Summer 2025 Project Descriptions

Reference Code: ANL

Title: Highly Efficient Electrochemical Oxide Reduction for U/TRU Recovery from Light Water Reactor (LWR) Fuel

Location: Argonne National Laboratory – Lemont, Illinois

Description: This project focuses on the development of a highly efficient oxide reduction process that is vital to enabling commercially viable recycling of used nuclear fuels. The intern will perform electrochemical sensor measurements while operating oxide reduction tests under the guidance of the mentor and staff researchers. The intern will assist with collecting samples of the reduced uranium product for analysis and will correlate the sensor measurements with those analyses. This project will provide a valuable opportunity for the intern to develop technical skills including operating oxide reduction equipment, electrochemical testing, material characterization, and data analysis.

Relevant Major(s): Chemical Engineering, Chemistry, Nuclear Engineering, Mechanical Engineering, Materials Science

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Reference Code: BLOS

Title: Monitoring, Reporting and Verification of Zooplankton-Mediated Export Pathways for Carbon Sequestration

Location: Bigelow Laboratory for Ocean Sciences – East Boothbay, Maine

Description: The Bigelow Laboratory for Ocean Sciences seeks to generate modeling tools and a stringent carbon accounting protocol that can be used for monitoring, reporting, and verification (MRV) of carbon transformed and exported by marine zooplankton during the deployment of Ocean Iron Fertilization (OIF) for marine carbon dioxide removal (mCDR). The summer intern will have the opportunity to learn about marine ecology while assessing the impact of different zooplankton/diel vertical migration (DVM) model configurations on model outputs, including DVM zooplankton biomass, and DVM daytime depth. The intern will learn some basic coding skills to examine how the outputs of different model configurations compare to one another. Finally, this intern will validate model outputs from different configurations with hold out field data, learning skills such as regression analysis, and plotting/data representation. The Z-TRACE summer intern will take part in the Laboratory's immersive summer research internship experience, which includes some field training in oceanographic data collection, and

seminars on various marine science and research topics. The intern will be learning and living alongside approximately 20 other undergraduate interns for the summer.

Relevant Major(s): Environmental science, Computer science, Oceanography or Marine biology

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Reference Code: PNNL

Title: Supercritical CO_2 Based Mining for Carbon-Negative Critical Mineral Recovery

Location: Pacific Northwest National Laboratory (PNNL) – Richland, Washington

Description: PNNL seeks to determine the critical mineral recovery potential and concurrent carbonation potential of the ultramafic deposits in Kenai, Alaska. To help answer this question, the intern will analyze the composition and texture of an ultramafic rock sample from Alaska before and after a 60-day reaction with supercritical CO_2 and water. This work will include processing and analyzing the pre-reaction characterization data and assisting with the post reaction characterization of the sample and interpretation of results. The internship will provide training and mentorship on a wide variety of analysis techniques, including X-ray fluorescence spectroscopy, scanning electron microscopy, thermogravimetric analysis/mass spectrometry and x-ray diffraction.

Relevant Major(s): Chemistry, Geology, Geochemistry, Earth Sciences, Chemical Engineering, and related fields

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Reference Code: VT

Title: Multi-Physics, Intelligent Sensing System (MISS) For Real-Time, Look-Ahead While Drilling

Location: Virginia Polytechnic Institute and State University – Blacksburg, Virginia

Description: Virginia Tech seeks to develop transformational look-ahead sensing technology to mitigate the risks associated with horizontal drilling. The intern's primary technical question will be the evaluation of the prototype look-ahead sensing system's sensitivity to the size, distance, and material composition of underground utilities using computational and experimental tools. The intern will learn the fundamentals of numerically simulating seismic and electromagnetic waves in three-dimensional space and will take advantage of VT's Advanced Research Computing facility and Center for Autonomous Mining to evaluate system performance via simulation and experiment in 12 different configurations. Using these results, the intern will look for ways to improve agreement between the numerical and experimental results.

Relevant Major(s): Civil Engineering, Mechanical Engineering, or related engineering-based discipline. Geophysics, Physics, or related science-based discipline

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Reference Code: Boeing

Title: Development Of Ultra-High Performance Metallic Turbine Blades for Extreme Environments, Phase 2

Location: Boeing Research & Technology - Huntsville, Alabama

Description: Boeing is working on material and manufacturing solutions to produce ultra-high-performance metallic turbine blades capable of inert operation up to 1300°C and up to 1800°C with bond coatings. The intern will design (using CAD software) and mechanically test samples of refractory complex concentrated alloys, or high temperature structural materials. Testing will include room and high-temperature tensile testing, compression testing, as well as testing for fatigue, creep, and fracture toughness. The intern will also independently prepare, mount, and polish alloy test specimens for hardness testing and microstructural characterization. Project work includes assisting the team in building fixtures, conducting metallography and failure analysis on the refractory complex concentrated alloys. The intern will also perform analysis in Excel and Matlab on the material test data once the mechanical tests are complete.

