

Undergraduate Student Posters

Poster session: 1:00 – 3:00 pm. Toray Commons Fascitelli Center for Advanced Engineering

1. **Signature O’Clock: Assessing Signature Verification Processing Times from Dawn to Midnight**

Presenter: Alexis Ahle, 3rd year Undergraduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Gretchen A. Macht, Ph.D. & Leonie S. Otte

In 32 states and Puerto Rico, Vote-by-Mail ballots need to have the voter’s signature on the return envelope, which must be verified before they can be opened and counted. Election workers use voters’ signatures from previous elections or voter registration to verify whether the current signature matches the voter on the ballot’s envelope. However, each county has different verification processes even under the same state regulation, including the levels of verification, procedures, and the time of day verification is conducted. The verification process can include multiple levels with different amounts of signatures available, instructions for verification, and team size. When the signatures cannot be matched during the first review, there is usually a second, and sometimes a third, level of verification where election workers have more prior signatures available. This research examines six counties’ signature verification data from two states: five with two levels of verification and one with three levels of verification. The goal of this research is to determine if the time of day that signature verification is performed impacts the time it takes to verify voter signatures. Through time-series analysis and statistical process control charts, patterns in signature verification processing times will be identified throughout hours of operation and between verification levels. The outcomes of this study can support election officials and administrators in planning their Vote-by-Mail process and scheduling election workers for Signature Verification throughout the day.

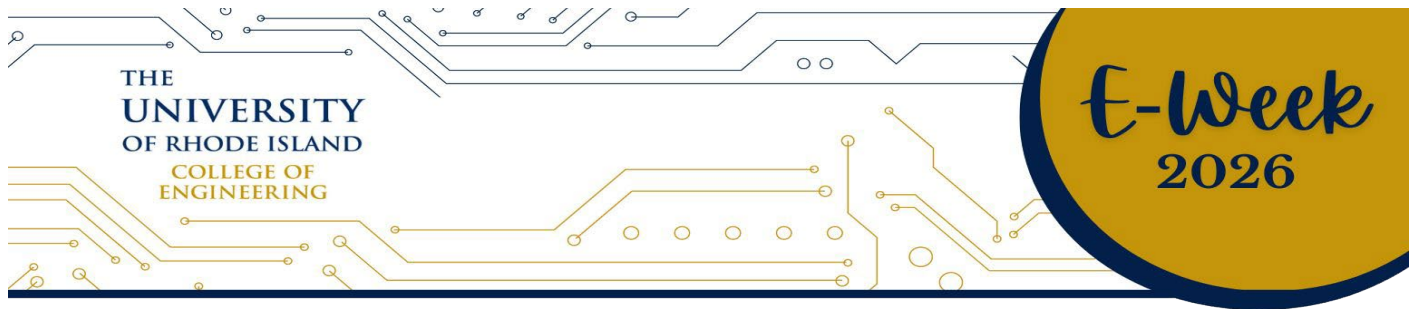
Research supported by: Undergraduate Research in Science and Engineering (URISE)

2. **Synthesizing Magnetic Nanoparticles for Bacteria Removal**

Presenter: Rory Ennis, 1st year Undergraduate Student, Chemical Biological and Materials Engineering

Advisor: Dr. Irene Andreu Blanco

Bacterial biofilms are communities of bacteria that grow on surfaces and are bound together through self-secreted biomolecules. Biofilms greatly contribute to persistent infections associated with medical devices, dental health and respiratory disorders, among others. Treatment of biofilm-associated infections is typically challenging because bacteria in biofilms often develop antibiotic resistance. Therefore, different approaches are needed to deal with them. One potential method is using magnetic nanoparticles in order to physically disrupt the cohesiveness of biofilm, leading to the bacteria’s removal and death. This research aims to study the synthesis of magnetic nanoparticles used in bacterial biofilm removal and study the relationship of Iron to solvent ratio and its effect on magnetic response. Iron oxide (Fe₃O₄, magnetite) magnetic nanoparticles were synthesized through a high-temperature polyol method using iron (III) acetylacetonate as the iron source, and tetraethylene glycol as solvent and surfactant, at different ratios. After washing by



centrifugation, the particle size and magnetic properties are evaluated. Particle sizes range between 10 and 25 nm, in a range that is useful for antibiofilm applications.

Research supported by: Undergraduate Research in Science and Engineering (URISE) and NSF Engineering Research Initiation #2301790

3. **Perception of Noise as a Health Risk in the Vote-by-Mail Process: Assessing Worker Training and Hearing Protection**

Presenter: *Jeremy Herrera Santos, 4th year Undergraduate Student, Mechanical, Industrial and Systems Engineering*

Advisor: *Gretchen A. Macht, Ph.D. & Leonie S. Otte*

Noise exposure is a leading occupational hazard faced by workers across many industries due to the use of machinery. Thus, the United States Occupational Safety and Health Administration, also known as OSHA, requires employers to provide annual training and personal protective equipment for workers when noise levels exceed certain thresholds in a work environment. In recent years, mail ballot processing throughout the United States has adopted the use of high-speed machines for mail sorting, envelope opening, and ballot tabulation, resulting in a louder work environment for election workers. At present, it is unclear how noise levels during ballot processing are perceived and considered by election administrators and staff during worker training and machine operation. To investigate the knowledge base of election workers regarding noise hazards, an anonymous survey will be distributed to election officials, administrators, and process supervisors throughout the Spring of 2026. This Institutional Review Board-approved survey asks respondents questions about machinery used in ballot processing, training protocols, hearing protection, and perception of noise as a risk.

This presentation aims to quantify the awareness and perception of noise risk within the ballot tabulation process and highlights the efforts jurisdictions may make to mitigate noise exposure. The results will assess the current state of noise in the ballot tabulation process and map strategies for worker safety. This quantitative and qualitative survey data assists election officials in creating improvements to the working environment and helps to advocate for including noise risk and personal protective equipment in the training and ballot processing operations.

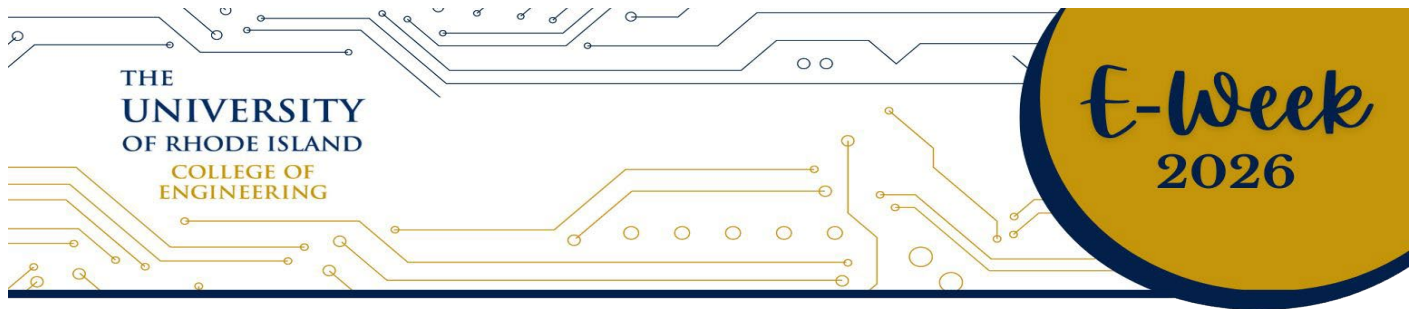
4. **Light-activated antibiofouling magnetic polymer composites**

Presenter: *Ethan Marchetti, 3rd year Undergraduate Student, Mechanical, Industrial and Systems Engineering*

Advisor: *Dr. Irene Andreu Blanco*

Unmanned underwater vehicles for seafloor exploration encounter issues after biofouling such as increased weight, changed hydrodynamics and polymer degradation. Remedies include physically scrubbing the surface, the use of high-pressure water jets, or treating it with a biocidal agent. However, these methods require operational downtime, manual labor, and can be quite costly for large vessels.

Previous research proposes to emulate antibiofouling observed in living animals by fabricating a magnetic composite using iron oxide microparticles that can be distally activated using magnetic fields to induce surface movement. This magnetically-generated undulatory motion leads to the formation of fluid vortices, with the possibility of preventing bacterial deposition. Additionally, exposing iron oxide microparticle



embedded materials to solar irradiance may induce photothermal mediated cytotoxic heating, demonstrating biofilm dispersal. Here, we propose to couple these magnetoactive and photothermal methods to achieve a dual antibiofouling response with potential applications in underwater vehicles. These novel magnetoactive materials can prevent the need for traditional biofouling removal techniques.

Research supported by: NSF Engineering Research Initiation # 2301790 and Undergraduate Research in Science and Engineering (URISE)

5. **Research Assistant**

Presenter: *Maya Luehmann, 3rd year Undergraduate Student, Chemical Biological and Materials Engineering*

Advisor: *Dr. Irene Andreu Blanco*

Microplastics are small polymer particles that pollute the environment. They typically originate from broken-down, improperly disposed of plastics that fragment. Although it is well known that environmental weathering, such as UV irradiation and temperature changes, promotes the formation of microplastics, the role of mechanical forces remains relatively underexplored. In this project, we systematically evaluated the role of microplastic-microplastic collisions in the generation of secondary microplastics. We compared different primary microplastic particle sizes and shapes subjected to up to 4 weeks of stirring in an aqueous environment at the same shear rate. The secondary microplastics were collected through filtration, and the particle counts and particle sizes were quantified through optical microscopy image segmentation. The data shows that the number of particles increases to the maximum amount after 1 week and then remains consistent for weeks 2 through 4. We also varied the number of primary microplastics in the test, as a higher number of particles leads to a higher number of particle-particle collisions, and we found that the number of secondary microplastics generated does not depend on the particle-particle collisions, indicating that water shear could be the dominant mechanical force leading to fragmentation. We also corroborated that microplastics weathered under UV light generated drastically more secondary microplastics than pristine microplastics. Overall, this study indicates that weathering state and shear flow conditions largely dictate the rate of microplastic generation.

Research supported by: RIWRC 2026 Seed Grant, for credit

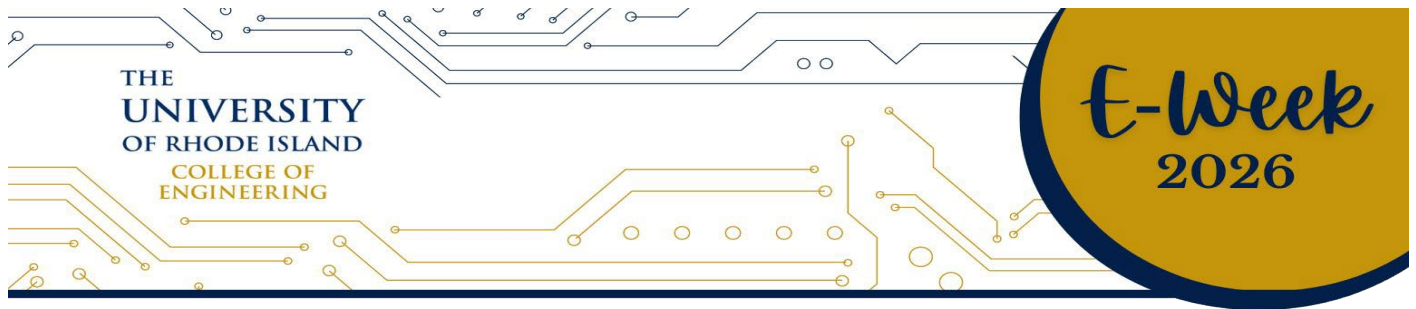
6. **Drop Box Routing Optimization for California's Contra Costa County**

Presenter: *Edgar | Oluwatosin Andrade | Okele, 4th year Undergraduate Student, Mechanical, Industrial and Systems Engineering*

Advisor: *Dr. Gretchen Macht | Dr. Nicholas Bernardo*

Efficient and secure ballot collection is a critical component of vote by mail election operations. This research project examines opportunities to improve the efficiency and reliability of mail ballot collection routes during election periods through data driven analysis and optimization, focusing on a California county with an established vote by mail system.

In this county, vote by mail is one of several voting methods available to constituents, alongside in person and accessible voting options. Voters submitting their ballot by mail deposit completed ballots into a drop box that is part of a larger network of secure drop boxes distributed across the county. These locations are



grouped into three collection routes which are serviced daily over the 30-day period leading up to and including Election Day by teams of election officials.

This study analyzes the current collection process, including route structure, geographic distribution, staffing, and operational constraints such as security requirements and limited collection durations. Data has been compiled and examined to identify key factors affecting efficiency and to highlight logistical challenges associated with servicing multiple collection routes composed of various drop box locations. This research explores the application of the Traveling Salesman Problem to evaluate alternative routing strategies and improve collection efficiency. The project's goal is to develop a structured analytical framework that supports better decision making and enhances operational performance, while maintaining the integrity and reliability of the mail ballot collection process.

7. Virtual Reality Environment For Human-Drone Interaction

Presenter: *Ervin Ranz Regalado, 2nd year Undergraduate Student, Electrical, Computer, and Biomedical Engineering*

Advisor: *Dr. Paolo Stegagno*

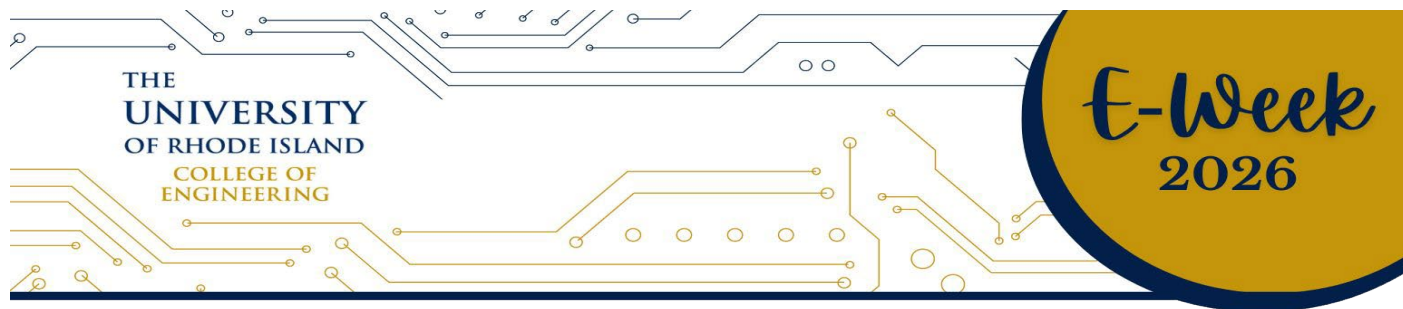
Human-Robot Interaction is a profound and promising field in advancing knowledge and technological advancements across a wide range of applications. While mobile robots and robotic manipulators have been thoroughly studied, the implementation and experimentation of unmanned aerial vehicles (UAVs) remain largely underexplored due to safety concerns.

