Student Research Internships and Apprenticeships

Summer 2023

HEMI

HOPKINS EXTREME MATERIALS INSTITUTE

From the Interim HEMI Director

The Hopkins Extreme Materials Institute has grown and evolved significantly since it began in 2012, but the institute's core values remain indelible. HEMI's commitment to education and mentorship are foundational to its mission to advance the fundamental science associated with materials and structures under extreme conditions and demonstrating extreme performance.

Each year, HEMI opens its doors to emerging scientists, artists, leaders, and innovators from around the globe. Our interns and apprentices are as diverse in their interests as they are in their backgrounds; they have integrated their enthusiasm for geology, mycology, sculpture, language, and various other fields into their study and interpretation of HEMI's research. Their passion, creativity, and willingness to learn make me truly optimistic for the next generation of scientists and artists, and it is my pleasure to present this year's class of interns and apprentices. The research summaries in this booklet are written entirely by the students, showcasing not only their aptitude for research but their ability to translate the advanced scientific concepts they study.

HEMI would like to acknowledge the following organizations for making these opportunities possible: the Army Educational Outreach Program, the Defense Threat Reduction Agency, the U.S. Military Academy at West Point, U.S. Army Combat Capabilities Development Command Army Research Laboratory (DEVCOM ARL), Morgan State University, the Maryland Institute College of Art, the National Aeronautics and Space Administration (NASA), and the Whiting School of Engineering at Johns Hopkins University. I would also like to express sincere gratitude and admiration for the faculty hosts, mentors, and administrative personnel who have facilitated these internship experiences for our program participants.

Sincerely,

Jaafar El-Awady
Interim Director of the Hopkins Extreme Materials Institute
Professor of Mechanical Engineering

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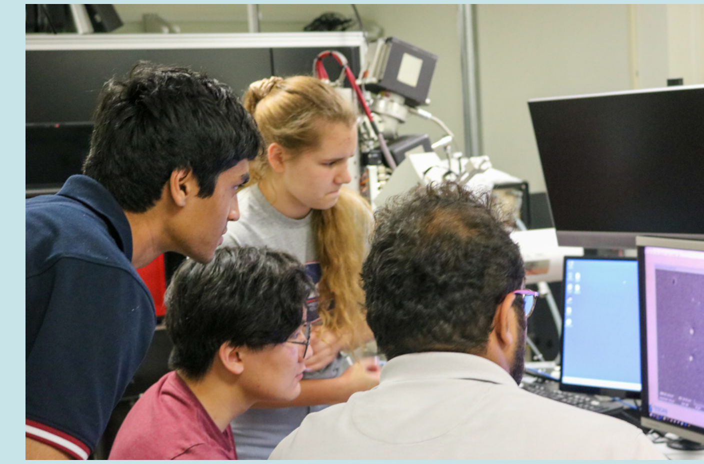
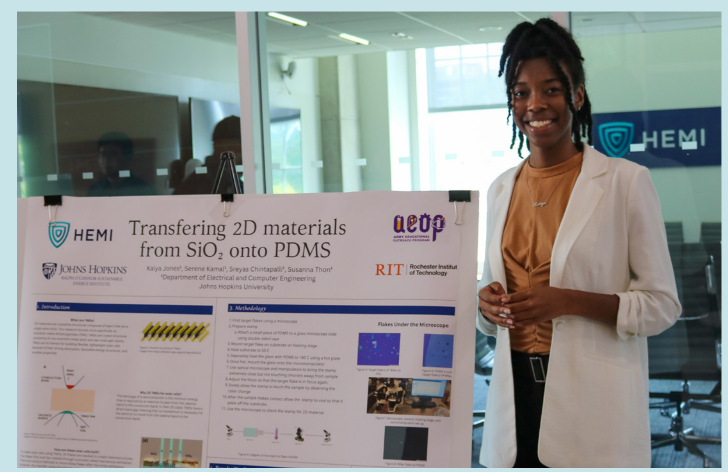
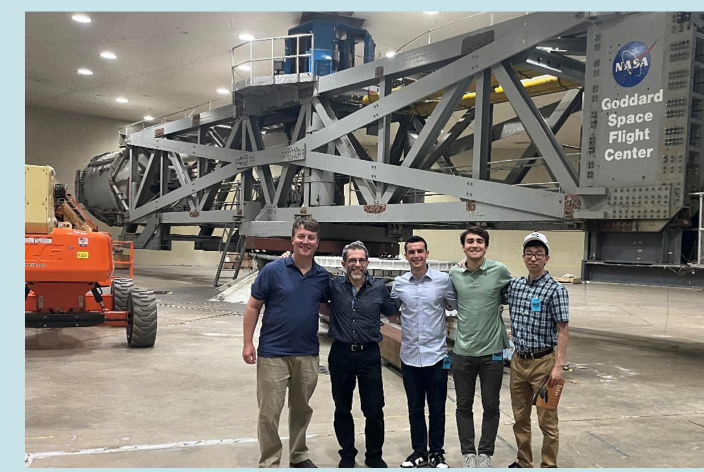
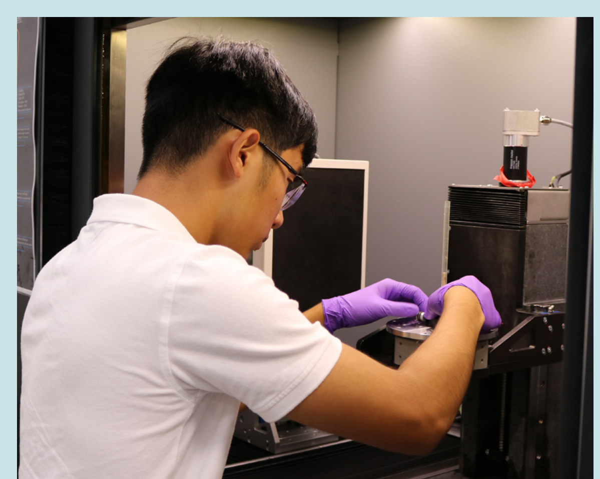