Relevant Major(s): Materials Science and Engineering, Metallurgical Engineering, Mechanical Engineering, Aerospace Engineering, and Chemical Engineering

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Reference Code: NREL

Tittle: X-ray Imaging and Computational Modeling to Evaluate the Safety of Batteries

Location: National Renewable Energy Laboratory (NREL) – Golden, CO

Description: Li-ion batteries are an enabling technology for electrified transport and grid-scale storage for renewable energy resources. NREL uses their advanced characterization and modeling capabilities to improve understanding of batteries as they undergo failure and thermal runaway. The intern will use X-ray nano-computed tomography (nano-CT) and image-based analysis to quantify the microstructure of solid-state battery electrodes and the particulates from batteries after they undergo thermal runaway. The intern will also build fluid-dynamics models to determine the gas-generation rates of batteries. This internship will help identify safe battery pack designs that can manage the hazards of next-generation electrical vehicle (EV) batteries.

Relevant Major(s): Electrical Engineering, Chemical Engineering, Chemistry, Material Science

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Reference Code: UIUC

Title: Diamond Photoconductive Semiconductor Switches

Location: University of Illinois at Urbana-Champaign (UIUC) – Urbana, IL

Description: The University of Illinois has a patent-pending photoconductive semiconductor switch (PCSS) that can reach a high current density of 44 A/cm. This is achieved by using a buried, highly conductive p+ current channel for current conduction instead of the traditional filamenting process. As a novel device, its performance needs to be rigorously tested and experimentally validated. The intern will use microelectronics cleanroom processing techniques to fabricate the PCSS. Then they will use standard transfer length method (TLM) to measure the Schottky barrier height and Ohmic contact resistance of these novel electronic devices.

Relevant Major(s): Electrical Engineering

Reference Code: TAMU

Title: Analysis of Refractory High Entropy Alloys (RHEAs)

Location: Texas A&M University (TAMU) – College Station, TX

Description: Texas A&M University is creating next-generation structural materials that can enhance the efficiency and performance of gas turbines and other systems to enable operation at temperatures exceeding 1300ºC. A potential solution to the materials challenge lies within the family of refractory high entropy alloys. Texas A&M has identified two promising RHEA compositions that can meet the performance standards for high temperature applications. The intern will use modeling tools to identify the optimum printing parameters to 3D print these alloys using electron beam melting (EBM) and/or direct energy deposition (DED). The intern will also use optical microscopy, scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDS) to analyze the composition, phase segregation, and potential contamination of the alloys during fabrication.

Relevant Major(s): Mechanical Engineering, Material Science, Advanced Manufacturing

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Reference Code: Sandia

Title: E1-Arrester for Improved Electro-Magnetic-Pulse (EMP) Protection

Location: Sandia National Laboratories (SNL) – Carlsbad, NM

Description: Sandia National Laboratories are developing self-breaking, nanosecond-responsive arresters to protect the electrical grid from high-voltage, high-current transients. The recently developed Mo-SiNx granular metals (GMs) will be an active element in future nanosecond-responsive arresters to protect electrical power grids and increase grid resiliency. The intern will conduct current voltage sweeps and dielectric breakdown measurements, perform conductivity measurements, and use a commercial software program to develop circuit models for these new devices based on the measurements. The intern will also have hands-on experience supporting failure analysis of these devices using optical microscopy.

Relevant Major(s): Physics, Electrical Engineering, Material Science

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Reference Code: Alaska

Title: Cellulose-mycelium Composites for Carbon Negative Buildings and Construction

Location: University of Alaska-Anchorage – Anchorage, AK

Description: Celium, a novel cellulose-mycelium composite material, offers a sustainable, carbon-storing solution for thermal insulation, cold-chain packaging, and even furniture. However, scaling production to meet real-world demands presents technical hurdles. This internship will aim to identify optimal incubation times, design parameters, structural configurations, and bioconversion efficiencies to enhance material performance. The intern will be a part of the development team. The intern will participate in the biofabrication pilot design, test samples for porosity, density, moisture retention, compressive strength, and thermal conductivity and take part in field work in Alaska. From these tests, they will also help optimize the bio-fabrication process by investigating the relationship between the growth of mycelium over time and the material's properties. By the end of the internship, the intern will gain hands-on experience in bio-fabrication, product design, and material science and will assist in scaling up Celium production in rural Alaskan communities and in other regions.

Relevant Major(s): Biology, Microbiology, Mechanical Engineering, Civil Engineering, Materials Science, Product Design, Architecture, Sustainability Studies, Forestry

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Reference Code: ProjectK

Title: OPERA: Optimizing a Potassium-ion Electrolyte for Revolutionary Automotive Batteries

Location: Project K Energy, Inc. – Pasadena, California

Description: Project K Energy is developing a potassium-ion battery for electric vehicles. Under this internship, the student will fabricate and test cells and analyze cell performance to understand how the thermal energy generated on extremely fast charging affects the cycle life.