The objective of this research is to develop a controlled simulation environment using the Robot Operating System (ROS) and virtual reality (VR) to facilitate safe human–drone interaction. In the proposed setup, a human subject wearing a VR headset will interact with a simulated hovering drone, while a physical robotic arm located outside the virtual environment and invisible to the user will generate and measure the corresponding haptic forces. This setup requires communication between the VR environment, the simulated drone, and the robotic arm to ensure synchronized interaction. By creating a controlled and safe testing environment, this approach provides a means to analyze human–UAV interaction dynamics and support the future development of real HRI-capable drones.

At the project's current stage of development, there are ROS enabled robotic simulations on Gazebo that enable real-time communication between the physical robotic arm and the virtual drone for position tracking and interaction dynamics. The simulated drone includes full attitude control and realistic flight dynamics, allowing it to tilt, rotate, and respond to external forces in a manner consistent with an actual aerial vehicle. Also, to ensure safe experimentation during these interactions, a boundary “bubble” has been implemented around the robotic arm. This controlled region limits the arm's permitted motion, preventing it from extending into unsafe positions or executing large unexpected movements. By limiting the arm's configuration to a defined space, the system provides a reliable and secure environment for testing human drone interaction behaviors without risking damage to equipment or creating unsafe conditions.

In the future, the project will focus more on improving the system's hand-tracking capabilities to create a more precise environment. These additions will help refine the overall setup and establish the consistency and safety needed to begin human–drone interaction trials with real participants.

Research supported by: Research credits & ESTEEMED Program



8. Detection of Breast Cancer Subtypes Using Machine Learning-Assisted Spectral Fingerprinting of SWCNTs in Live Cells

Presenter: Katherine Van Gorden, 3rd year Undergraduate Student, Chemical Biological and Materials Engineering

Advisor: Dr. Daniel Roxbury

Detecting Breast cancer at an early stage is a significant challenge because of its multiple subtypes and elusive heterogeneous nature. An innovative single-walled carbon nanotube (SWCNT) NIR fluorescence spectral fingerprinting approach in conjunction with a machine learning algorithm could precisely detect breast cancer subtypes in vitro. We demonstrate this concept by incubating DNA-functionalized SWCNTs with a panel of human breast cell lines: the non-tumorigenic MCF-10A and cancer cell lines MCF-7, HCC1954 (HER2+), MDAMB-231, and MDA-MB-468 (triple-negative). The NIR fluorescence spectra of SWCNTs across 500 individual cells of the mentioned cell types showed significant differences in emission peak intensities, center wavelengths, and peak intensity ratios, attributable to variations in cellular uptake and biomolecular interactions. These features were used to train a support vector machine learning (SVM) model. The model achieved more than 90% classification accuracy, selectivity, and precision, effectively distinguishing cancerous subtypes from noncancerous cells. Moreover, using Raman microscopy, we statistically analyzed SWCNT uptake across all cell lines. Insights from this research enhance the development of nanomaterial-based platforms for biosensing and provide potential for real-time monitoring of in vivo cellular differentiation.

Research supported by: Credit and Fall 2025 Undergraduate Project Grant.

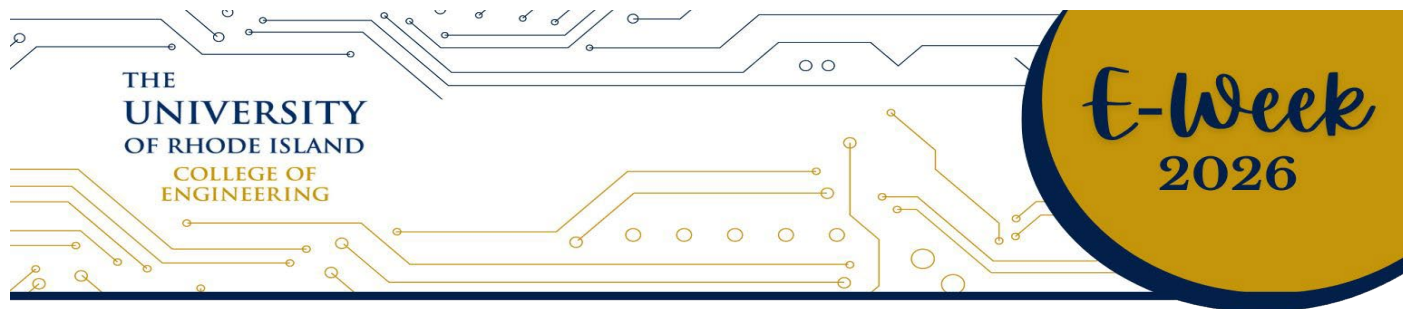
9. Detection Method For Magnetic Nanoparticle Aerosols

Presenter: Joshua Taylor, 3rd year Undergraduate Student, Chemical Biological and Materials Engineering

Advisor: Dr. Irene Andreu Blanco

Magnetic nanoparticles (MNPs) are finding growing applications in both research and commercial products, but it remains unclear how much airborne MNP-containing aerosols are produced during various laboratory processes. This knowledge gap makes it challenging to evaluate exposure risks and establish safe handling practices. This project aims to study the release and propagation of iron oxide MNP aerosols produced in common laboratory processes by leveraging their magnetic properties. As a proof of concept, MNP aerosols are generated, collected through filtration, and their magnetic response is measured using a Quantum Design VersaLab vibrating sample magnetometer. The magnetic signal is directly proportional to the mass of magnetic material, as determined from calibration curves. By using this method, accurate measurements of the MNP mass collected across different laboratory processes can be obtained, thereby informing best practices for safe laboratory work.

Research supported by: This work was supported through CHE 491 Special Problems credits



10. Introduction of sp³ Defects on Carbon Nanotube Surface to Enhance Photoluminescence

Presenter: Jayden, Jenna St. Louis, Berg, 4th year Undergraduate Student, Chemical Biological and Materials Engineering

Advisor: Dr. Daniel Roxbury

Single-Walled Carbon Nanotubes (SWCNTs) have emerged as a promising candidate for biosensing due to their unique photophysical properties. Specifically, their emission in the Near Infrared (NIR) is a useful feature to leverage. SWCNTs are composed of several chiralities, each possessing a characteristic emission peak. It has been found that introducing sp³ defects results in a new emission peak at ~1150nm (E11*). While diazonium salts have traditionally been employed for this purpose, these reactions have proved to be incredibly sensitive and often quench photoluminescence. By simply using arylazo sulfonates as the defect-introducing reagent, the E11* peak can be generated without quenching the nano sensor from byproduct formation, and result in a brighter sensor overall. This work can be extended in several different directions including cell studies, creation of biologically selective sensors, and increased tunability of nanotube systems.

Research supported by: NIH Grant

11. A Wearable Microneedle Patch for Controlled, On-Demand Drug Delivery

Presenter: Ayendry Lopez Reyes, 2nd year Undergraduate Student, Mechanical, Industrial and Systems Engineering

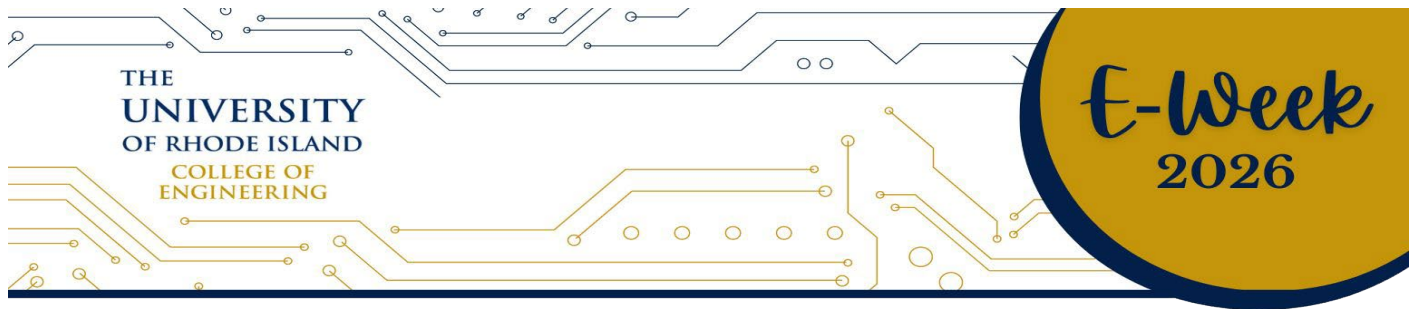
Advisor: Professor Yang Lin, PhD

Microneedle patches have emerged as a promising platform for transdermal drug delivery due to their minimal invasiveness, improved patient comfort, and compatibility with wearable applications. However, most existing microneedle systems rely on passive diffusion, which limits control over dosing rate and timing once the patch is applied. This lack of active control restricts their use in applications that require precise or time-dependent drug delivery.

In this work, a wearable microneedle patch that incorporates acoustic actuation is investigated as a strategy for enabling on-demand transdermal delivery. The approach integrates hollow microneedles with a compact acoustic system to actively drive drug transport through microneedle microchannels. By modulating acoustic stimulation, the system has the potential to support multiple delivery modes, including rapid bolus dosing, pulsed delivery, and sustained release, within a single wearable device. The study focuses on the fabrication of hollow microneedles with consistent channel openings and the integration of acoustic actuation into a scalable patch design. Preliminary evaluations examine whether acoustic stimulation enhances transport and absorption compared to passive microneedle delivery under similar conditions, and how acoustic parameters influence delivery performance. Overall, this work aims to demonstrate the feasibility of an acoustically actuated microneedle patch for controllable, on-demand drug delivery, offering improved dosing flexibility while maintaining the simplicity and comfort of wearable microneedle systems.

Research supported by: URI ESTEEMED Program

12. Mechanical Performance and Environmental Durability of Recycled Polymer–Sand Construction Blocks



Presenter: *Giovanni Benevides, 2nd year Undergraduate Student, Civil and Environmental Engineering*
Advisor: *Dr. Craver*

Increasing landfill pressure and plastic waste accumulation have driven the need to find a solution to a national waste problem. This research explores how reapplying resources can support the development of a more sustainable future. This solution involves transforming recycled plastics into polymer-sand composite blocks capable of supporting structural loads.

Titanium dioxide was incorporated as a UV stabilizer, and two aging approaches were evaluated: surface aging of finished blocks and pre-aging of polymer feedstock prior to fabrication.

Blocks composed of HDPE and PP were tested for compressive strength, creep behavior, and UV aging durability. Results indicate stable mechanical performance across all conditions, with recycled materials performing comparably to pristine polymers that meet construction standards. While aging increased deformation, no structural failure was observed.

This work demonstrates a solution for converting plastic waste into durable infrastructure materials, supporting sustainable construction and reducing landfill dependence.

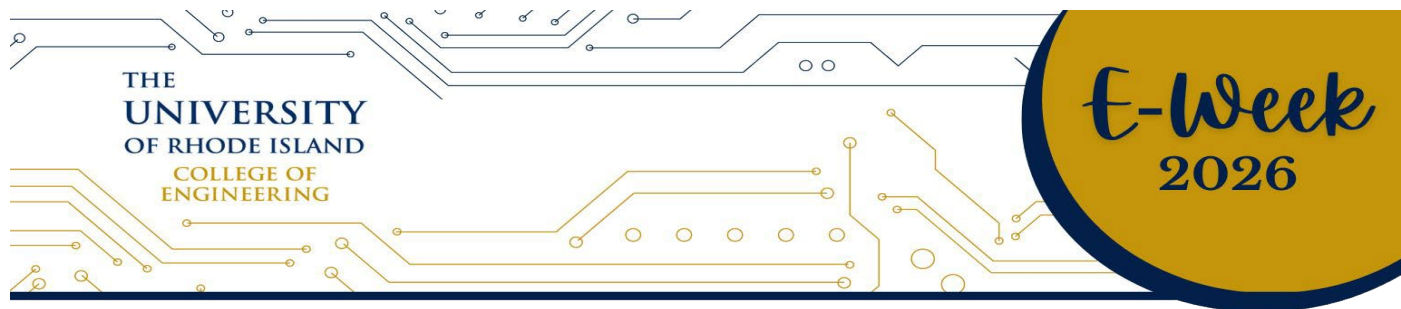
Research supported by: Undergraduate Research in Science and Engineering (URISE)

13. Promoting Aggregation of Polymer-Functionalized Emulsion Droplets

Presenter: *Daniele Russo, 2nd year Undergraduate Student, Chemical Biological and Materials Engineering*

Advisor: *Dr. Ryan Poling-Skutvik*

A water-in-oil emulsion was made to study optimal temperature ranges within different polymer-functionalized emulsion droplets to discover maximum aggregation. The emulsion consisted of cyclohexane as the continuous phase and then combined with a selected surfactant and then a controlled addition of water under sonication. It was then followed by the addition of a small amount of polymer to alter the emulsions properties. To evaluate the effects of these polymer compositions on emulsion stability and aggregation behavior, I used three polymers (28-41, 235-41, and 63-41) and introduced each one to the system under consistent preparation conditions. Each polymer-emulsion mixture underwent a quenching process, in which samples were heated to 50°C in order to promote polymer dissolution and then it was followed by a controlled, rapid cooling. Particle sizes were then measured and collected at 5°C intervals from 10°C to 40°C using DLS to monitor the temperature-dependent aggregation behavior. This quenching approach allowed for analysis of polymer-driven congregations as a function at different temperatures. I hypothesized that each polymer will correspond to a specific temperature at which aggregation occurs. By comparing these particle size distributions and aggregation trends, this research aims to find out which polymer is the best at inducing the highest degree of congregation and to find its optimal tempering window that maximizes yield.



14. Following whales towards advancement in submersible technology

Presenter: Connor Ham, 4th year Undergraduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Dr. Bahram Nassersharif

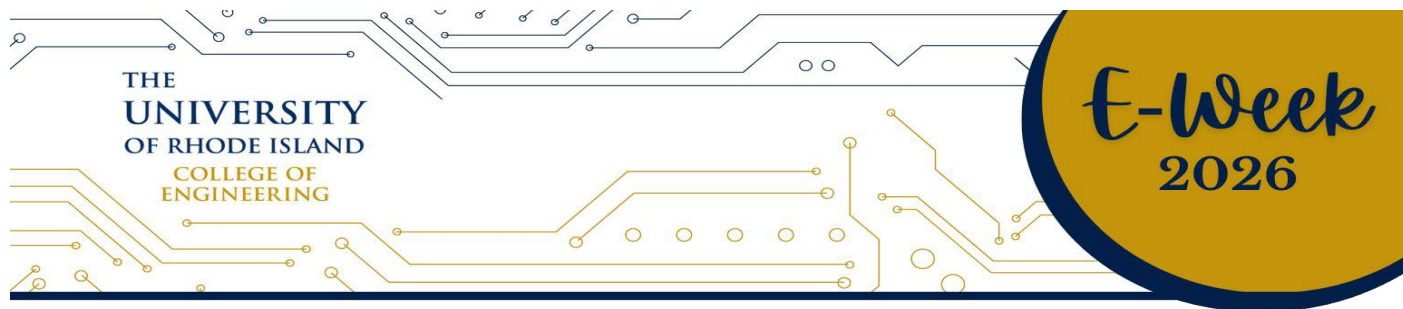
When it comes to underwater vehicles, efficiency is of the utmost importance, as it dictates what missions and tasks they can be assigned. Maneuverability is also important for mission success, especially in complex research and exploration excursions. The evolution of humpback whales has resulted in pectoral fins that encompass these features, as research has shown these fins to be efficient and increase maneuverability of the whale through the water. Comparisons between the cross-sectional area of a standard airfoil and the pectoral fins of a humpback whale were made using CAD design (SolidWorks) and tested in a simulation environment (Ansys Fluent). In addition, tests were conducted on whether the presence of tubercles on the fins affected efficiency and maneuverability. Results of this study will be useful in developing submersibles that can take on a wider range of undersea endeavors.