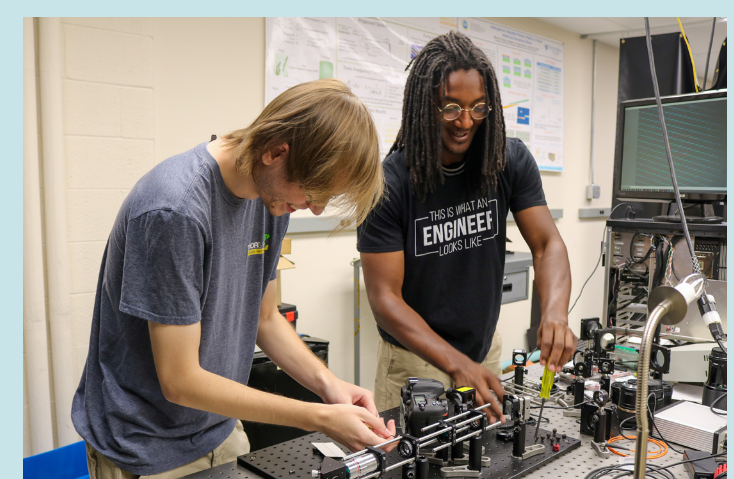
The HEMI Internship Experience

Every internship is different. Internship programs are as unique as the students participating in them, but one common thread is extracurricular engagement. Students often engage with their research beyond the walls of classrooms and labs. This summer, HEMI interns took part in poster sessions, short courses, workshops, tours, and technical presentations, joining peers from other schools and programs in networking and professional development activities.









Army Educational Outreach Program (AEOP) High School Apprenticeship

The AEOP High School Apprenticeship is a summer STEM program that places talented Maryland high school students in research apprenticeships at Johns Hopkins University. Apprentices work under the direct supervision of a mentor on a hands-on research project, gaining valuable mentorship and real-world research experience. AEOP High School Apprenticeships are 5–8 weeks in length (minimum of 200 hours) and apprentices receive a stipend.

