excellent alternative to the growing issue of microplastics because it can be readily degraded through hydrolysis. Although PLA is biodegradable, it induces environmental change when degrading. Specifically, the degradation of PLA in soil via hydrolysis has been shown to lower the soil's pH, adversely affecting plant growth. Previous research demonstrates that certain plants containing nitrogen-processing bacteria use nitrogen moieties to raise the pH of soil. Furthermore, PLA has been shown to degrade at an accelerated rate in alkaline conditions. We hypothesize PLA degradation can be induced by introducing nitrogen functional groups on the surface via nitrogen plasma treatment (NPT), which can then act as Lewis bases upon degradation. The impact of NPT on PLA degradation has not been previously investigated at large.

This study examined the change in pH as NPT PLA degraded in room temperature DI (deionized) water. PLA films were fabricated and plasma treated in an inductively-coupled plasma reactor using nitrogen gas as the precursor. Plasma treatment parameters including 30 W, 328 mTorr, and two minutes of treatment time were selected based on previous literature and optimized to maximize nitrogen incorporation. NPT PLA films and untreated control films were then submerged in 10 mL of DI water at room temperature to initiate degradation. Changes in pH of NPT and control PLA films were compared after degradation. Previous results showed no significant difference in pH change associated with one week of degradation of PLA between control and NPT films, necessitating longer-term degradation studies of NPT PLA film degradation with a specialized pH probe. Collectively, NPT shows potential to alter the chemical degradation of PLA when compared to native PLA degradation.

**UN-ThP-2 Studying Dna Base Pairing by Examining Adenine and Thymine Through Electrospray-Ionization Mass Spectrometry***, **Connor McIlvain**[1], S. Alex Kandel,* University of Notre Dame

Examining molecular interactions in solution can give insight into intermolecular forces with applications to cluster formation and crystallization. Electrospray-ionization mass spectrometry (ESI-MS) allows for the study of non-covalent molecular clustering patterns as electrospray is a soft enough ionization technique to preserve molecular clustering. Cluster stability is expected to decrease with size; however, large, unusually stable clusters, called magic number clusters, occasionally occur and are disproportionately represented in the mass spectra. Adenine and thymine are Watson-Crick base pairs, so the interactions driving their assembly deserve further study. Alone, adenine displays expected exponential cluster decay with size, except in the case of adenine trimers, which are disproportionately disfavored. Adenine dimer and tetramer formation could be explained by both Watson-Crick and Hoogsteen binding. The expected exponential cluster decay is also observed for thymine, with the exception of the dimer, which is disproportionately represented. Together, adenine and thymine display the same clustering tendencies with the addition of adenine:thymine clusters. In this case, the exponential decay is disrupted by the formation of magic number clusters, the3:1 adenine:thymine tetramer, and the 3:2 adenine:thymine pentamer. Trimers of all kinds were still underrepresented. This clustering behavior indicates a high level of noncovalent intermolecular interaction outside of traditional Watson-Crick base pairing. This system is further studied through the introduction of the nontraditional base pair 6-O-methylguanine (6-OMG) with thymine to better understand the forces around Watson-Crick base pairing and Hoogsteen binding. These solution clustering experiments have the potential to improve the current understanding of molecular self-assembly, even outside of traditional Watson-Crick base pairing, and could further be augmented by future scanning tunneling microscopy experiments.

**UN-ThP-3 Investigation of Spinel and Sapphire Plasma Etching for Development of Anti-Reflection Nanostructures***, **Sean Campbell**, Thomas Hutchens, Stephanie Alvarez, Jacob Hay, Tyler Benge, Ishwar Aggarwal,* The University of North Carolina at Charlotte

In the field of high-energy lasers, there is a need for optical windows that exhibit high transmittance in the visible to mid-wave-infrared wavelength range (MWIR). This can be done with the patterning of nanoscale anti-reflective (AR) structures onto spinel and sapphire substrates. AR structured surfaces (ARSS) have shown to exhibit higher laser damage thresholds compared to thin-film AR coatings. The substrates are etched with a reactive ion plasma etcher and subsequently characterized with the help of a Fourier Transform Infrared Spectrometer(FTIR). Different etch chemistry and their respective etch rates were investigated, as well as optical transmission performance of the materials at visible to MWIR wavelengths. Future work involves masking of the substrate via photoresist and fine-tuning the scalability of the masking and etching process to larger substrate form factors.