15. Investigating the Impact of Biomolecular Corona on Intracellular Fluorescence of DNA-SWCNTs

Presenter: Eryn Wale, 3rd year Undergraduate Student, Chemical Biological and Materials Engineering

Advisor: Dr. Daniel Roxbury

The intracellular processing of nanomaterials in biological systems is governed less by their shape or surface, but more by the biomolecular corona that forms upon exposure to proteins, lipids, and other biomolecules. The composition of this corona is driven by molecular interactions—such as charge and hydrophobicity—rather than simple abundance, and in turn dictates nanoparticle stability, cellular interactions, and intracellular fate. However, the structure–function relationship between specific corona constituents and single walled carbon nanotubes (SWCNTs) optical responses remain poorly understood. Moreover, variations in SWCNT surface functionalization are known to influence cellular uptake, fluorescence behavior, and intracellular processing, yet the interplay between functionalization and corona formation has not been systematically explored. This project aims to investigate how the biomolecular corona modulates the intracellular fluorescence and uptake behavior of SWCNTs across different surface chemistries. DNA–SWCNTs are uniquely suited for this study because of their stable near-infrared (NIR) photoluminescence, which enables real-time, label-free tracking in live cells. By systematically varying DNA sequences (e.g., (GT)₁₅ and (AT)₁₅) and controlling corona composition through isolated incubation with select proteins, such as human serum albumin (HSA), ubiquitin (UBQ), and transferrin (TFR), this study will evaluate how corona constituents with differing stability, bio functionality, and immunogenicity will alter SWCNT (NIR) spectral properties, cellular uptake and retention efficiency, and intracellular trafficking. Ultimately, this work aims to establish a link between biomolecular corona composition, conformational stability, and DNA–SWCNT fluorescence behavior in cells. These insights will not only clarify fundamental mechanisms of nanoparticle–cell interactions but also inform rational design of SWCNT-based biosensors and delivery platforms with tunable biological performance.



Research supported by: Research is supported by the National Science Foundation (Award Numbers # 1844536 and 2231621) and the Rhode Island Institutional Development Award (IDeA) Network of Biomedical Research Excellence from the National Institute of General Medical Sciences of

16. Investigating the Impact of Biomolecular Corona on Intracellular Fluorescence of DNA-SWCNTs

Presenter: *Ella Junge, 5th year Undergraduate Student, Chemical Biological and Materials Engineering*
Advisor: *Dr. Daniel Roxbury*

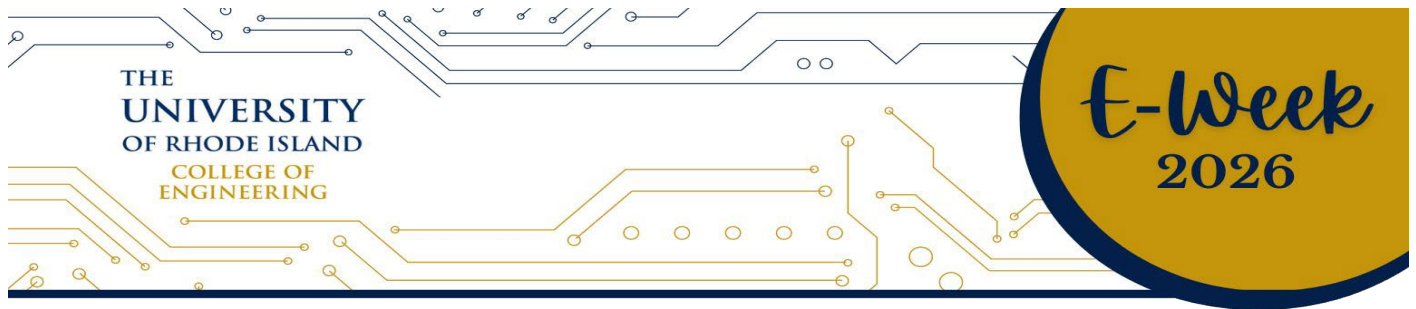
The intracellular processing of nanomaterials in biological systems is governed less by their shape or surface, but more by the biomolecular corona that forms upon exposure to proteins, lipids, and other biomolecules. The composition of this corona is driven by molecular interactions—such as charge and hydrophobicity—rather than simple abundance, and in turn dictates nanoparticle stability, cellular interactions, and intracellular fate. However, the structure–function relationship between specific corona constituents and single walled carbon nanotubes (SWCNTs) optical responses remain poorly understood. Moreover, variations in SWCNT surface functionalization are known to influence cellular uptake, fluorescence behavior, and intracellular processing, yet the interplay between functionalization and corona formation has not been systematically explored. This project aims to investigate how the biomolecular corona modulates the intracellular fluorescence and uptake behavior of SWCNTs across different surface chemistries. DNA–SWCNTs are uniquely suited for this study because of their stable near-infrared (NIR) photoluminescence, which enables real-time, label-free tracking in live cells. By systematically varying DNA sequences (e.g., (GT)₁₅ and (AT)₁₅) and controlling corona composition through isolated incubation with select proteins, such as human serum albumin (HSA), ubiquitin (UBQ), and transferrin (TFR), this study will evaluate how corona constituents with differing stability, bio functionality, and immunogenicity will alter SWCNT (NIR) spectral properties, cellular uptake and retention efficiency, and intracellular trafficking. Ultimately, this work aims to establish a link between biomolecular corona composition, conformational stability, and DNA–SWCNT fluorescence behavior in cells. These insights will not only clarify fundamental mechanisms of nanoparticle–cell interactions but also inform rational design of SWCNT-based biosensors and delivery platforms with tunable biological performance.

Research supported by: Credit

17. Versatile Functionalization Method for Magnetic Iron Oxide Nanoparticles

Presenter: *Anna Erb, 4th year Undergraduate Student, Electrical, Computer, and Biomedical Engineering*
Advisor: *Dr. Irene Andreu Blanco*

While iron oxide magnetic nanoparticles (MNPs) have a variety of uses in the field of biomedicine, their specific applications are highly dependent on their surface functionalization. A prominent example of this is PEGylation—the coating of particles with biocompatible polymer polyethylene glycol (PEG)—to increase their stability as they circulate through the bloodstream. However, direct attachment of PEG to MNPs remains difficult because of poor affinity of the typical -OH terminal groups in PEG to the iron oxide surface. This study demonstrates a multi-step functionalization strategy utilizing dopamine as an anchoring bridge. We use the polyol synthesis method to make spherical MNPs, with tetraethylene glycol (TEG) acting



as a solvent, capping and reducing agent. The MNPs are then coated with dopamine hydrochloride. The catechol side of the molecule binds strongly to iron oxide, while the amine group provides anchoring functional groups to then attach a carboxylic acid-terminated molecule of choice via click chemistry performed at room temperature. Rhodamine B is a useful candidate to prove this concept, allowing us to monitor attachment through its fluorescent properties and assess if this method can be implemented to facilitate the attachment of other useful functionalization molecules such as PEG. In this study, we proved the feasibility of this functionalization method and tested the stability of the produced surface coatings.

Research supported by: NSF Engineering Research Initiation #2301790

18. **Virtual Reality Upper Extremity Rehabilitation for Stroke Patients**

Presenter: *Ayomide Olagundoye, 3rd year Undergraduate Student, Electrical, Computer, and Biomedical Engineering*

Advisor: *Susan D'Andrea, PhD, Department of Kinesiology*

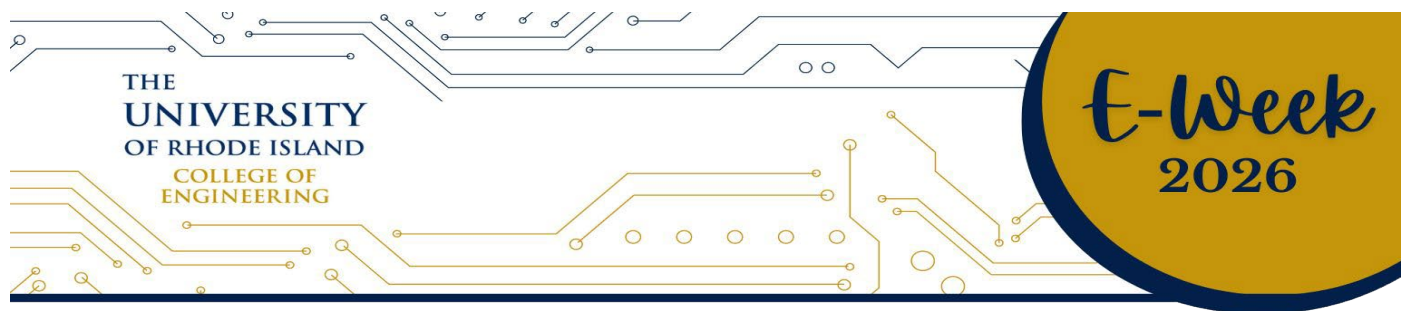
BACKGROUND: Stroke is the second leading cause of death and disability worldwide, and is a growing global health challenge, impairing the lives of many aging individuals [1]. A stroke is a cardiovascular event characterized by a disturbance of blood supply to the brain which leads to the death of neural tissue and further results in acute or chronic impairments to vision, speech, behavior, somatosensation, coordination, and motor function [2]. Up to 80% of stroke patients experience hemiparesis or the partial paralysis, weakening, and lack of motor control in the upper limb [3]. Rehabilitation plays a crucial role in improving post-stroke complications and may feature common strategies such as muscle strengthening, stretching and repetitive movements [4]. Research shows, however, that over 60% of stroke patients have persistent upper limb motor deficits after six months [5]. As a result, new strategies are being explored to address the limitations of conventional rehabilitation and enhance the process of recovery. Virtual reality (VR) is emerging as a helpful tool for neurorehabilitation providing many benefits such as feedback, increased user engagement, high repetition, more personalized training, and improved motivation [6].

PURPOSE: This study evaluates the feasibility and effectiveness of virtual reality for upper extremity rehabilitation in stroke patients.

METHODS: Two virtual reality games were designed to promote repetitive, goal-directed upper limb movements of the paretic arm. Stroke participants attended a total of 14 consistent visits, 2 assessment visits and 12 visits engaging them in VR-based rehabilitation games. Each game had four levels of increasing difficulty and participants were instructed to play each level for two minutes. A game performance score was recorded and indicated the number of targets that were successfully navigated at each level. To assess functional improvement, the Wolf Motor Function Test (WMFT) was administered before and after the VR training. Additionally, participants completed the Suitability Evaluation Questionnaire (SEQ) to evaluate usability, acceptance and safety of the VR games [7].

RESULTS: Two participants were evaluated for this abstract. Both participants demonstrated improvements in the WMFT performance evidenced by a 41% and 48% decrease in median task completion time. The WMFT Functional Ability Scale also improved by 0.5 and 1.0 points after the VR intervention. Game performance scores increased between 20-30 points between the first and last visits.

CONCLUSION: The stroke participants demonstrated improved performance throughout the progression of the visits and reported on their enjoyment of the study through the Suitability Evaluation Questionnaire. This study may continue to reveal a novel, feasible, and engaging approach for clinicians to incorporate virtual reality into their rehabilitation routines. By facilitating recovery, this VR rehabilitation technology



could improve quality of life and assist stroke survivors in regaining independence in daily activities.

REFERENCES: [1] Murphy SJ, Werring DJ. Stroke: causes and clinical features. *Medicine* (Abingdon). 2020 Sep;48(9):561-566. doi: 10.1016/j.mpmed.2020.06.002. Epub 2020 Aug 6. [2] Yu Z, Prado R, Quinlan EB, Cramer SC, Ombao H. Understanding the Impact of Stroke on Brain Motor Function: A Hierarchical Bayesian Approach. *J Am Stat Assoc*. 2016;111(514):549-563. doi: 10.1080/01621459.2015.1133425. Epub 2016 Aug 18. [3] Hirayama, K., Matsuda, M., Teruya, M. et al. Trends in amount of use to upper limb function in patients with subacute stroke: a cross-sectional study using segmental regression analysis. *BMC Neurol* 23, 429 (2023). <https://doi.org/10.1186/s12883-023-03469-z>. [4] Hatem SM, Saussez G, Della Faille M, Prist V, Zhang X, Dispa D, Bleyenheuft Y. Rehabilitation of Motor Function after Stroke: A Multiple Systematic Review Focused on Techniques to Stimulate Upper Extremity Recovery. *Front Hum Neurosci*. 2016 Sep 13;10:442. doi: 10.3389/fnhum.2016.00442. [5] Langhorne P, Coupar F, Pollock A. Motor recovery after stroke: a systematic review. *Lancet Neurol*. 2009 Aug;8(8):741-54. doi: 10.1016/S1474-4422(09)70150-4. [6] Khokale R, S Mathew G, Ahmed S, Maheen S, Fawad M, Bandaru P, Zerine A, Nazir Z, Khawaja I, Sharif I, Abdin ZU, Akbar A. Virtual and Augmented Reality in Post-stroke Rehabilitation: A Narrative Review. *Cureus*. 2023 Apr 14;15(4):e37559. doi: 10.7759/cureus.37559. [7] Gil-Gomez JA. SEQ: Suitability Evaluation Questionnaire for Virtual Rehabilitation systems. *International Conference on Pervasive Computing Technologies for Healthcare (PervasiveHealth)*; 2013; Venice, Italy. 2013. pp. 335–338.