Program Goals

- To provide high school students from groups historically underrepresented and underserved in STEM, including alumni of the AEOP's UNITE program, with an authentic science and engineering research experience;
- To introduce students to the Army's interest in science and engineering research and the associated opportunities offered through the AEOP;
- To provide participants with mentorship from a scientist or engineer for professional and academic development purposes; and
- To develop participants' skills to prepare them for competitive entry into science and engineering undergraduate programs.

2023 Participants *shown above from left to right*
Kaiya Jones, **Radhati Srisukwattananan**, **Karthik Muthukkumar**, and **Joanne Li**

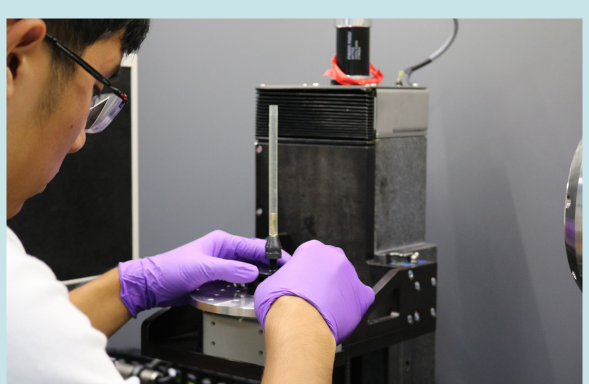
Funding Sponsor:

Army Educational Outreach Program

Program Coordinator:

Dr. Laszlo Kecskes

Website: *https://www.usaeop.com/program/high-school-apprenticeships/*



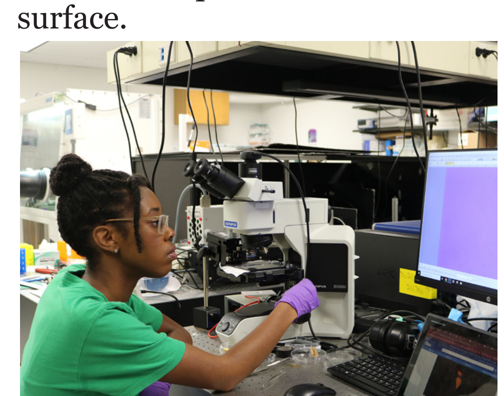
"Becoming familiar with benchwork now while I am in high school will help me immensely in college. I am very grateful for the opportunity." — Kaiya Jones

Kaiya Jones

Long Reach High School, Columbia, MD
Mentor: Serene Kamal
Faculty Host: Prof. Susanna Thon
Department of Electrical and Computer Engineering
Johns Hopkins University
Project Title: Transferring 2D materials from SiO2 onto PDMS for Solar Cell Application

The qualities of 2-dimensional transition metal dichalcogenides (TMDs) have been explored for the application of solar cells. 2D materials are crystalline structures composed of layers that are a single atom thick. TMDs are crystal structures consisting of one transition metal atom and two chalcogen atoms. They are also classified as semiconductors. TMDs are of interest for building flexible, lightweight solar cells because of their strong absorption, favorable energy structures, and tunable properties.

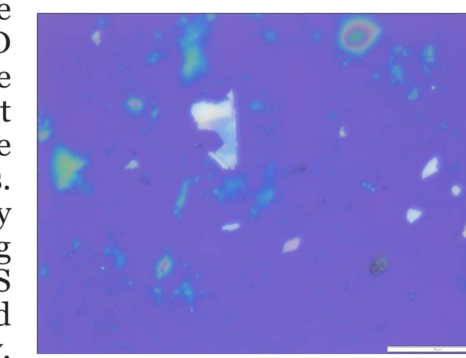
To make solar cells using TMDs, 2D flakes are stacked to create heterostructures. First mechanical exfoliation turns bulk crystals into few layer flakes. These flakes then are moved. There are various methods to move these flakes however, dry transfer using polydimethylsiloxane (PDMS) is the most efficient. PDMS is a silicone polymer that when heated becomes sticky which can be used to pick up flakes. Once the PDMS is cooled down, it will release the flake for deposition on another surface.