**UN-ThP-5 Freshwater Biofouling Analysis of Nano-Textured and Anti-Reflection Coated Windows***, **Stephanie Alvarez**, Thomas Hutchens, Sean Campbell, Jacob Hay, Tyler Benge, Ishwar Aggarwal,* University of North Carolina at Charlotte

Most high performance optical components, like lenses and windows are designed for sterile, low-contaminate environments, however, optical systems used by the Navy often operate in harsh marine and sandy environments. Improving the lifespan of optical elements in these conditions is essential. Optical elements with anti-reflective (AR) coatings or structured surfaces, which feature nano-textured elements, are particularly vulnerable to degradation. This study aims to evaluate the impact of submerged environments on these components. Long term testing was conducted on five 1-inch-diameter fused silica windows with different surface treatments: a polished blank, a hydrophilic "web-like" AR, a hydrophobic "moth-eye" AR structured surface (ARSS), a commercially available ARSS and a thin-film AR coating. Samples produced in-lab are done through high-vacuum mask deposition and plasma etching to produce the AR structured surface desired. Prior to submersion, the contact angles and optical transmission spectra of each window was measured. The samples were placed in a flotation housing unit and submerged in a semi-controlled biological freshwater environment for 30 days. Once removed, the windows were analyzed for biofouling accumulation and changes to optical performance. This experiment aims to identify how surface coatings and nano-structures influence the biofouling resistance of optical elements, providing insights into improving optical components durability in challenging environments.

**UN-ThP-6 Sol-Gel Hyper-Hydrophilic Anti-Fog Coatings Study & Model Of Surface Condensation Vs. Current Anti-Fog Strategies To Maximize Time-To-Fog & Optical Properties On Medical Lenses***, Nicole Herbots,* Sio2 Innovates LLC / Infinitum BioMed LLC / UV One Hygienics Inc. / Arizona State University Department of Physics*; **Arya Bhakta**[2],* SiO2 Innovates LLC / Case Western Reserve University*; Shreyash Prakash,* Sio2 Innovates LLC / Infinitum BioMed LLC*; Viraj Amin,* Sio2 Innovates LLC / Infinitum BioMed LLC / University of Missouri-Kansas City School of Medicine*; Ashwin Suresh,* Sio2 Innovates LLC / Infinitum BioMed LLC / University of Arizona Department of Physiology*; Srivatsan Swaminathan,* Sio2 Innovates LLC / Infinitum BioMed LLC / Arizona State University / Icahn School of Medicine at Mount Sinai*; Visheshwar Swaminathan,* Sio2 Innovates LLC / Infinitum BioMed LLC / UV One Hygienics Inc.*; Dora D. Suppes, Mark Russell-Hill,* Infinitum BioMed LLC / UV One Hygienics Inc.*; Robert J. Culbertson,* Arizona State University Department of Physics*; Eric J. Culbertson,* Providence Santa Rosa Memorial Hospital / SiO2 Innovates LLC

Endoscope lenses easily fog within closed body cavities, disrupting the visual field during surgery within minutes. Lens opacification is due to water vapor condensation, which forces surgeons to remove the scopes, wipe their lenses, and reinsert them. Repeated scope wiping and reinsertion increases infection risks, length of surgery and OR use, and tissue scarring due to prolonged air exposure.

Current strategies to inhibit fogging, such as alcohol-based coatings and heating, introduce complications. For example, alcohol solutions evaporate quickly and irritate damaged tissue due to their acidity. Another strategy is to pre-heat endoscope lenses; this requires reheating due to the cooling of small diameter lenses (2- 12 mm) connected to 30-200 mm endoscopes.

[1] **JVST Highlighted Poster**

[2] **JVST Highlighted Poster**

Textured lens surfaces rapidly wear and are very difficult to clean and sterilize.

This work has developed a phenomenological model for fogging on smooth surfaces: the SEE (or Surface Energy Engineering) model with direct surface energy measurements. SEE has guided development and testing of new *hyper-hydrophilic* sol-gel coatings, KnoxFog[1], using two key properties to inhibit fogging. First, coating' surfaces are *super-hydrophilic*, meaning molecules condense in 2D sheets (Frank-Vander Merwe Growth Mode) instead of 3D droplets (Volmer-Weber Growth Mode). Second, nanopores in the Sol-Gel absorb water as the condensate thickens. This combination yields a lasting anti-fog coating, where water condenses for 2+ hours into a continuous, flat film, free of optical distortion and droplets, even when exposed to blood and tissue debris.