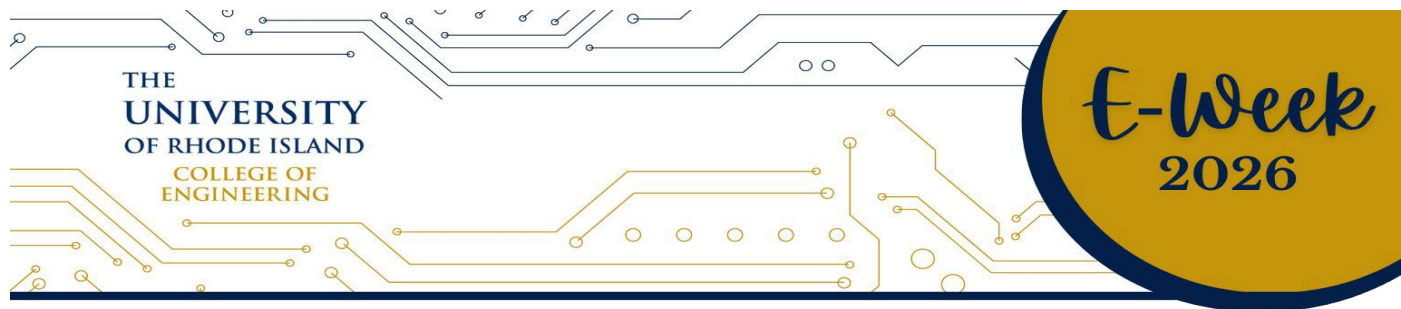
Research supported by: Credit

19. **Development and Characterization of Paclitaxel and Iron Oxide-Loaded PEGylated Nanocomposite Microparticles via Spray Drying for Synergistic Pulmonary Chemotherapy and Hyperthermia**

Presenter: *Caroline Forrest, 3rd year Undergraduate Student, Chemical Biological and Materials Engineering*

Advisor: *Dr. Irene Andreu Blanco*

Lung cancer remains a leading cause of cancer-related death and is often treated with intravenous chemotherapy, which results in significant systemic toxicity and limited tumor targeting. Paclitaxel (PTX) is a widely used chemotherapeutic to treat lung cancer, but its intravenous (IV) delivery limits drug diffusion into the lungs and contributes to undesirable side effects. Dry powder inhalation offers a localized and non-invasive alternative to IV treatment, improving drug deposition in the lungs while minimizing systemic side effects. However, nanoparticle-based therapeutics often suffer from poor aerodynamic properties, reducing their efficiency for inhalation therapy. Nanocomposite microparticles (nCmPs) address this limitation by embedding nanoparticles within larger, respirable micro-carriers that improve dispersion and deep lung deposition. Magnetic iron oxide nanoparticles (MNPs) are activated under exposure to an alternating magnetic field, which results in heat production capable of triggering localized drug release from PTX nCmPs. MNPs were synthesized through a high-temperature polyol method and capped with tetraethylene glycol. Dynamic Light Scattering (DLS) was used to measure the size of the particles, and AC Susceptometry was used to measure their dynamic magnetic response. The synthesized MNPs had a heating efficiency of around 20 W/gMNP when excited with sinusoidal magnetic fields of 30 mT amplitude and 102400 Hz and are stable in the solvents required for the spray drying procedure. The MNPs and PTX were encapsulated into nCmPs via spray drying. The spray-dried nCmPs were tested for particle size,



morphology, drug loading, aerosol dispersion, and magnetic heating capabilities. Ongoing work aims to optimize these formulations and assess their in vitro therapeutic efficacy.

Research supported by: NSF Engineering Research Initiation # 2301790, CHE 492 Special problem credits

20. Simulated Diffusion Dynamics of Multicomponent Asphalt Systems

Presenter: *Lucas Meier, 2nd year Undergraduate Student, Chemical Biological and Materials Engineering*

Advisor: *Dr. Michael Greenfield*

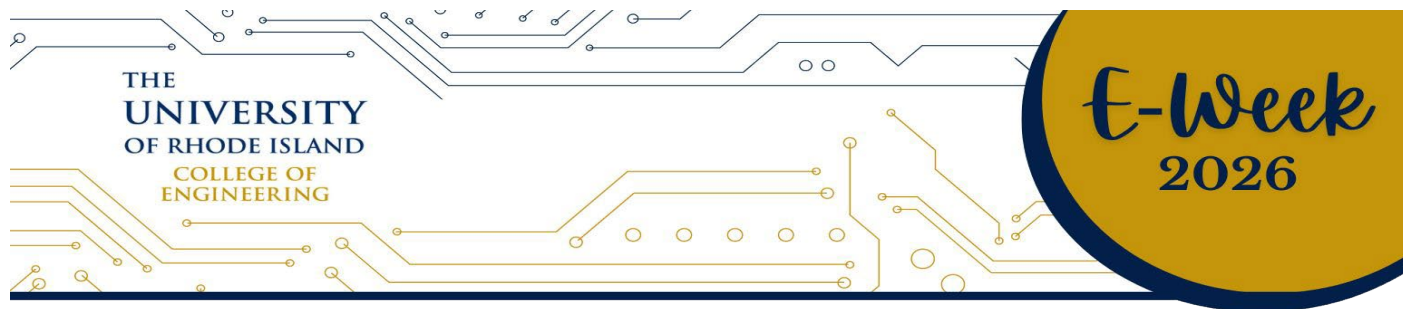
Molecular dynamics simulations provide a method for investigating the viscoelastic properties and molecular interactions within asphalt. A methodological consideration in these simulations is the choice of thermodynamic ensemble. This work investigates the impact of ensemble selection on the diffusive motions taken by individual molecules within a multicomponent asphalt system. We process trajectory data generated from these different simulation environments to track the time-dependent mean-squared displacement of various chemical constituents, which range from smaller molecules to larger complex asphaltenes. Current data analysis efforts focus on the mean-squared displacement and diffusivity for each constituent molecule type to evaluate their effects on an overall system. Comparing these transport properties across the different thermodynamic ensembles will ultimately clarify how simulation environments alter predicted micro-scale dynamics and will help ensure a robust computational framework for modeling asphalt behavior.

21. Synthesis and Characterization of Polyol-coated Magnetic Nanoparticles for Targeting Biofilms

Presenter: *Franny Duong, 3rd year Undergraduate Student, Chemical Biological and Materials Engineering*

Advisor: *Dr. Irene Andreu Blanco*

Marine biofilms, formed by the accumulation and growth of microorganisms on surfaces, are responsible for significant economic losses in industries such as shipping, aquaculture, and offshore engineering, due to their role in corrosion, fouling, and the increased energy required for vessel propulsion. This study investigates the synthesis of polyol-coated magnetic nanoparticles (MNPs) through the high-temperature polyol method, with potential applications in biofilm removal. Ethylene-based glycols enhance the colloidal stability of MNPs in bacterial cell growth media due to steric stabilization, enabling penetration of the MNPs within the biofilm and thus promoting the physical disruption of bacterial clusters under dynamic magnetic actuation. The magnetic properties of the nanoparticles also allow for targeted delivery and actuation to biofilms. In this project, the influence of synthesis conditions on MNP magnetic properties and morphology were evaluated. The high-temperature polyol method employs a Fe(III) organometallic precursor and ethylene-based glycols as solvents, capping agents and reducing agents, and reacting at temperatures above 200 °C in a self-pressurized vessel. The effect of polyol chain length (ethylene glycol vs. diethylene glycol vs. tetraethylene glycol) and reaction times (2hrs up to 24hrs) was evaluated. The synthesized particles were characterized using dynamic light scattering, dynamic magnetic susceptometry, vibrating sample magnetometry and transmission electron microscopy (TEM). Our findings suggest that



longer reaction times lead to larger particles, while larger polyols lead to larger particle size for a given reaction time. This systematic study also showed that, although fine size control can be achieved with this synthetic method, the formed MNPs do not reach their maximum saturation magnetization. Future research will explore a secondary heating step to increase magnetic crystallinity, and evaluate the effectiveness of MNPs on wild and laboratory-grown biofilms.

Research supported by: NSF Engineering Research Initiation # 2301790, Federal Work Study

22. Single Particle Tracking for Intracellular Viscosity Sensing

Presenter: *Hayden Reilly, 4th year Undergraduate Student, Chemical Biological and Materials Engineering*

Advisor: *Dr. Daniel Roxbury*

Single-Walled Carbon Nanotubes (SWCNTs) have been investigated for their use in biosensing applications due to their distinctive optical properties. Due to their ability to be functionalized, SWCNTs are able to be used as biocompatible, long-term sensing devices. These unique characteristics of SWCNTs make them an ideal tool to track how nanomaterials can impact the environment and living organisms. This study proposes a method for detecting various cell-type dependent intracellular properties through the tracking of SWCNT movement within cells. GT-15 ssDNA-SWCNTs were first introduced into cells with differing intracellular conditions via the cell membrane where they entered the early endosomal pathways. Conditions included tumorigenic vs non-tumorigenic cells, and cells with induced osmotic stress. Using near-infrared (NIR) fluorescence spectroscopy the ssDNA-SWCNTs were tracked as they moved inside of the cells. Particle tracking was performed via MATLAB code that quantified the dynamics of the SWCNTs inside of the cells. Analysis was performed, and a statistical difference was determined between the SWCNTs in the various cells. These findings provide evidence that this method of single-particle tracking can be used as a sensor of the intracellular cell properties.

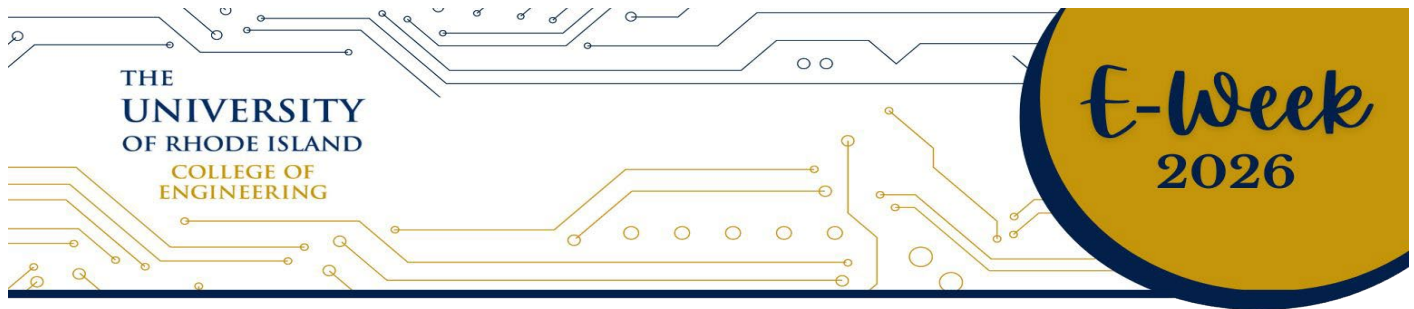
Research supported by: Credit

23. URISE Research Assistant

Presenter: *Anthony Nardolillo, 4th year Undergraduate Student, Mechanical, Industrial and Systems Engineering*

Advisor: *Professor Craver/Sirri Akongnwi Neba Nforsoh*

This project focuses on the creation and development of an attachable stamp to be applied to Concrete pavers being placed near the new development at URI. The objective is to develop a stamp that will withstand the heat of the molten material, last for multiple cycles, and be able to imprint textures and logos repeatedly and effortlessly. The emphasis of this design is focused on the repeatability of the process so that fellow colleagues can produce as well, along with scalability to be able to mold around any shape paver. Prototyping and testing are conducted to evaluate the aesthetic of the logo on an object as well as testing varying roughnesses to counter environmental conditions including freeze through cycles and foot traffic.



The final design aims to offer a viable solution to improve sidewalk components through repeated surface pattering.

Research supported by: Undergraduate Research in Science and Engineering (URISE)

24. Auxetic Reinforcement for Improved Fracture Resistance in Composite Hockey Sticks

Presenter: Tyler Dickson, 4th year Undergraduate Student, Mechanical, Industrial and Systems Engineering

Advisor: Dr. Sumanta Das

Ice hockey sticks are commonly constructed using carbon fiber composite materials that provide high stiffness relative to their weight, but remain susceptible to fracture, particularly near the lower hand, where bending stresses concentrate during shooting. This research explores the application of an auxetic wrap in this critical region to improve fracture resistance without compromising the stick's flex characteristics, crucial for generating powerful shots. Auxetic materials, characterized by a negative Poisson's Ratio, expand when stretched and contract when compressed, which may enhance energy absorption and slow crack propagation. The research is in the preliminary stages, with finite element modeling conducted using Abaqus to simulate loading conditions representative of shooting. Current simulations focus on evaluating stress concentrations, strain distribution, and deformation behavior in the reinforced region compared to a standard composite configuration. Once the reactions of the model are determined, physical testing of composite hockey sticks will be orchestrated to simulate their response during shooting. This study aims to establish a foundational understanding of how localized auxetic reinforcement influences durability while maintaining the mechanical behavior necessary for effective energy transfer during shooting.

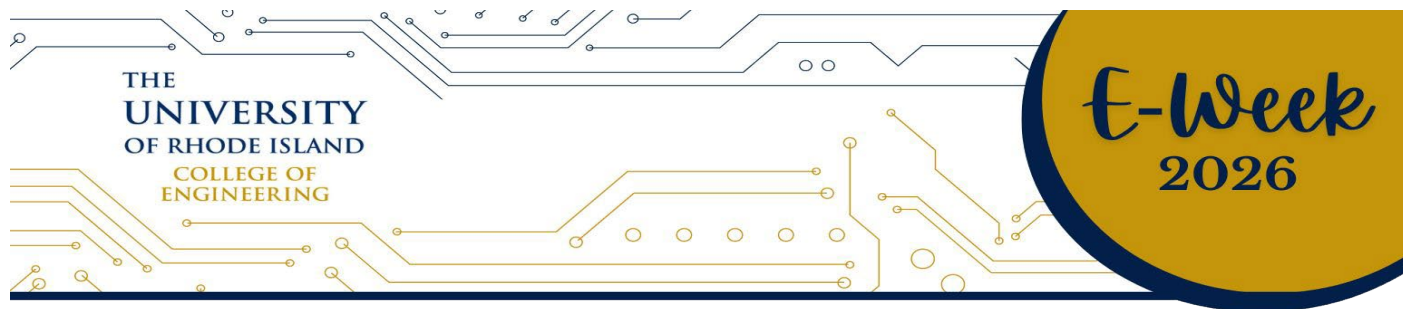
25. The Haptic Feedback Belt

Presenter: Nicholas Worshek, 3rd year Undergraduate Student, Electrical, Computer, and Biomedical Engineering

Advisor: Dr. Dhaval Solanki

The Haptic Feedback Belt is an undergraduate research project focused on developing a wearable device designed to provide calming sensory stimulation for individuals with anxiety, autism spectrum disorder, and related conditions. The purpose of this project is to create a non-invasive, accessible tool that delivers controlled haptic feedback to help regulate sensory input and promote relaxation. The system integrates an array of vibration motors embedded within a belt, controlled by an Arduino-based microcontroller and supported by custom Python software for testing and configuration. This software enables individual and grouped motor activation, allowing for adjustable intensity and pattern-based stimulation tailored to user needs. An inertial measurement unit (IMU) sensor is incorporated to monitor movement and support adaptive feedback during use. The project emphasizes phantom-based electrical validation testing to ensure precise motor control and system reliability. Expected outcomes include a functional prototype capable of delivering consistent, customizable haptic feedback, contributing to assistive technology solutions that support emotional regulation and sensory comfort.