This will include electrode slurry making and casting, electrolyte formulation, pouch cell fabrication, linear-sweep and cyclic voltammetries, constant-current electrochemical testing, and technoeconomic analysis. The goal for the internship will be to quantify electrochemical performance (cycle life, charging power), and thermal energy generation in various iterations of Project K's potassium-ion design.

Relevant Major(s): Materials science and engineering; chemistry and chemical engineering; physics and applied physics; and related disciplines

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Reference Code: WISC

Title: Direct High-Temperature Electrochemical Hydrogenative Depolymerization for Waste Plastic Upcycling

Location: University of Wisconsin-Madison (Madison, Wisconsin)

Description: The University of Wisconsin-Madison seeks to develop an innovative solid-state electrochemical membrane reactor and demonstrate its thermal integration. If successful, this project will create a transformative waste plastic upcycling process via high-temperature electrochemical hydrogenative depolymerization of long amorphous and semi-crystalline polymers. The intern will focus on the design of exsolved electrocatalyst nanoparticles for the electrochemical anode half-reaction. Namely, the intern will theoretically explore the trade-offs between the electrocatalyst selectivity and its resource sustainability and develop a recipe for the synthesis of <20 nm exsolved electrocatalyst nanospheres. By the end of the internship, the student will have synthesized the catalyst phase of the electrode, generated the final exsoluted phase for the electrode, and identified promising surface acid electrocatalyst alternatives. The student will also learn how to use the R&D Greenhouse gases, Regulated Emissions, and Energy use in Technologies (GREET) model to perform a lifecycle analysis to identify the cradle-to-grave global warming potential for the selected materials. This work will be instrumental to understanding the viability of the chosen materials towards the commercialization of the electrochemical membrane reactor.

Relevant Majors: Chemical Engineering, Material Science and Engineering, Mechanical Engineering

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Reference Code: NMT

Title: Subsurface Engineering Solutions and Management for the Sustainable In-situ Hydrogen Production and Economic Extraction

Location: New Mexico Institute of Mining and Technology - Socorro, New Mexico

Description: New Mexico Institute of Mining and Technology is developing new technologies for the hydraulic fracturing of ultramafic rock and for the in-situ generation of hydrogen from the ultramafic rock. To support this effort, the intern will assist in the characterization of rocks before and after serpentinization to establish a method for ensuring rocks selected for serpentinization contain enough olivine for the desired reaction. Various rocks of interest; including dunite, peridotite or other rocks rich in olivine; will be analyzed via scanning electron microscopy and energy dispersive X-ray spectroscopy (SEM-EDS) measurements. The student will also help to characterize the mineralogy of samples and to determine how grain sizes and shapes (fine-grained vs coarse-grained) are related to each other. Work will include supporting the development of 3D surface maps and models from the 2D SEM images to visualize the surface available for water/steam and hydrogen flow. By the end of the internship, the student will be able to determine if selected rock samples are suitable for serpentinization experiments and will have gained hands-on experience with SEM-EDS and assessing mineralogy.

Relevant Majors: Geology, Geochemistry, Geoscience, Petroleum Engineering, Environmental Engineering or similar (e.g. physics), Earth Science

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Reference Code: UNL

Title: Multicell Electrical-Transient-Accelerated Press-Pack Modules (METAPAK)

Location: University of Nebraska – Lincoln (Lincoln, Nebraska)

Description: The University of Nebraska-Lincoln is building an innovative 10 kV presspack silicon carbide metal-oxide-semiconductor field-effect transistor (MOSFET) module grid-level power electronics converters, such as HVDC, FACTS and others. The MetaPak module's unique layout and advanced EMI mitigation techniques are expected to yield electromagnetic interference (EMI) behavior that could differ significantly from that of current state-of-the-art modules. This internship will focus on the conductive EMI modeling and characterization of the novel MetaPak module. Work will include a literature review, circuit simulations of EMI models, upgrading the MetaPak testing platform and testing of the MetaPak module, and model calibration. This effort will fill knowledge gaps around the team's new circuit design and layout, mitigating EMI-related risk for this technology.

Relevant Majors: Electrical Engineering

Reference Code: GE

Title: Fuel Cell Embedded Engine (FLyCLEEN)

Location: GE Aerospace Research Center – Niskayuna, NY

Description: GE Aerospace is developing a hybrid system concept prototype integrating fuel cells with a gas turbine combustor. Solid oxide fuel cell (SOFC) is a promising technology for clean and efficient energy conversion, but its long-term stability remains a challenge. The intern will investigate the stability of GE's fuel cells using advanced material characterization techniques. They will use electrochemical impedance spectroscopy (EIS), scanning electron microscopy (SEM), and electron dispersive spectroscopy (EDS) to identify degradation mechanisms of fuel cells with the support of material scientists and specialists at GE Aerospace Research.

Relevant Major(s): Material Science, Chemistry, Chemical Engineering