Using four pairs of endoscopes *in vitro*, at T= 38±2°C, the time-to-fog (TTF) of a pair of identical endoscopes whose lens is coated with KnoxFog is compared in a closed cavity *simultaneously* with a pair of bare lenses and two pairs using the current anti-fog strategies. TTFs of KnoxFog coatings exceed 131 min with a variation of < 1 %. TTFs of bare lenses average less than 8 ± 8 min. *In these same simultaneous conditions of water evaporation*, a variation of 100% can occur in surgery due to a lack of controlled surface conditions on bare lenses. KnoxFog™ improves TTF by 1625 ± 1% over bare lenses, reduces by two orders of magnitude the TTFs unpredictability of bare lenses, and improves over lens tip heating, whose TTF averaged less than 1 min *in the same conditions*, and on alcohol-based coatings, whose TTF averages 47.5 min with a variability of 56%.

*In vivo* animal studies show that KnoxFog performance significantly increases TTFs and optical clarity while reducing the need for frequent lens cleaning from blood and tissues.

[1] Trademark owned by SiO2 Innovates

**UN-ThP-8 An Investigation into the Optoelectronic Properties of Layered and Vertically Aligned $MoS_2$-$MoSe_2$ Heterostructures on Different Substrates***, **Elycia Wright**,* Clark Atlanta University*; Kedar Johnson,* Clemson University*; Amari Gayle, Robin Rouseau, M.K. Indika Senevirathna, Michael D. Williams,* Clark Atlanta University

Two-dimensional transition metal dichalcogenide (TMD) materials offer exciting opportunities for various applications, particularly due to their unique layer-sensitive band structures, valley-selective optical coupling, and remarkable catalytic activities. Their notably large exciton binding energies and strong nonlinear optical responses underscore their potential. Moreover, by strategically stacking different monolayer TMD materials, we can create heterostructures that allow tuning band gaps across visible to infrared spectrum. This approach enhances their optoelectronic properties and opens new avenues for advancements in fields such as optoelectronics and photonics.

This research investigates the optoelectronic properties of $MoSe_2$-$MoS_2$ heterostructures grown on various substrates, including gallium nitride (GaN) and sapphire, using the chemical vapor deposition (CVD) technique. The study also examines how the choice of substrate affects the growth of layered versus vertically aligned heterostructures. We utilize CVD techniques because they have proven more effective for producing samples with extensive monolayer growth than the commonly used exfoliation method. By analyzing the differences in bandgap, the Raman and infrared (IR) vibrational modes, we aim to reveal the unique properties of these heterostructures.

**UN-ThP-9 Correlation Analysis of In Situ Atomic Layer Deposition Mass Spectrometry Data for Surface Reaction Analysis***, **Ayelen Mora**, Eric Bissel, Parag Banerjee,* University of Central Florida

Atomic Layer Deposition (ALD) enables precise, conformal thin-film coatings on high-surface-area nanoparticle powders through sequential, self-limiting reactions. However, coating nanoparticle beds presents unique challenges, including precursor diffusion limitations, particle agglomeration, and extremely high surface areas (reaching ~10s of $m^2/g$). These factors complicate the ALD process, making it essential to monitor reaction progress and identify saturation ("end-pointing") within the powder bed.

In this work, we employ quadrupole mass spectrometry (QMS) as an *in situ* diagnostic tool to study $Al_2O_3$ ALD on ZnO nanoparticle powder beds. Using trimethylaluminum (TMA) and ozone ($O_3$) as precursors at a deposition temperature of 120 °C, we track methane ($CH_4$) evolution—a key reaction byproduct—to gain insights into surface reaction kinetics and saturation behavior. Furthermore, we develop multivariate analysis tools to interpret ALD reaction dynamics in powder bed reactors with the hope of enabling better process control and optimization.