Research supported by: Undergraduate Research in Science and Engineering (URISE)



Graduate Students Posters

Poster session: 3:30 – 5:00 pm. Toray Commons Fascitelli Center for Advanced Engineering

1. Magnetically Assisted Retention of Surface-Modified Iron Oxide Nanoparticles in Biofilms

Presenter: Payel Biswas, PhD Graduate Student, Chemical Biological and Materials Engineering
Advisor: Dr. Irene Andreu Blanco

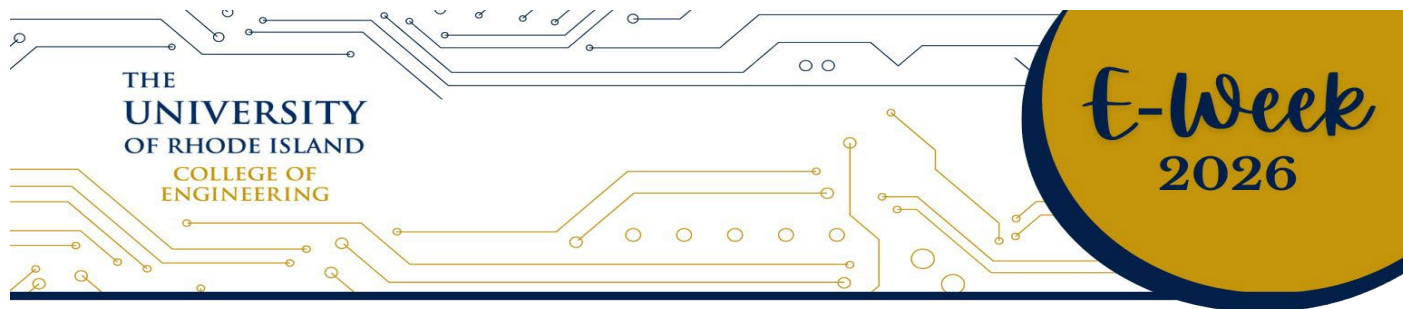
Magnetic iron oxide nanoparticles (IONPs) are being explored as an effective strategy for disrupting bacterial biofilms commonly under alternating magnetic fields (AMF). In this study, tetraethylene glycol (TEG)-coated and polyethyleneimine (PEI)-coated IONPs with comparable core sizes were synthesized and characterized to investigate the role of surface chemistry on nanoparticle behavior in biofilm environments. The IONPs were incubated with lab-grown *S. epidermidis* biofilms under conditions with and without static magnetic field exposure to evaluate their penetration, and retention within the biofilm matrix. The uptake of nanoparticles was quantified as the mass ratio of magnetic material to biofilm (gIONP/gBiofilm), enabling a direct comparison between coatings and incubation conditions. It is hypothesized that PEI-coated particles, due to their positive surface charge, will exhibit stronger attachment to the negatively charged extracellular polymeric substance (EPS) matrix compared to TEG-coated particles under no-field conditions. Under static magnetic field exposure, enhanced nanoparticle transport toward the biofilm is expected to increase overall accumulation for both particle types, potentially reducing differences arising solely from surface chemistry. This study aims to quantify nanoparticle retention within biofilms under different surface coatings and static magnetic field conditions to better understand nanoparticle-biofilm interactions.

Research supported by: NSF Engineering Research Initiation (grant # 2301790)

2. Magnetically Assisted Retention of Surface-Modified Iron Oxide Nanoparticles in Bacterial Biofilms

Presenter: Payel Biswas, PhD Graduate Student, Chemical Biological and Materials Engineering
Advisor: Dr. Irene Andreu Blanco

Magnetic iron oxide nanoparticles (IONPs) are being explored as an effective strategy for disrupting bacterial biofilms commonly under alternating magnetic fields (AMF). In this study, tetraethylene glycol (TEG)-coated and polyethyleneimine (PEI)-coated IONPs with comparable core sizes were synthesized and characterized to investigate the role of surface chemistry on nanoparticle behavior in biofilm environments. The IONPs were incubated with lab-grown *S. epidermidis* biofilms with and without static magnetic field gradient exposure to evaluate retention within the biofilm matrix. The uptake of nanoparticles was quantified as the mass ratio of magnetic material to biofilm (gIONP/gBiofilm), enabling a direct comparison between coatings and incubation conditions. It is hypothesized that PEI-coated particles, due to their positive surface charge, will exhibit stronger attachment to the negatively charged extracellular polymeric substance (EPS) matrix compared to TEG-coated particles under no-field conditions. Under static magnetic field exposure, enhanced nanoparticle transport toward the biofilm is expected to increase overall accumulation for both particle types, potentially reducing differences arising solely from surface chemistry.



This study aims to quantify nanoparticle retention within biofilms under different surface coatings and static magnetic field conditions to better understand nanoparticle-biofilm interactions.

Research supported by: NSF Engineering Research Initiation (grant #2301790), TA

3. MIT Green Building Imaging

Presenter: Andrew Martin, MS Graduate Student, Civil and Environmental Engineering

Advisor: Dr. Aser Abbas

Ambient noise studies using horizontal-to-vertical (H/V) spectral ratio measurements were conducted to determine the fundamental site period in the Cambridge, Massachusetts area near the MIT Green Building. Geophones were used to record ambient ground vibrations at multiple locations, and the resulting H/V spectral ratios were analyzed to identify peak frequencies corresponding to the fundamental site period. These frequencies were used to estimate sediment thickness and develop a two-dimensional map of the bedrock surface. In addition, a downhole geophone array will be installed near the MIT Green Building to obtain shear wave velocity profiles and calibrate the surface measurements, supporting the development of the three-dimensional model of the bedrock surface.

Research supported by:

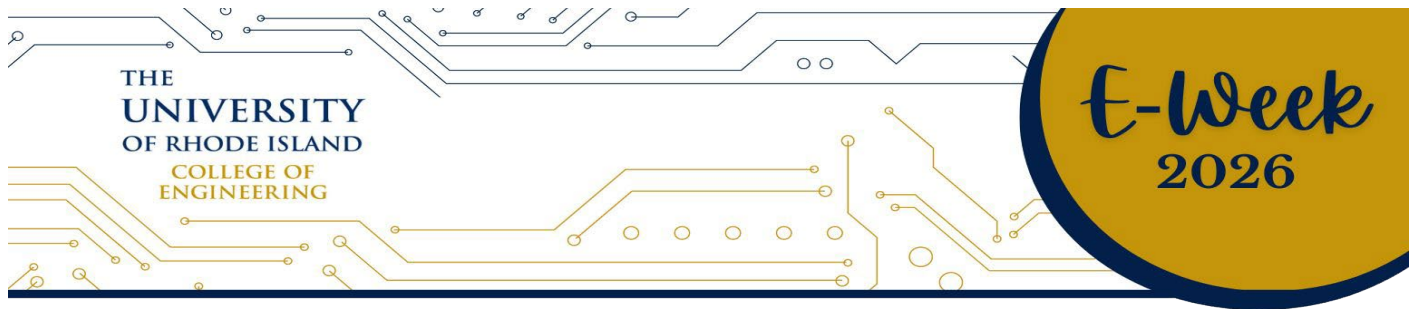
4. Swcnts Transport Faster Than Expected in Polymer Solutions

Presenter: Sepehr Yari, PhD Graduate Student, Chemical Biological and Materials Engineering

Advisor: Dr. Daniel Roxbury, Dr. Ryan Poling-Skutvik

Particle tracking offers powerful insights into nanoparticle dynamics within complex environments. Single-walled carbon nanotubes (SWCNTs), owing to their intrinsic fluorescence in the near-infrared region and high aspect ratio, have become useful tools for studying local physical and chemical conditions. In this study, we leverage the particle tracking of SWCNTs to explore their transport behavior in viscoelastic media as a foundation for developing physical biosensors capable of detecting intracellular changes indicative of disease.

To test our hypothesis, we conducted a series of experiments aimed at understanding the coupling between the dynamics of SWCNTs and the structure and viscoelasticity of complex fluids. We prepared solutions of polyethylene oxide (PEO) with varying molecular weights at concentrations of 1, 3, 5, 10, 20, and 30 c^* , where c^* denotes the overlap concentration of polymer chains. Surfactant-functionalized SWCNTs were introduced into these solutions and imaged using near-infrared (NIR) fluorescence microscopy. To identify the effects of anisotropy, we compared these measurements to similar experiments performed using spherical nanoparticles with diameters of roughly 150 nm, similar to the hydrodynamic diameter of SWCNTs. We find significant deviations in the diffusivity of SWCNTs in high molecular weight PEO solutions, with SWCNTs diffusing up to 300 times faster than predicted by the Stokes-Einstein equation. By contrast, spherical nanoparticles exhibited diffusivities consistent with SE predictions across all molecular weights. This anomalous transport behavior of SWCNTs, which we hypothesize is caused by their anisotropic shape and their ability to rapidly navigate through the polymer mesh, indicates that SWCNTs exhibit a high sensitivity to variations in solution viscosity. Ongoing investigations aim to identify the



specific factors influencing their motion to develop a predictive model. Upon establishing the correlation between SWCNT dynamics and medium properties, we will proceed to investigate how changes in these properties within the cellular environment affect SWCNT motion.

Research supported by: 0.5 TA

5. From Signature Rejection to Signature Curing - Investigating and Visualizing State Regulations

Presenter: Leonie S. Otte, PhD Graduate Student, Mechanical, Industrial and Systems Engineering
Advisor: Gretchen A. Macht, Ph.D.

Vote-by-Mail can make the voting process more convenient by allowing voters to fill out their ballots from anywhere and mail them in. In eight states and Washington, D.C., every registered voter receives an absentee ballot by mail and has the option to return their ballot via the postal service, drop boxes, or in person at a designated polling location. The remaining states allow absentee voting either with or without providing an excuse. Thirty-two states implement some form of Signature Verification in their mail ballot process prior to the removal from the return envelope and counting. Certain states that employ Signature Verification provide voters with the opportunity to “cure” the signature in cases where it cannot be matched during processing or is absent. The curing process allows voters the chance to resolve the signature discrepancy, so that their vote can be counted. The timeframe for curing varies by state and may range from the day before Election Day to several days before the election certification deadline.

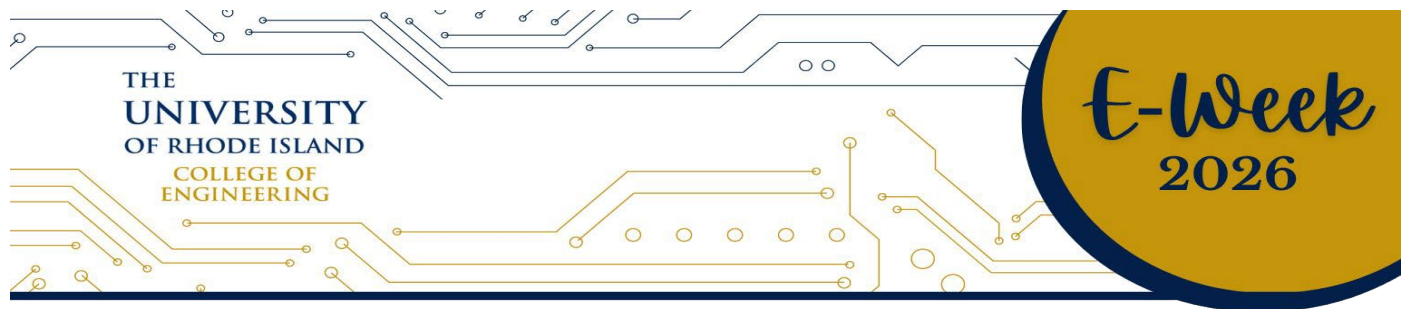
This research creates and compares timeline visualizations from the earliest start time allowed for processing mail ballots and the signature-curing deadline across more than thirty states. It highlights the brief window for curing in some states, as well as signature requirements and the matching process that can result in voter disenfranchisement. The findings can encourage a discussion about evaluating the effectiveness of cure rules to ensure voters have a reasonable period to cure their signatures and have their ballots counted in the election.

Research supported by: First-Year Doctoral Fellowship from the URI Graduate School

6. Hypersonic Shock Response of Fiber-Reinforced Composite Structures

Presenter: Moazzem Hossain Saeem, PhD Graduate Student, Mechanical, Industrial and Systems Engineering
Advisor: Dr. Helio Matos

There is an increasing demand for composite materials due to their high stiffness-to-weight ratio. The mechanical behavior of fiber-reinforced composites depends not only on the properties of their constituent materials, but also on ply orientation and stacking sequence. This study investigates the hypersonic shock response of helicoid composite configurations and compares their performance with quasi-isotropic composite laminates and stainless steel (SS) plates under extreme loading conditions. Laminated composite specimens were fabricated and tested using a Mach 6 hypersonic shock tube. Full-field out-of-plane deformation and strain evolution on the rear surface of the specimens were quantified using three-dimensional Digital Image Correlation (3D-DIC) with a two high-speed camera system. The layup orientation with a helicoid configuration was able to outperform composites with the traditional quasi-



isotropic configuration, whereas an equal-mass SS specimen showed significantly larger displacement. These results demonstrate that CFRP composites with variations in fiber orientation significantly influence energy dissipation, damage progression and structural resilience under hypersonic shock loading, underscoring their potential for naval, aerospace, and defense applications.