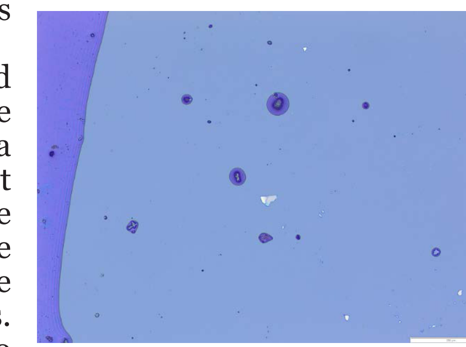


This research focuses on finding an effective and replicable method of transferring 2D TMD flakes from a SiO2 substrate onto PDMS in order to deposit the flakes onto another substrate for use in optoelectronic devices. The general process began by identifying the target flake using an optical microscope. The PDMS stamp was then prepared and heated to 180 C. Simultaneously, the SiO2 with the target flake was heated to 50 C.

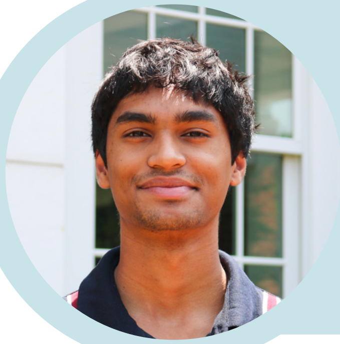
When all the materials reached their desired temperature, the stamp was mounted onto a micromanipulator and brought microns away from the surface of the substrate. The microscope focus was adjusted to bring the target flake back into focus. Slowly, the stamp was made to contact the target flake. After contact was made, the stamp was left to cool and then slowly lifted from the substrate. The stamp was then observed using the microscope for 2D material.

So far, this method has been effective for transferring smaller flakes (< 10 microns). The transfer method is not yet 100% repeatable, so future work could focus on changing the mechanism of transfer and explore the possibilities of polypropylene carbonate (PPC) coated PDMS stamps and stamps made of viscoelastic material.





Top: Target flake 1 of WSe_2 on SiO_2
Middle: PDMS in contact with target flake 2 of WSe_2 on SiO_2
Bottom: WSe_2 flake on PDMS
Left: Jones identifies flakes of interest using an optical microscope



Karthik Muthukkumar

Urbana High School, Frederick, MD
Mentor: Sreenivas Raguraman
Faculty Host: Prof. Timothy Weihs
Department of Materials Science and Engineering
Johns Hopkins University
Project Title: Advancing Biomedical Implants: Impact of Processing on the Structure-Property Relationship of the ZX10 Magnesium Alloy

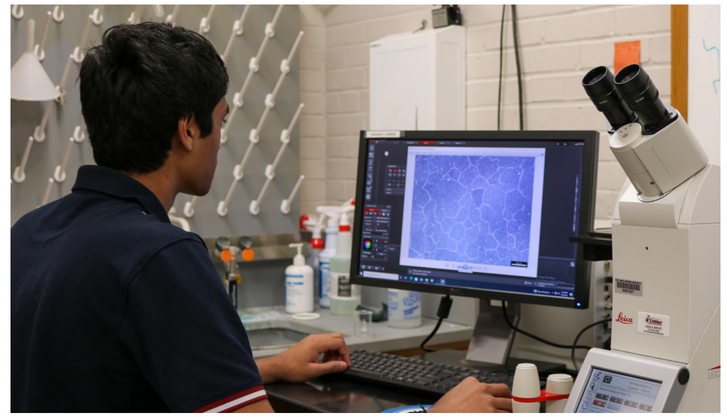
In the last decade, researchers have focused on developing biodegradable metallic implants such as nails, screws, stents, and sutures.

Magnesium (Mg) alloys have emerged as promising biomaterials for temporary biomedical implants due to their advantageous mechanical properties, inherent biocompatibility, and natural biodegradability. Most predominantly in orthopedic implants, the use of Mg alloys can prevent complications such as stress shielding and a second surgery as well as promote osteo-induction due to the density and Young's Modulus similarities to bone.

However, some limitations of these Mg alloys include their high corrosion rate and subpar fatigue properties. Thus, it is critical to determine methods to improve these less desirable properties as the rapid deterioration of magnesium alloys leads to loss of mechanical integrity and hydrogen evolution, resulting in constrained use.