**UN-ThP-10 Naturally Derived Polymers for Biomedical Applications: Stabilizing Hydrophilicity after Nitrogen-Plasma-Treatment***, **Mina Abdelmessih**[1], Morgan Hawker,* California State University, Fresno

Polylactic acid (PLA) and chitosan (CS) are popular biopolymers that display tremendous potential for scaffolding applications in the biomedical field. Both polymers are renewable: PLA is produced from renewable feedstock, while CS is obtained through the deacetylation of chitin. The use of these polymers in biomedical-related applications such as scaffolding is promising due to their non-toxicity *in vivo* and biodegradability. Additionally, they each contain distinct mechanical and degradation properties suitable for different applications. However, both polymers have a hydrophobic surface, which restricts their biomedical implementations where cell adhesion is critical (e.g., in applications related to tissue and bone engineering). There is some evidence that cell adhesion and growth are facilitated by hydrophilic surfaces. Radio-frequency nitrogen plasma treatment displays promise in increasing the polymers' hydrophilicity, but also displays potential aging instability with hydrophobic recovery. This poses a significant problem for applications of the treatment especially when considering storage-induced aging. Approaches to prevent this phenomenon in PLA and CS are widely unexplored.

This work investigated the impact of various aging conditions (storage in vacuum, cold temperature, and air) on the surface hydrophilicity of PLA and CS after exposure to nitrogen plasma. Films were prepared as model substrates using the solvent-casting method, and treated in a RF plasma reactor under optimized parameters (power, pressure, and treatment time). After treatment, the films were aged in the different aging environments for two weeks. Throughout the aging period, multiple surface analyses were conducted on samples exposed to the various preservation environments, including untreated samples as controls. Surface wettability analysis utilizing water contact angle goniometry displayed that vacuum aged PLA films and cold temperature aged CS samples possess the least hydrophobic recovery in comparison to other aging conditions. Surface chemical composition of PLA and CS samples was examined using x-ray photoelectron spectroscopy. These treatment preservation methods to PLA and CS have potential to positively impact their future use in the biomedical field as scaffolds.

**UN-ThP-12 Bacterial Infection Detection in Drops Flattened into Thin Films by Super-hydrophilic Collection Surfaces using Macroscopic DNA/RNA Epi-Fluorescence: A hand-held sensor for Bacterial Infection Diagnosis: BacteroBug™***, **Arya Saravanan**,* SiO2 Innovates/Arizona State University, Life Sciences & BioChemistry*; Sriram Rajesh,* SiO2 Innovates LLC*; Nila Kathiravan,* SiO2 Innovates LLC/InnovaBug LLC*; Sudharshini Ram, Nithish Prakash,* SiO2 Innovates LLC/InnovaBug LLC/ViroBug LLC*; Viraj Amin,* SiO2 Innovates LLC/InnovaBug LLC/University of Missouri - Kansas City (School of Medicine)*; David Guo,* SiO2 Innovates LLC/Innovabug LLC/Drexel University/University of Arizona School of Medicine*; Eric J. Culbertson,* SiO2 Innovates LLC/InnovaBug LLC/Microbe Lab-On-Chip LLC*; Robert J. Culbertson,* Arizona State University Department of Physics*; Nicole Herbots,* SiO2 Innovates LLC/InnovaBug LLC/Microbe Lab-On-Chip LLC/Arizona State University

In 2025, the gold standard for bacterial infection diagnosis, developed in the 70s, is plate culturing. State-of-the art infection diagnostics use the universally accepted Colony Forming Units (CFUs) counting on cultured plates, which requires 10-30 mL of blood, urine, sputum, etc... and 2-3 days for results.

However, about 40% of all positive cultures are false positives due to contamination from skin pathogens and handling in blood, urine, sputum, etc... during collection or environmental contaminations.

Per the NIH, false positives are "independently associated with increased subsequent laboratory charges (+20%) and IV antibiotic charges (+39%)". The excess of diagnosed infections costs US hospitals about $20+Billions/year in 2025. False positives lead to administration of antibiotics in healthy patients, leading to antibiotic resistance, and to more than 48,000 US deaths/ year.

New, reliable methods are needed for bacterial detection, loads, infection diagnosis.

The present research investigates whether Macroscopic DNA Epi-Fluorescence (MaDRE) can be used for bacterial detection, and whether macroscopic epi-fluorescence intensity scales quantitatively with bacterial load in small volume drops using fluorophores developed for fluorescence microscopy. To sort detected microbes by class, 3 fluorophore combinations

[1] **JVST Highlighted Poster**

are designed to detect DNA/RNA in live bacteria and protozoa, RNA in viruses, and fungi-specific proteins.