Research supported by: Helicoid Industries
79420 Granada Drive, Indio, CA, 92203

7. **Investigating the Impact of Biomolecular Corona on Intracellular Fluorescence of DNA-SWCNTs**

Presenter: Raodatullah Abodunrin, PhD Graduate Student, Chemical Biological and Materials Engineering
Advisor: Dr. Daniel Roxbury

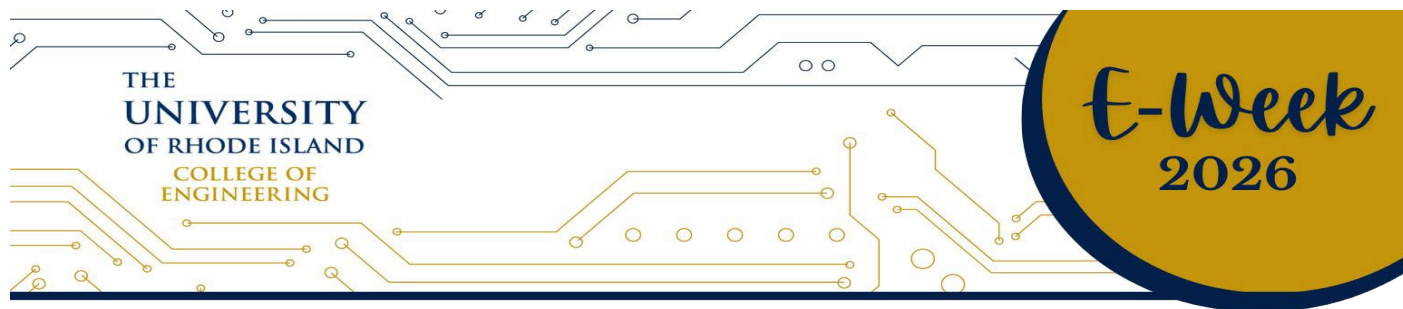
The intracellular processing of nanomaterials in biological systems is governed less by their shape or surface, but more by the biomolecular corona that forms upon exposure to proteins, lipids, and other biomolecules. The composition of this corona is driven by molecular interactions—such as charge and hydrophobicity—rather than simple abundance, and in turn dictates nanoparticle stability, cellular interactions, and intracellular fate. However, the structure–function relationship between specific corona constituents and single walled carbon nanotubes (SWCNTs) optical responses remain poorly understood. Moreover, variations in SWCNT surface functionalization are known to influence cellular uptake, fluorescence behavior, and intracellular processing, yet the interplay between functionalization and corona formation has not been systematically explored. This project aims to investigate how the biomolecular corona modulates the intracellular fluorescence and uptake behavior of SWCNTs across different surface chemistries. DNA–SWCNTs are uniquely suited for this study because of their stable near-infrared (NIR) photoluminescence, which enables real-time, label-free tracking in live cells. By systematically varying DNA sequences (e.g., (GT)₁₅ and (AT)₁₅) and controlling corona composition through isolated incubation with select proteins, such as human serum albumin (HSA), ubiquitin (UBQ), and transferrin (TFR), this study will evaluate how corona constituents with differing stability, bio functionality, and immunogenicity will alter SWCNT (NIR) spectral properties, cellular uptake and retention efficiency, and intracellular trafficking. Ultimately, this work aims to establish a link between biomolecular corona composition, conformational stability, and DNA–SWCNT fluorescence behavior in cells. These insights will not only clarify fundamental mechanisms of nanoparticle–cell interactions but also inform rational design of SWCNT-based biosensors and delivery platforms with tunable biological performance.

Research supported by: Fellowship NIH T32 BSBE

8. **Correlating SAM Capture and SERS Response for Detection of Anionic Pollutants in Marine Field Samples**

Presenter: Kathryn Terceiro, PhD Graduate Student, Chemical Biological and Materials Engineering
Advisor: Dr. Geoff Bothun

Monitoring anionic pollutants such as nitrate and phosphate in marine environments is essential to maintain water quality at acceptable levels and prevent eutrophication and algae blooms from occurring. Current



methods to conduct this monitoring have major sensitivity and selectivity issues that limit their effectiveness. They also require sample preparation and large instrumentation that prevent the detection of real-time changes in pollutant levels. Surface Enhanced Raman Spectroscopy (SERS) works by enhancing the Raman scattering emitted by target analytes using nanostructured plasmonic materials excited by a laser in the near infrared regime. The resulting spectra consists of energy shifts specific to target analytes that can be used to detect its presence. The functionalization of the gold-plated Silmeco substrates functionalized with cationic cysteamine can be used as a pre-concentration step to increase the total number of target molecules within the SERS active region and boost the selectivity and analyte capture.

We have previously shown that cysteamine self-assembled monolayers (SAMs) can be used to capture and detect anionic analytes like nitrate. Detection arises from interactions between the SAM and the nitrate anions and changes in the conformational state of the SAM. In this work, we apply this cysteamine SAM capture+reporter approach to real marine field samples deposited directly onto the substrate and dried prior to analysis. Changes in Raman peak intensities are evaluated across sampling locations and depths and compared to concentration trends using traditional analysis methods. These comparisons provide insights into the relationship between SERS spectral response and anionic pollutant distributions in environmental samples. Understanding the correlations between changing Raman peak intensities and varying anion concentrations helps establish the potential for quantitative analytes and demonstrates the viability of SERS for detecting anionic pollutants in complex environmental matrices.

Research supported by: Rhode Island Research, 2025 Collaborative Research Grant

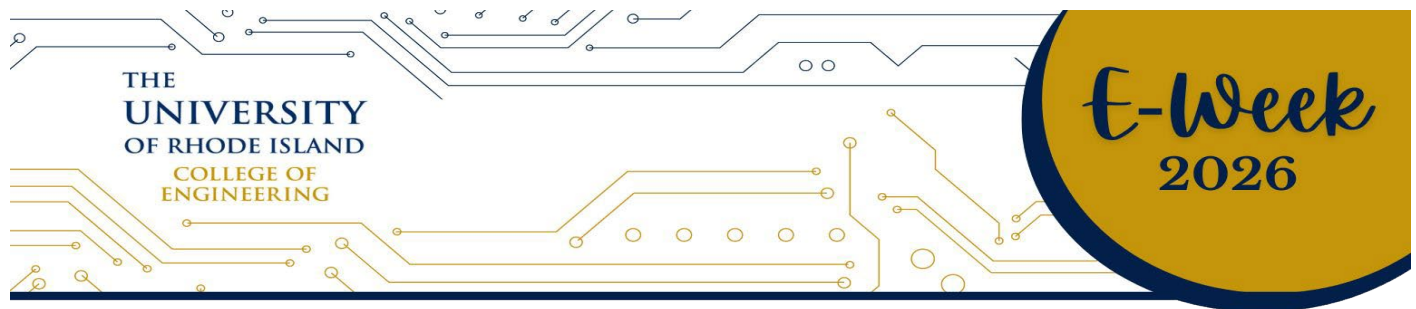
9. **Detection of Breast Cancer Subtypes Using Machine Learning-Assisted Spectral Fingerprinting of SWCNTs in Live Cells**

Presenter: *Maryam Rahmani, PhD Graduate Student, Chemical Biological and Materials Engineering*
Advisor: *Dr. Daniel Roxbury*

Detecting Breast cancer at an early stage is a significant challenge because of its multiple subtypes and elusive heterogeneous nature. An innovative single-walled carbon nanotube (SWCNT) NIR fluorescence spectral fingerprinting approach in conjunction with a machine learning algorithm could precisely detect breast cancer subtypes in vitro. We demonstrate this concept by incubating DNA-functionalized SWCNTs with a panel of human breast cell lines: the non-tumorigenic MCF-10A and cancer cell lines MCF-7, HCC1954 (HER2+), MDAMB-231, and MDA-MB-468 (triple-negative). The NIR fluorescence spectra of SWCNTs across 500 individual cells of the mentioned cell types showed significant differences in emission peak intensities, center wavelengths, and peak intensity ratios, attributable to variations in cellular uptake and biomolecular interactions. These features were used to train a support vector machine learning (SVM) model. The model achieved more than 90% classification accuracy, selectivity, and precision, effectively distinguishing cancerous subtypes from noncancerous cells. Moreover, using Raman microscopy, we statistically analyzed SWCNT uptake across all cell lines. Insights from this research enhance the development of nanomaterial-based platforms for biosensing and provide potential for real-time monitoring of in vivo cellular differentiation.

Research supported by: RA

10. **Miniaturized Geometry-Controlled Sharp-Edge Acoustofluidic Pumps for Nanoliter Flow Control and Microfluidic Bioassays**



Presenter: Erfan Eskandari, PhD Graduate Student, Mechanical, Industrial and Systems Engineering
Advisor: Dr. Yang Lin

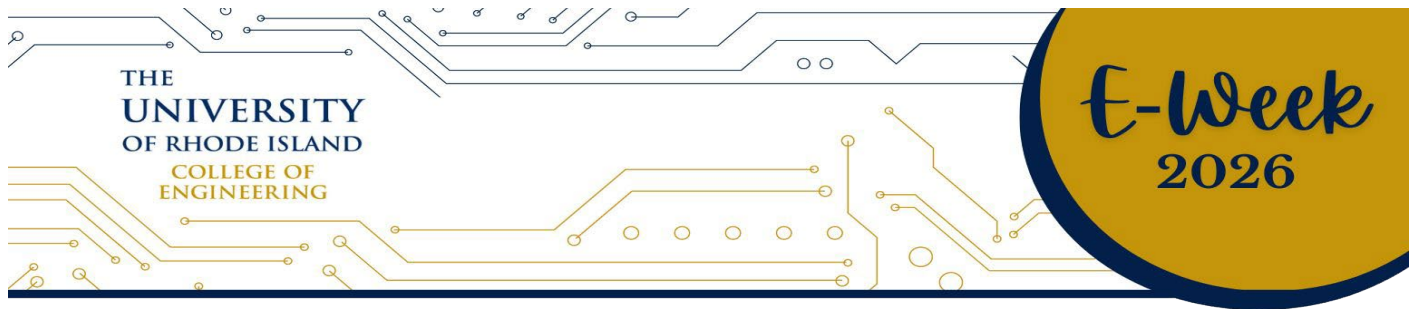
Precise fluid manipulation at the nanoliter scale is essential for emerging microfluidic bioassays, yet conventional pumping approaches often introduce significant dead volume and require bulky external equipment. Sharp-edge acoustofluidic pumps provide a compact and bubble-free alternative, but their implementation has largely been limited to structures larger than 100 μm due to fabrication constraints. In this study, we present miniaturized geometry-controlled sharp-edge acoustofluidic pumps fabricated using two-photon polymerization, enabling three-dimensional wedge-like microstructures with characteristic dimensions below 30 μm . The key geometric parameters, including sharp-edge spacing, edge length, initial edge distance, orientation angle, and tip angle have been studied. The results reveal that pumping behavior in the miniaturized regime is governed by a balance between localized acoustic streaming, viscous damping, and hydrodynamic coupling between adjacent edges. The optimal configurations is observed with 20 μm edge length, 30 μm spacing, 25 μm initial distance, 60° orientation angle, and 20° tip angle produced stable nanoliter-scale flow rates up to 20-25 nL min^{-1} at a driving voltage of 6 V with a frequency of 60 kHz. To explore potential biological applications, the optimized pump design was integrated into a microfluidic platform for single-cell trapping experiments, enabling controlled chemical exposure within nanoliter microenvironments. The experimental setup allows investigation of how acoustically driven flow influences chemical transport and cellular microenvironments in single-cell assays.

Research supported by: Defense Advanced Research Projects Agency (DARPA) through the Young Faculty Award (YFA) under Grant No. HR00112410003

11. Environmental impacts of manufacturing plastic paver blocks using pristine and recycled waste plastics, and the impact of UV weathering on its performance

Presenter: Sirri Akongnwi Neba Nforsoh, PhD Graduate Student, Civil and Environmental Engineering
Advisor: Dr. Vinka Oyanedel-Craver

The use of plastic waste in the production of bricks is an alternative for reducing plastic waste, saving raw materials, enhancing the properties of bricks, and providing low-cost construction materials. In the present study, the mechanical performance, contaminant release, and influence of ultraviolet (UV) weathering of feedstock and blocks produced using Pristine and recycled High-Density Polyethylene (HDPE) and Polypropylene (PP) plastics were investigated. Plastics sourced from dining services, mixed with sand at a 30:70 ratio were used to manufacture plastic bricks. The blocks were tested for compressive strength, creep behavior at 45% of the maximum compressive strength, leaching tests, particulate emissions during extrusion and the effects of UV weathering on the mechanical and environmental performance of the blocks. Blocks made using unaged feedstock achieved a compressive strength between 30.17 N/mm^2 to 35.25 N/mm^2 , suitable for paving, with blocks made from pristine plastics having higher strength. Aging reduced strength by up to 13% and 16% for aged feedstock and aged blocks respectively. Strain percentages in creeping were up to 10.10% for VPP blocks, with recycled plastic blocks creeping less than pristine ones. Aging reduced the resistance to creeping with aged blocks creeping more than aged feedstock blocks. Particulates sizes were within the nano and micro ranged with majority of sizes being $<1\mu\text{m}$. The particulates were composed of elements like C, O, Si, Al, Fe, K, Ca, Mg, Ti, N and Mo. UV weathering of feedstock increased particulate count by ~69%, with recycled plastic block compositions emitting more



particulates. The leaching test showed that more metals were leached by aged than the unaged feedstock, with aging increasing leaching by up to 5 times. Blocks leached out more elements including additional metals like Ni, Pb for unaged samples with concentrations going up to 83.57ug/g of block material. Aging increased the leaching concentrations in blocks by up to ~80%, likely due to the action of UV which causes photo-oxidation, chain scission and embrittlement of the polymer structure, exposing more elements. Very few elements were leached out of whole blocks, since the leaching fluid was mostly in contact with just the surface. Aging increased metal concentrations with aged blocks leaching more than aged feedstock blocks, likely because mostly the surface of the aged blocks was exposed to UV, so photo-oxidation was concentrated more on that surface.

Overall, the results show that virgin and waste plastics can be effectively incorporated into construction materials, as they have great mechanical properties comparable to traditional bricks. However, optimizing the manufacturing process, and reducing the effect of UV aging can improve durability, while minimizing occupational health and environmental impacts.

Keywords: Plastic waste, recycling, UV aging, emissions.