In this study, we explore ZX10 Mg alloy, a high-strength low-alloy material, consisting of trace quantities of Zn and Ca. The influence of orientation pre and post cold rolling on the microstructure, mechanical, and biocorrosion behavior were investigated in this study using a wide range of techniques including X-ray diffractometry (XRD), and Optical Microscopy.

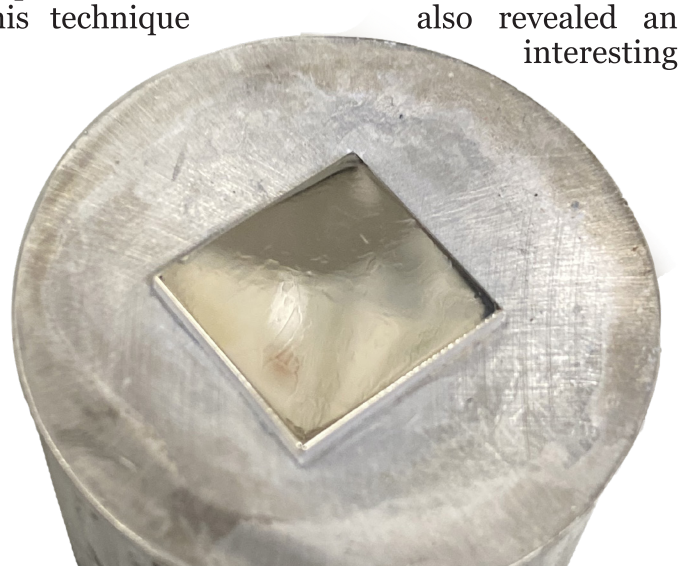
XRD analysis revealed the textural changes upon cold-rolling and orientation changes impacted the corrosion behavior. Furthermore, this technique also revealed an interesting



correlation between the peak ratios of prismatic plane to basal plane to corrosion behavior. The ratios close to 1 exhibited high corrosion rates due to the galvanic effect between the prismatic and basal planes. Texture seemed to have minimal effect on the hardness. Significant grain refinement was observed post-rolling, leading to higher hardness due to Hall-Petch hardening. It was also observed that dislocation density and texture may drastically affect corrosion behavior due to higher corrosion rates being discovered post-rolling.

This investigation provides valuable insights into understanding processing-structure-property relationships for Mg alloys, paving the way for developing superior biodegradable implant materials.

Muthukkumar studied samples of magnesium alloys (like the ones below) using XRD and optical microscopy.



"This apprenticeship has been a wonderful experience to develop my professionalism. I was able to apply my programming and physics knowledge to a real-world project. Throughout the process, there were several frustrating times when troubleshooting, but it was very satisfying once I finished the final algorithm. My mentor and the other HEMI members provided a welcoming and supportive environment for me to learn. In the future, I look forward to attending college and finding my passions."
— Joanne Li

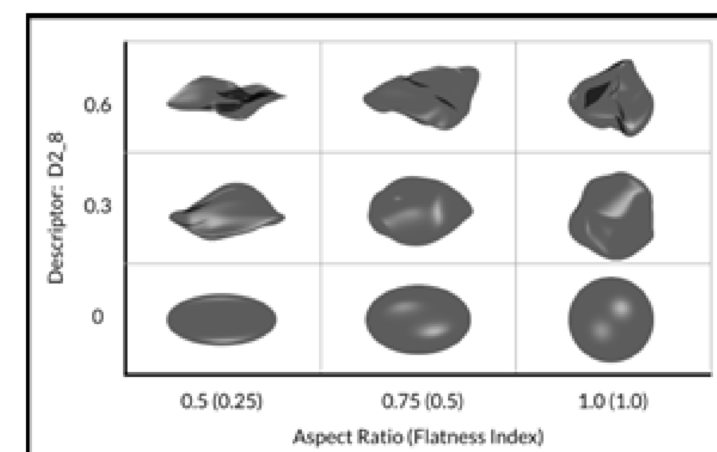
Joanne Li

Thomas S. Wootton High School, Rockville, MD
Mentor: Sohanjit Ghosh
Faculty Host: Prof. Ryan Hurley
Department of Mechanical Engineering
Johns Hopkins University
Project Title: A spherical harmonics approach to model deformation during rapid compaction in granular materials