A quantitative study was thus conducted to establish whether a MaDRE-based device is viable in accuracy and reproducibility. An initial stock solution in Luria Broth is diluted logarithmically into 10 bacterial serial loads from 1.0 to $10^{-9}$ for calibration. Next, MaDRE's sensitivity is tested on these 2 x ten bacterial loads, to establish whether 520 nm fluorescence intensity of safe green DNA fluorophores $I_G$ scales reproducibly with bacterial concentration. The two sequential experiments were conducted by applying four 0.1 mL identical drops from each of the 20 solutions on 2 hyper-hydrophilic prototype strips.

$I_G$ is normalized to the 497 nm excitation intensity, $I_B$, before and after 0.1 mL dye drops are applied, as RG/B. The difference between post-dye $R_{Raw}$ and pre-dye $R_{Bgd}$ yields the net $R_{Net}$

$R_{Net}$ averages of 8.5 ± 2.1 for 300k *E.Coli* CFU/mL, and 3.6 ± 0.34 for 100 k *E.Coli* CFU/mL. Thus, $R_{Net}$ decreases 250% with a decrease of one order of magnitude in bacterial load.Pre-dye $R_{Bgd}$ averages = 1.8 ± 0.25, thus lower by a factor 2 to 4 than post-dye $R_{Net}$.

Hence, the normalized fluorescence ratio $R_{G/B}$ scales with bacterial concentration consistently using 0.15 mL drops, and a handheld, small volume device is presently prototyped, BacteroBug™.

**UN-ThP-14 Statistical Optimization of Polynomial Fits for Carbon Bonding Analysis in XPS**, ***Garrett Lewis,*** *Matthew Linford, Alvaro Lizarbe,* Brigham Young University; *David Aspnes,* North Carolina State University

X-ray photoelectron spectroscopy (XPS) is a valuable tool for surface-level chemical analysis, particularly effective in assessing carbon hybridization states through the D-parameter, which distinguishes $sp^2$ and $sp^3$ bonding. Because this analysis involves differentiation, proper signal smoothing is critical to minimize the effects of noise. In this work, we explore high-order polynomial fitting as a general approach to prepare carbon Auger data for D-parameter analysis. To enhance reproducibility and reduce subjectivity, we introduce an algorithmic method for identifying the most suitable polynomial orders for smoothing. This approach evaluates the underlying structure of the data to balance over- and underfitting without relying on visual judgment. The results demonstrate that using statistical tools to guide polynomial selection leads to more reliable analysis of carbon bonding in XPS data. While developed for carbon Auger analysis, this method can be extended to other contexts where spectral smoothing is required for derivative-based measurements.

**UN-ThP-15 Formation of Etch Masking Layer on Fiber Optic Tip via Laser Annealing for ARSS**, ***Riley van Ravesteyn,*** *Jacob Hay, Stephanie Alvarez, Sean Campbell, Tyler Benge, Ishwar Aggarwal, Thomas Hutchens,* UNC Charlotte

In high-energy laser systems containing fiber optics cables, cable end faces and connectors are susceptible to laser induced damage, prompting the development of novel methods to increase the interface laser induced damage thresholds (LiDT). This can be done by applying a nano-scale anti-reflective structured surface (ARSS) to the end of these connectors. ARSS have been shown to exhibit a higher LiDT than conventional thin-film, anti-reflection (AR) coatings. Typical methods for fabricating ARSS involve masking and plasma etching steps. To apply ARSS to a fiber optic cable connector with performance in longer wavebands, like infrared, annealing of a gold film deposited via e-beam evaporation on the end of the connector is needed. This study focuses on a method for annealing, utilizing an off-the-shelf 1.6 W, 450 nm wavelength laser to deliver energy through the fiber optic cable in order to heat the opposing fiber endface to annealing temperatures, preserving the connector and fiber packing. Successful annealing was achieved on the fiber tip, forming an "island" mask layer, verified by scanning electron microscope imaging. Future goals for this project include developing the plasma etching step, and making the annealing process a readily available resource for commercial usage.