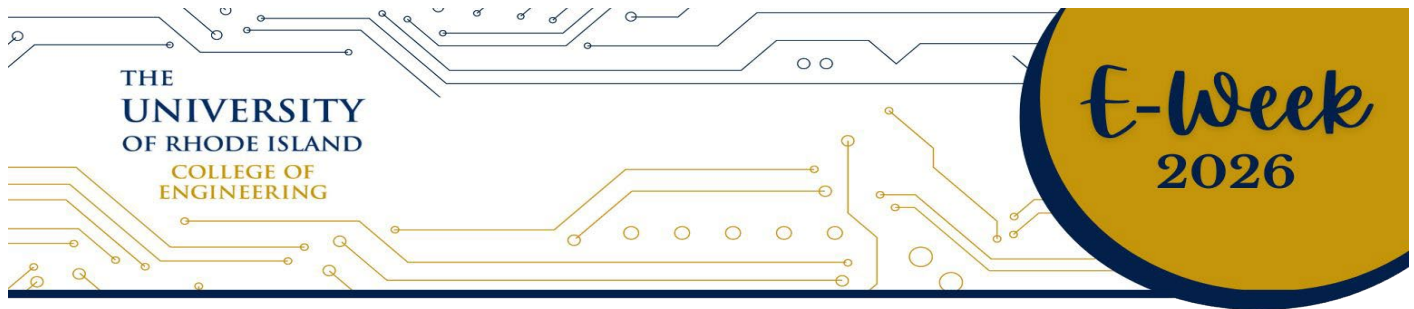
Research supported by: CommerceRI, as part of the innovation voucher program

12. Biosynthesis of Manganese Oxide Nanoparticle for Agricultural Fertilization Application

Presenter: Nicolay Welter, PhD Graduate Student, Civil and Environmental Engineering

Advisor: Dr. Vinka Oyanedel-Craver

Green synthesized nanoparticles have been the object of study for their use as fertilizers in the agricultural field. Among them, manganese oxide nanoparticles (MnONPs) have been used to increase the growth and biomass of rice seedlings, mung bean, moringa plants, among others. In this work, we explore the biosynthesis and purification of MnONPs for these environmental applications, seeing as the biosynthesis of MnONPs consumes less thermal energy compared to chemical synthesis methods. In this study, MnONPs were biosynthesized using a strain derived from the marine environment, *Pseudomonas putida* GB-1. The bacteria were incubated in a batch system in Leptothorix media, enriched with MnCl₂ as the manganese source, for 24 hours at 30 °C and 144 rpm, until the late stationary phase. During the incubation *Pseudomonas putida* GB-1 transforms aqueous Mn(II) to Mn(III/IV) particles. After 24 hours, the media was centrifuged at 3000 rpm for 10 minutes. The supernatant was collected and filtered for investigation using Inductively Coupled Plasma Mass Spectrometry (ICP-MS), while the MnONPs pellet was re-suspended and soaked in absolute ethanol for 10 minutes aiming the dissolution of organic remnants to obtain a high yield of reactive particles. The pellet was then left to air dry for 48h and then analyzed in the XRF (X-ray Fluorescence) to determine the elemental composition of the remaining solids. The results showed a significant decrease of Mn concentration in the supernatant media after incubation (from ~2300 ppb to below detection level), suggesting the transformation of MnCl₂ into MnONPs by the bacteria. Moreover, the elemental analysis of the pellet showed a high percentage of Mn in the remaining solids and possible formation of manganese and oxygen bonds, suggesting once more the formation of MnONPs. The particles obtained will be further characterized using Fourier Transform Infrared Spectroscopy, Energy-Dispersive X-ray Spectroscopy, Transmission Electron Microscopy, X-ray Diffraction, Zeta Potential and Inductively Coupled Plasma Optical Emission Spectroscopy. Moreover, after characterized, the nanoparticles will later be used as fertilizers by foliar application to soybean plants.



Research supported by: This work is supported by USDA NIFA AFRI 2023-67021-3974

13. The Development of Rechargeable Magnesium Batteries with Carbon Cathode Materials

Presenter: Lauren Rainone, PhD Graduate Student, Chemical Biological and Materials Engineering
Advisor: Dr. Arijit Bose

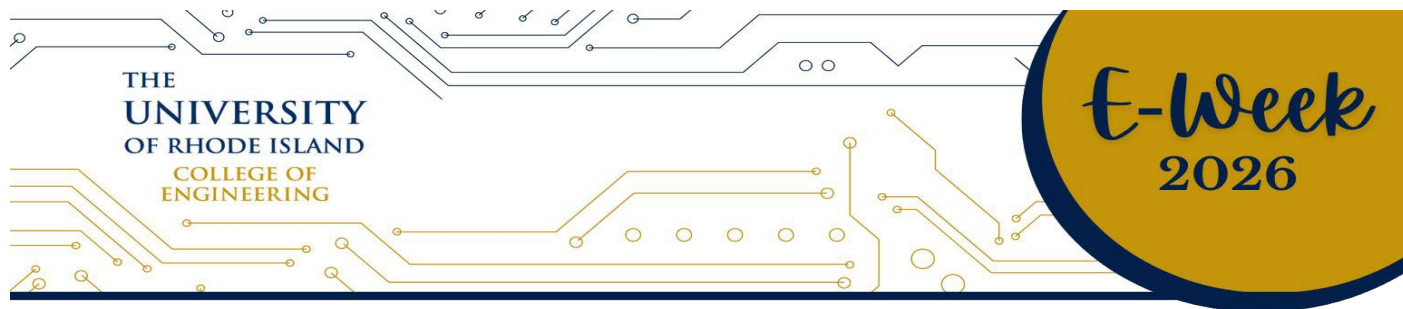
As the need for alternative energy storage systems grows, more research is being done to find suitable cathode materials for rechargeable magnesium battery systems. Magnesium batteries are being explored as an alternative to lithium-ion batteries because magnesium is more abundant, offers improved safety features, and has a higher volumetric capacity (3833 mAh/cm³ compared to lithium's 2061 mAh/cm³). Compared to monovalent lithium ions, divalent magnesium ions possess a higher charge density, inducing strong interactions between magnesium ions and negatively charged transition metal oxide cathode materials. Fullerene, a carbon allotrope with covalently bonded carbon atoms forming a spherical cage-like structure, is investigated as a potential alternative cathode material due to its unique ability to distribute charges across multiple molecules. This has the potential to improve energy densities and diffusion rates, enhancing cycling capabilities. The compatibility of fullerene as an active material in rechargeable magnesium batteries is explored using galvanostatic cell cycling and surface microanalysis of cell components. Magnesium batteries with fullerene cathodes experience low initial capacities and have rapid capacity fade caused by material dissolution through the electrolyte. Additionally, the dispersion of C60 in the electrolyte is observed, indicated by reduced capacity loss at higher cycling rates, the detection of soft shorts during cycling, and the presence of C60 in the separator after cycling.

Research supported by: NIUVT

14. Analyzing Physical Adversarial Example Threats to Machine Learning in Election Systems

Presenter: Khaleque Md Aashiq Kamal, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering
Advisor: Dr. Kaleel Mahmood

Developments in the machine learning voting domain have shown both promising results and risks. Trained models perform well on ballot classification tasks (> 99% accuracy) but are at risk from adversarial example attacks that cause misclassifications. In this paper, we analyze an attacker who seeks to deploy adversarial examples against machine learning ballot classifiers to compromise a U.S. election. We first derive a probabilistic framework for determining the number of adversarial example ballots that must be printed to flip an election, in terms of the probability of each candidate winning and the total number of ballots cast. Second, it is an open question as to which type of adversarial example is most effective when physically printed in the voting domain. We analyze six different types of adversarial example attacks: l_{∞} -APGD, l_2 -APGD, l_1 -APGD, l_0 PGD, $l_0 + l_{\infty}$ PGD, and $l_0 + \sigma$ -map PGD. Our experiments include physical realizations of 144,000 adversarial examples through printing and scanning with four different machine learning models. We empirically demonstrate an analysis gap between the physical and digital domains, wherein attacks most effective in the digital domain (l_2 and l_{∞}) differ from those most effective in the physical domain (l_1 and l_2 , depending on the model). By unifying a probabilistic election framework with digital and physical adversarial example evaluations, we move beyond prior close race analyses to explicitly quantify when and how adversarial ballot manipulation could alter outcomes.



Research supported by: RA from Computer Science Department

15. Design Strategy for a Flexible Non-Contact Strain-Sensing Platform

Presenter: *Marcus, James, Los Orr, Joubert, Estrada Rosa, PhD Graduate Student, Chemical Biological and Materials Engineering*

Advisor: *Dr. Daniel Roxbury*

Strain-sensing textiles have important applications in medical monitoring and durability assays due to their flexibility and potential for reversible deformation. Currently, the most common kind of flexible strain sensor is piezoresistive. The main drawback with these sensors is that they require constant physical contact with a power source, which limits their use as an implantable and adds bulk to any potential wearable devices. To combat these limitations, a non-contact sensor is developed by incorporating single-walled carbon nanotubes (CNTs) into electrospun polymeric micro-fibrous textiles. These textiles take advantage of CNTs' intrinsic, photostable, and reversible optical responsiveness to strain, enabling quantitative, non-contact measurement. The production method of this platform is easily scaleable to industrial volumes, and tunable for various environments; however, the sensing efficacy and mechanical properties of the system are highly sensitive to small changes in fiber morphology, material selection, and composition. A method of designing a novel sensing platform that overcomes the inherent shortcomings of existing contact sensors by simultaneously optimizing all three of these parameters is presented.

Research supported by: NIUVT

16. Promoting polymer bridge formation in colloidal suspensions

Presenter: Sabirul Khan Priyo, PhD Graduate Student, Chemical Biological and Materials Engineering

Advisor: Dr. Ryan Poling-Skutvik

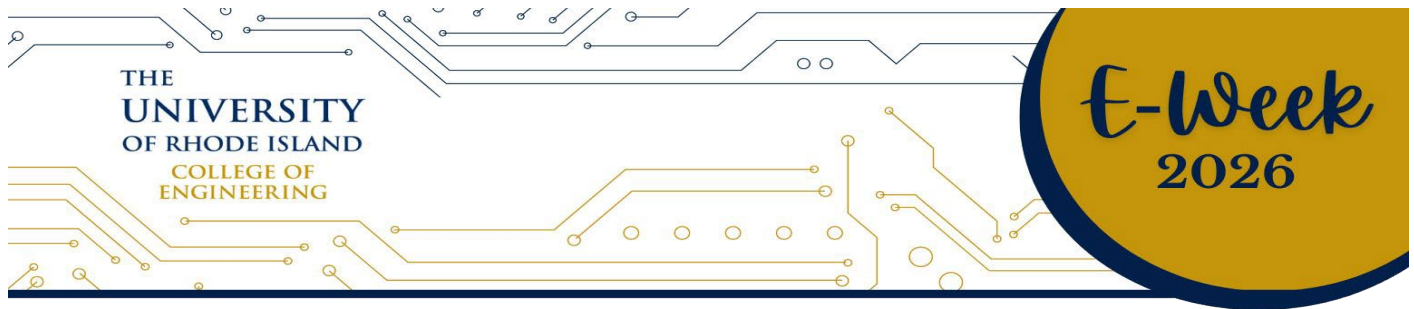
Think about any biological tissue, how complicated their structures are and how difficult it is to handle, transport and store them? So much, right? So how about we create a structure that looks and behaves and shows the properties of a biological tissue.

My name is Sabirul Khan Priyo. I am currently a Ph.D student under Ryan Poling-Skutvik and my research is about investigating the relationship between structure, dynamics, and mechanics in polymer-linked emulsions (PLEs). The emulsion we use is an oil-in-water emulsion where decanol is used as the dispersed phase and water as the continuous phase, where a network is formed with the help of a triblock copolymer named polydioctane norbornene–poly Jeffamine-norbornene – polydioctane norbornene. In this system, the long norbornene side chain works as the brush of this bottlebrush copolymer that we call POJO.

My current characterization work includes rheology, SAXS, and XPCS to quantify stress relaxation and slow collective dynamics. In our system we have used silica particles as tracers. We observed the dynamics of silica in our complex system and measured the relaxation of the particles to predict the complex network structure of our system.

Our next goal is to use Small Angle Neutron Scattering (SANS) in order to allow us to determine the conformation of polymer blocks, enabling direct quantification of network connectivity and chain conformation under different volume fractions and molecular weights.

Research supported by: RA, grant



17. Multiscale Evaluation of Adhesion in ABS/TPU Fused Interfaces

Presenter: *Jonathan Villada, PhD Graduate Student, Civil and Environmental Engineering*

Advisor: *Dr. Sumanta Das*

This work implements reactive forcefield molecular dynamics (MD) simulation to evaluate the mechanical performance of the fusion bond line formed between acrylonitrile butadiene styrene (ABS), and thermoplastic polyurethane (TPU). The simulated interfacial adhesion responses, as obtained from MD simulation, are further implemented as the interfacial properties between ABS and TPU in an upscaled cohesive zone-based finite element analysis (FEA) model for macroscopic response evaluation. Such upscaling enables fair comparison of the simulated macroscopic stress–strain response with experimental results obtained for 3D printed ABS/TPU hybrid samples with a fusion-bonded interface. Overall, the stress–strain response predicted from a FEA-based model shows a good correlation with the experimental data signifying good predictive efficacy of the simulation approach. Thus, by interactively linking the molecular structures of the polymers and the processing parameters with the macroscale interfacial adhesion response of the fusion bond line, the experimentally validated comprehensive approach presented in this paper paves the way for atomistic engineering of the molecular structures as well as efficient fine tuning of processing parameters to meet desired macro-scale performance needs besides enabling exploration of the mechanisms and atomistic origins of the interfacial damage at the fused bond line.

Research supported by: TA/401Tech Bridge

18. How AI Helps Design Stronger, Greener Concrete

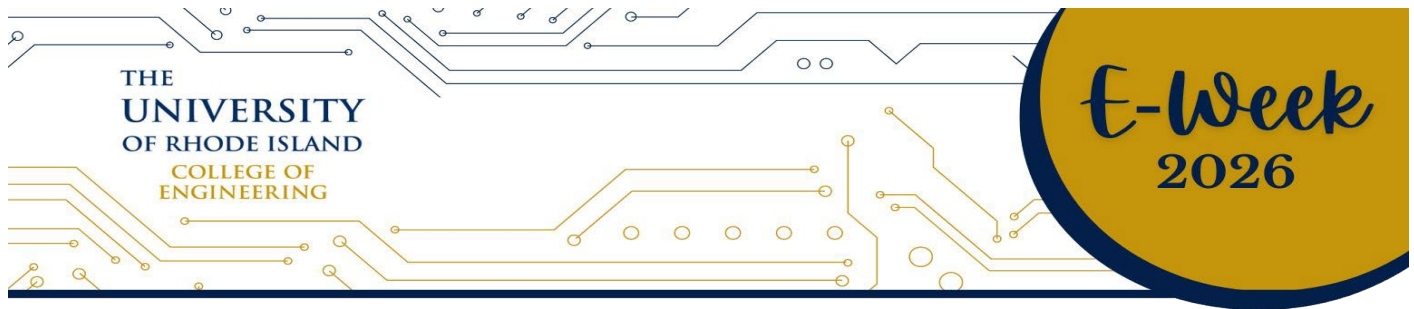
Presenter: *Nausad Miyan, PhD Graduate Student, Civil and Environmental Engineering*

Advisor: *Dr. Sumanta Das*

Designing stronger and greener alkali-activated concretes (AAC) is challenging due to limited experimental data and high variability in precursor compositions derived from industrial by-products. This study presents an AI-driven framework that learns the relationship between material composition and compressive strength to support more reliable concrete design. A small experimental dataset (188 samples) was expanded to 4,950 statistically consistent data points using generative adversarial networks (GANs). Transfer learning (TL) was then applied to improve prediction accuracy and generalization across different data domains. The proposed approach outperformed a conventional neural network, achieving high predictive accuracy ($R^2 > 0.94$) with stable performance and efficient model complexity. To make the model transparent and useful for design, SHapley Additive exPlanations (SHAP) were used to interpret how different input parameters influence strength. The analysis revealed curing time as the dominant factor, while variables such as NaOH content, silicate modulus, precursor composition, and aggregate proportions contributed through interaction effects. Overall, this AI-driven framework captures the composition–strength relationship in AAC and provides a practical tool for designing stronger, greener concrete with reduced experimental effort.