**UN-ThP-16 Investigating the Surface Evolution of the Self-Assembly of Quinone Derivatives on Au(111) Using Ambient STM and CV**, ***Cara Plaisance,*** *Nazila Hamidi, Erin Iski,* University of Tulsa

Quinones are an interesting class of redox active molecules due to their ability to undergo a reversible two electron transfer process. These molecules can be utilized in a multitude of applications from energy storage and electrochemical carbon dioxide capture to redox mediators in batteries. This research used ambient Scanning Tunneling Microscopy (STM) to observe the interactions of the quinone derivative, 2,3-dichloro-5,6-dicyano-1,4-benzoquinone, on the surface of Au(111) at room temperature following varying times of immersion. Immersion times in a saturated solution of the molecule in 0.1M $HClO_4$ varied from 30 minutes to 15 hours in order to study the effects of immersion on the adsorption kinetics, surface coverage, orientation, and self-assembly of the molecule on the surface. Cyclic voltammetry (CV) measurements were used in tandem with STM imaging to confirm redox activity and to act as a mode of electrochemical and topographical comparison for the different immersion times. STM imaging revealed that the immersion time influenced the molecular orientation and surface coverage of the quinone derivative on the crystal and that the best molecular resolution was achieved with minimal immersion times, which were needed to limit the amount of molecules on the surface. While these molecules and their associated derivatives have been extensively studied under ultra-high vacuum (UHV) and low temperature (LT) environments, it is critical to understand their adsorption behavior under ambient conditions and to interrogate their stability on electrodes in air. These findings highlight the ability of using STM in ambient conditions to study redox-active systems which have a wide range of applications in electrochemistry and molecular electronics.

**UN-ThP-17 Recommendations & Justifications for Peak Fitting PDMS & Similar Polymers**, ***Heidi Meyers,*** *Joshua Pinder, Matthew Linford, George Major,* Brigham Young University

Peak fitting is a critical tool that enables the determination of a substance's chemistry through data analysis techniques such as X-ray Photoelectron Spectroscopy (XPS). However, obtaining accurate and meaningful results can be challenging. By examining a few common, though sometimes overlooked, errors, we can improve the accuracy of data fitting. Some of these errors include overfitting, fitting noisy data, and peak envelope filling.

By applying these recommendations to our own experiments, we provide justifications and reasoning behind polymer peak fitting, specifically for Polydimethylsiloxane (PDMS). One useful approach is to compare pure $SiO_2$ to PDMS. Comparing measured reference data to unknown samples helps predict peak shapes and intensities, particularly for the contributing oxygen and silicon peaks. Valuable resources for measured spectra include Beamson & Briggs (especially for polymer databases) and Surface Science Spectra.

These guidelines aim to provide a practical foundation for accurate peak fitting in polymer systems.

**UN-ThP-18 Structural Characterization of Gadolinium-Doped Indium Tin Oxide Thin Films Grown on Various Substrates for Dilute Magnetic Semiconductor Applications**, ***Landon Brown,*** *Masoud Kaveh, David Lawrence, Costel Constantin,* James Madison University

Dilute magnetic semiconductors (DMS) are materials of great interest because they combine semiconducting and magnetic properties, enabling simultaneous control of electron charge and spin—an essential feature for emerging spintronic technologies. These materials hold promise for the development of faster, low-power electronic devices and quantum computing components. Gadolinium-doped indium tin oxide (Gd-ITO) thin films are promising DMS candidates, as gadolinium exhibits near room-temperature ferromagnetism ($T_{(C)}$ ≈ 290 K). In this study, Gd-ITO thin films with Gd concentrations ranging from 0% to 16% were deposited using DC magnetron sputtering. The films, approximately 1 µm thick, were simultaneously grown on silicon, oxidized silicon, quartz, and sapphire substrates. X-ray diffraction (XRD) measurements were conducted to compare lattice constants across all substrates. The FullProf Suite, employing the Le Bail method, was used to accurately extract lattice parameters.

**UN-ThP-19 Benchmarking Active Learning Protocols for Collaborative Cross-Facility Autonomous Workflows**, ***Stephen Xiao,*** Oak Ridge National Laboratory; *Ryan Lewis, Noah Paulson,* Argonne National Laboratory; *Yongtao Liu, Sumner Harris,* Oak Ridge National Laboratory

Self Driving Labs (SDLs), which combine robotic automation with machine-learning-driven design of experiments, will benefit from cross-facility collaborative workflows by mutually enriching research capabilities through shared experimental and computational resources. Here, we prototype a cross-facility workflow by conducting a simple color-mixing experiment, which is analogous to a wide variety of possible chemical synthesis/processing experiments. Automated robotic color–mixing experiments are conducted at Argonne National Laboratory's Rapid Prototyping Lab (RPL), and the resulting data are streamed to Oak Ridge National Laboratory for machine–learning surrogate modeling in sequential decision–making. This results in an autonomous experimental workflow sharing robotic infrastructure at one facility and computing resources at another. We first created a digital twin of the color-mixing experiment to benchmark surrogate model choice, acquisition function, and experiment batch size to select the appropriate active learning protocol which balances both equipment time-cost and material cost. We find that a Gaussian process surrogate with an expected improvement acquisition function outperforms both Bayesian neural network (BNN) and random forest surrogates. We then deploy the optimal active learning protocol in the cross-facility autonomous workflow in real color-mixing experiments and compare the performance with the digital twin.

**UN-ThP-20 Atom-based Quantum Sensors: Electromagnetic Induced Transparency in Rubidium***, Brian Holloway,* United States Military Academy*; **Michael Speer**,* West Point*; Tyler Catapano,* United States Military Academy

Atom-based quantum sensors are emerging as powerful tools for detecting electromagnetic signatures, offering advantages in size, weight, power consumption, and cost. One promising approach involves Electromagnetically Induced Transparency (EIT)—a quantum interference effect that enables precise, Doppler-free spectroscopy in atomic systems.

Our group has developed a sensor based on EIT in a dilute gas of Rubidium atoms, where electromagnetic radiation excites atoms into high-lying Rydberg states. We recently achieved Rydberg-level EIT for principal quantum numbers 53, 54, 68, and 85, allowing us to probe the hyperfine structure of Rubidium with high resolution.

We performed detailed spectroscopic analysis including:

1. Frequency spacing measurements between $53^2D_3/_2$ and $53^2D_5/_2$ states using quantum defect theory.
2. Line shape analysis to identify homogeneous and inhomogeneous broadening mechanisms.
3. Angular momentum coupling studies using relative peak heights and Clebsch-Gordon coefficient ratios.
4. Microwave-induced splitting of EIT features (Autler-Townes effect), which provides insight into transition dipole matrix elements in multi-level atomic systems.

These results contribute to a deeper understanding of atomic interactions in Rydberg-state atoms and offer a validated experimental framework for advancing atom-based quantum sensing technologies.

**UN-ThP-21 Electrodialytic Separation of Cobalt and Nickel in the Presence of EDTA***, **Jonah Buck**, Samuel Perkins,* Oregon State University

Cobalt and nickel are toxic heavy metal ions often found in waste solutions from battery recycling and energy product manufacturing facilities. Both are classified as critical materials by the United States and other governments due to their importance in energy technology and national security. However, their similar atomic radii and identical charge makes traditional separation techniqueslargely ineffective. Prior research has been performed into the selective conjugation of ethylenediaminetetraacetic acid (EDTA) with nickel over cobalt to form an anion to facilitate better electrochemical separation. This study investigateselectrodialytic separation in the presence of EDTA as a solution for recovering the critical materials from industrial wastewater solutions.

Using a BED 1-2 electrodialysis bench from PCCell GmbH (Germany), we use various ion exchange membrane configurations to draw the Ni(EDTA) anions out of an acidic solution consisting of equal parts cobalt and nickel and an Ni:EDTAmolar ratio of 85:100. The supporting ions are sulfates (sulfuric acid, metallic sulfate hydrates).

Preliminary analysis using inductively coupled plasma optical emission spectroscopy (ICP-OES) shows that over 85% of nickel can be effectively extracted from a solution containing cobalt with this method, with minimal cobalt co-transport. Ongoing experimentation aims to optimize various experimental variables such as membrane selection and current density to increase separation efficiency. EDTA-assisted electrodialysisis a promising strategy for critical metal recovery from industrial wastewater in a potentially scalable and environmentally conscious manner. Recovered materials could then be reused in their respective processes.

**UN-ThP-22 Denoising X-ray Photoelectron Spectroscopy Data by Fourier Analysis***, **Kristopher Wright**, Matthew Linford, Alvaro Lizarbe, Garrett Lewis,* Brigham Young University*; David Aspnes,* North Carolina State University*; David Morgan,* Cardiff University, UK*; Mark Isaacs,* University College London, UK*; Jeff Terry,* Illinois Institute of Technology

SmoothingX-ray photoelectron spectroscopy (XPS)spectra is widely discouraged. Indeed, filtering data should not be employed as a means to repair poorly taken data. However, there are times when special circumstances would warrant the use of a filter to denoise XPS data. We propose using Fourier analysis to denoise spectra in these circumstances. The Gauss-Hermite filter displayed in this poster makes improvements on the boxcar and Savitsky-Golet filters in artifact-reduction. We compare filtered low-scan number spectra with signal averaged "true" spectra taken over many scans.

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