Research supported by: Fellowship

19. Mitigating Trailing Edge Failure in Wind Turbine Blades



Presenter: Manjeet Kumar Heeragowlikar, MS Graduate Student, Mechanical, Industrial and Systems Engineering
Advisor: Dr. Sumantha Das

Wind turbine blades are subjected to complex loading conditions during service, which can lead to different forms of structural damage and reduce their long-term reliability. Among these failure modes, trailing edge failure is one of the most critical because it directly affects blade durability, structural safety, and maintenance cost. This thesis investigates the structural response of a wind turbine blade with a specific focus on the trailing edge region, where damage is most likely to initiate and propagate.

A finite element model of the blade is developed in Abaqus and used to perform a large number of simulation cases under varying material input conditions. Material response data obtained from separate simulations is incorporated into the blade model to capture the influence of material behavior on the overall structural performance. For each simulation case, key outputs such as deformation, stress distribution, and failure-related parameters are extracted and analyzed. Particular attention is given to the Tsai–Wu failure criterion in order to identify critical failure zones and evaluate failure-sensitive behavior in the blade. Beyond finite element analysis, this work also establishes a structured simulation framework for generating a machine learning-ready dataset. By running multiple Abaqus jobs and extracting the results in a consistent format, the study creates a database that can be used for future data-driven modeling, failure prediction, and design assessment. In this way, the work connects material-level response with blade-level structural behavior and provides a foundation for integrating finite element simulation with machine learning techniques. The overall goal is to improve the understanding of trailing edge failure and contribute toward the design of more reliable, damage-resistant wind turbine blades.

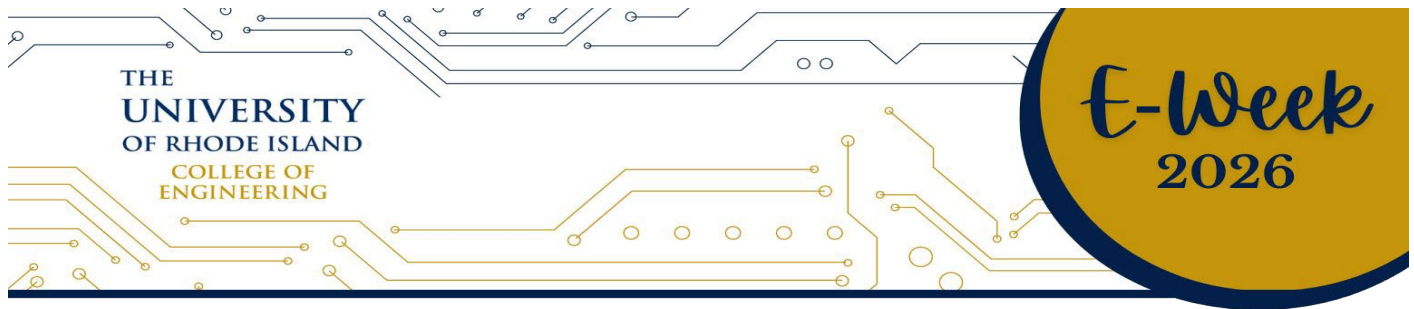
Research supported by: TA

20. Compressive Strength of 3D Printed Concrete: Role of Interlayer Bonding

Presenter: Timothy Borden, MS Graduate Student, Civil and Environmental Engineering
Advisor: Dr. Sumanta Das

This study investigates the influence of interlayer bonding on the compressive behavior of 3D printed concrete loaded perpendicular to the printing direction. The layer-by-layer extrusion process introduces anisotropy at interlayer interfaces, which can reduce structural performance compared to bulk concrete. A finite element modeling (FEM) approach was implemented in Abaqus to simulate and compare the response of 3D printed and homogeneous concrete specimens with identical geometry and material properties. The printed specimen was represented as a nine-layer system with cohesive zone interactions between layers, while the bulk specimen was modeled as a single homogeneous body. The nonlinear behavior of concrete was captured using the Concrete Damage Plasticity model. Simulations under displacement-controlled loading were used to evaluate stress distribution, damage evolution, and failure modes. Results indicate that interlayer bonding significantly governs compressive strength and failure behavior. Compared to bulk concrete, 3D printed specimens exhibited reduced strength and earlier damage initiation due to weak interlayer interfaces. These findings highlight the critical role of interlayer bonding and underscore the need for improved interface quality to enhance the structural performance of 3D printed concrete.

Research supported by:



21. Interpretable Machine Learning for Renewable Energy Forecasting

Presenter: Eleonora Massa, MS Graduate Student, Mechanical, Industrial and Systems Engineering
Advisor: Dr. Sumanta Das

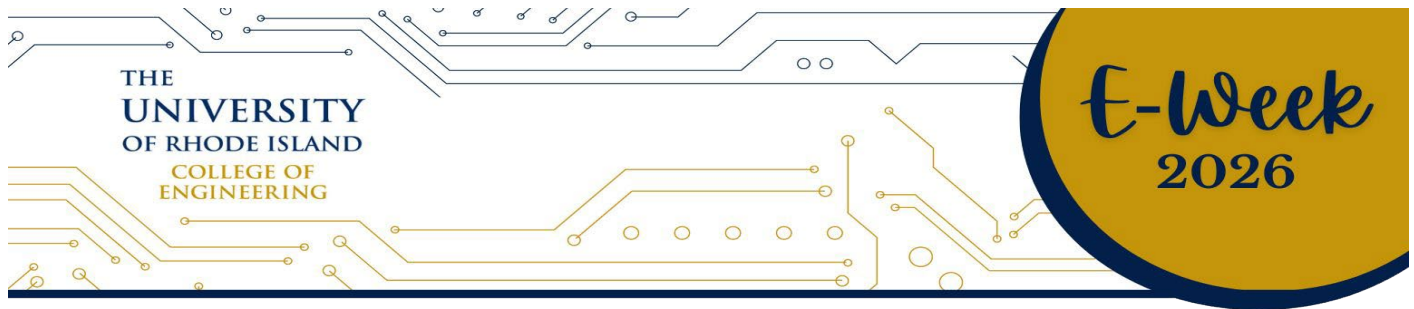
This study explores the use of machine learning (ML) to forecast solar and wind energy generation using meteorological and temporal data. Due to the inherent variability and intermittency of renewable energy sources, accurate prediction remains a significant challenge, emphasizing the need for robust data-driven approaches. A supervised learning framework was developed using key input variables, including irradiance, temperature, humidity, wind speed, and time-based features. A multilayer perceptron (MLP) neural network was implemented and systematically optimized through extensive hyperparameter tuning to improve predictive performance. Model accuracy was evaluated using Mean Squared Error (MSE) and the coefficient of determination (R^2). The optimized model demonstrated strong predictive capability, highlighting the critical role of hyperparameter tuning in capturing complex nonlinear relationships. To enhance model transparency, SHapley Additive exPlanations (SHAP) analysis was applied to identify the most influential input variables. The results provide insight into the key drivers of renewable energy generation and improve model interpretability. Overall, this work presents a structured and reproducible framework for accurate and interpretable ML-based forecasting of renewable energy.

22. Object-Guided Sequential Image Stitching Using YOLO and ORB Matching

Presenter: Xiangjun Meng, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering
Advisor: Dr. Paolo Stegagno

Abstract

This research presents an object-guided image stitching framework for the automated monitoring of spalling defects in bridge infrastructure. The proposed method addresses a key challenge in structural health monitoring [1]: capturing the spatial and temporal evolution of localized surface damage using sequential imagery. Traditional inspection methods often rely on manual documentation, which can be labor-intensive, inconsistent, and error-prone [2][3]. To overcome these limitations, we integrate object detection and feature-based matching to construct panoramic representations of structural surfaces over time. A deep learning model (YOLO11), enhanced with modules such as SPPF, C2PSA, and C3k, is trained on a dataset of 498 annotated high-resolution images to detect spalling regions across sequential frames. Within each detected region, ORB features are extracted and matched between consecutive images to estimate object-specific motion flow [4]. By accumulating the relative displacement of matched keypoints, the method aligns and stitches multiple frames into a single panoramic image. The model demonstrates strong performance in detection precision (86-90%) and matching concrete defects across multiple images. Unlike traditional keypoint-based approaches [5], our object-aware pipeline maintains high spatial accuracy in defect localization, even in the presence of illumination changes and texture variation. The resulting panoramas preserve structural detail and provide an intuitive visual summary of damage evolution. This work contributes a novel integration of deep learning and classical computer vision to the field of bridge infrastructure monitoring. For the academic community, it opens new pathways for vision-based structural assessment. For public infrastructure stakeholders, it provides a reliable and efficient tool to support data-driven maintenance strategies and enhance safety in the built environment.



Acknowledgements: Funding for this research is provided by the Transportation Infrastructure Durability Center at the University of Maine under grant 69A3551847101 from the U.S. Department of Transportation's University Transportation Centers Program.

References [1] Xu, W., Li, X., Ji, Y., Li, S. and Cui, C., 2024. BD-YOLOv8s: enhancing bridge defect detection with multidimensional attention and precision reconstruction. *Scientific Reports*, 14(1), p.18673. [2] Su, H., Kamanda, D.B., Han, T., Guo, C., Li, R., Liu, Z., Su, F. and Shang, L., 2024. Enhanced YOLO v3 for precise detection of apparent damage on bridges amidst complex backgrounds. *Scientific Reports*, 14(1), p.8627. [3] Li, T., Liu, G. and Tan, S., 2024. Superficial Defect Detection for Concrete Bridges Using YOLOv8 with Attention Mechanism and Deformation Convolution. *Applied Sciences*, 14(13), p.5497. [4] Mahjoubi, S., Barhemat, R., Guo, P., Meng, W. and Bao, Y., 2021. Prediction and multi-objective optimization of mechanical, economical, and environmental properties for strain-hardening cementitious composites (SHCC) based on automated machine learning and metaheuristic algorithms. *Journal of Cleaner Production*, 329, p.129665. [5] Guo, P., Meng, W. and Bao, Y., 2021. Automatic identification and quantification of dense microcracks in high-performance fiber-reinforced cementitious composites through deep learning-based computer vision. *Cement and Concrete Research*, 148, p.106532.

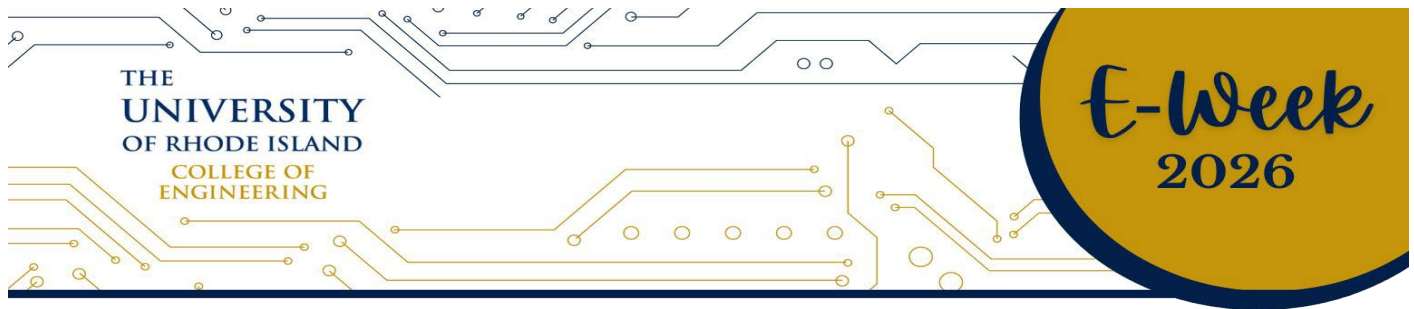
Research supported by: Transportation Infrastructure Durability Center at the University of Maine under grant 69A3551847101 from the U.S. Department of Transportation's University Transportation Centers Program

23. Rehabilitation of Degraded Concrete Structures via CFRP Confinement

Presenter: Owen Klusak, MS Graduate Student, Civil and Environmental Engineering

Advisor: Dr. Sumanta Das

The utilization of fiber-reinforced polymers as a structural strengthening method has become widely investigated, with many studies aiming to establish more sustainable methodologies. Due to the materials very high strength properties and low weight compared to a more commonly used material such as steel, these studies display great promise for real world engineering applications. This work specifically evaluates the implementation of carbon fiber-reinforced polymer wraps around simple concrete cylinders. A finite element analysis was performed on an unconfined concrete cylinder in order to receive a baseline compressive strength and strain capacity. The same concrete cylinder was then modeled additional times, each with an increasing number of layers of the CFRP wraps. The CFRP material properties utilized the Hashin damage criteria in order to predict the damage initiation. Results showed that as the number of CFRP layers increased, so did both the compressive strength and strain capacity. These observations show strong potential for CFRP encasement around concrete members as a structural strengthening method, effectively increasing strength while performing more efficiently than current structural strengthening methods.



24. Hardware-Accelerated Machine Learning (ML)-aided Electronic Design Automation (EDA) for Integrated Power Electronics Building Block (iPEBB)

***Presenter: Sooran Pack, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering
Advisor: Dr. Yeonho Jeong***

Electronic design automation (EDA) tools are promising for achieving fast and high-performance design in various power electronics applications, especially in circuit simulation of complex systems, such as the integrated power electronics building block (iPEBB). The discrete-time ideal model has been widely used in power electronics, particularly within digital platforms, including circuit simulation. However, this simplicity in simulation often results in reduced accuracy, leading to non-optimal design parameters and degraded design performance. While incorporating complex component or switching models can improve simulation accuracy, it also significantly increases simulation time, which is a critical consideration in EDA tools. To address these issues, this project focuses on developing an ideal model to capture the nonlinear characteristics of the components while maintaining the computational burden.

Research supported by: Office of Naval Research (ONR)

25. Novel Power Conversion System and Power Management Control for Water Monitoring Stations

***Presenter: Sooran Pack, PhD Graduate Student, Electrical, Computer, and Biomedical Engineering
Advisor: Dr. Yeonho Jeong***

This research is focusing on design a novel integrated three-switch hybrid converter for water monitoring systems (WMSs), generally consisting of a photovoltaic (PV) and battery. In such applications, both the PV and battery voltages vary widely due to unpredictable and varying environmental conditions. Moreover, the system mostly operates in light-load conditions, supplying only low-power consumption water quality sensors or non-frequently operating parts, such as communication modules and data acquisition systems. To achieve high efficiency in light-load conditions, conventional converters operate in low switching frequencies, resulting in limited power density and bulky passive components. To address these limitations, a three-switch-based integrated topology is proposed to achieve high efficiency through optimized switching loss design, while covering the wide input voltage range requirements. Proper operational modes for WMSs are selected, along with an optimal inductor design guidance to ensure soft-switching of all switches, thereby reducing switching losses while ensuring high-frequency operation for smaller passive components.

Research supported by: USGS