The shape of particles affects the macroscopic response of granular materials in geology and planetary science. For instance, shape can influence stiffness and resistance to flow during slow or rapid impact events (e.g., asteroid impacts). This phenomenon motivates the development of a method to predict the evolution of particle shapes during impact events. Our ultimate goal is to use 2D X-ray radiographs (e.g., X-ray images you would see at the doctor's office) of a rapidly impacted granular material and determine each particle's 3D form change.

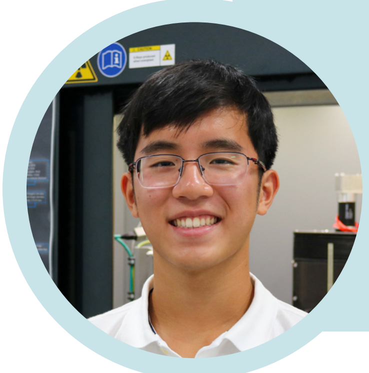
In this work, we approach this problem by first building an algorithm to quantify shapes. The program takes an X-ray tomography image (a 3D image) of a particle and measures its elongation index (EI), flatness index (FI), sphericity, convexity, and curvature. We can then generate an arbitrary particle using these rotation-invariant parameters and a spherical harmonics-based mathematical formula.

From these shapes, synthetic 3D images and radiographs can be exported for visualization. These quantities are insufficient to constrain a particle's shape in 3D, but we will work towards an optimisation technique to specify its features deterministically.



The aspect ratio is the mean of the elongation and flatness indexes. The descriptor is the inverse of the spherical harmonic degree between 2 and 8. The angularity and arbitrary factor increase with D2_8.

“With my experience in Micro-CT and exposure to the different manufacturing and characterization capabilities at Hopkins, I plan on applying this knowledge to future research projects.” — Radhati Srisukwattananan



Radhati Srisukwattananan

Science and Mathematics Academy, Aberdeen High School
Mentor: Jesse Grant
Faculty Host: Prof. Timothy Weihs
Department Department
Johns Hopkins University
Project Title: Micro-Computed Tomography Analysis of Swaged Aluminum Zirconium Reactive Materials

Aluminum-zirconium reactive materials are at the forefront of chemical and biological agent defeat, sought for their ability to ignite easily, combust efficiently, deliver heat effectively, and produce oxide materials consistently, overall improving the defeat process. The capability to produce structural components comprised of reactive material enables the development of enhanced agent defeat solutions.

Our structural reactive material is formed through swaging a composite jacketing material containing reactive material powder. The reactive material is produced by ball milling precursor elemental powders including Al, Mg, Zr, Ta, and W. During the swaging process, the powder material is consolidated into a dense core while the metallic jacket is formed simultaneously. This process results in a fully dense composite structural reactive material.

The goal is to measure the chemical and kinetic energy delivered during an impact event when samples are accelerated within a rifled barrel. During early testing, several failures were experienced throughout the launch process which necessitated the evaluation of the internal structure and physical properties of the samples to understand the root cause.

Microstructure characterization of the reactive core is vital in ensuring not only the survivability of the sample during testing but also in determining its effectiveness at its primary function of agent defeat. We determined inner sample morphology by implementing micro-computed tomography (micro-CT) imaging, in combination with the development of image analysis algorithms using Python and OpenCV. Micro-CT analysis is a valuable technique to uncover physical properties, density variation, and internal structure, within micron-level precision.

We used image-processing algorithms for digital metrology of the internal structure to evaluate several parameters including sample diameter, jacket thickness, core diameter, and center of mass. Using these measurements combined with known physical constants such as mass and jacket density, we further determined the reactive core volume and density and identified root causes of sample failures. With a more complete understanding of the properties of the samples, we can determine the chemical energy delivered during impact, and assess the mechanical properties of samples with variations in chemical composition, jacketing material, degree of swaging, and milling parameters.

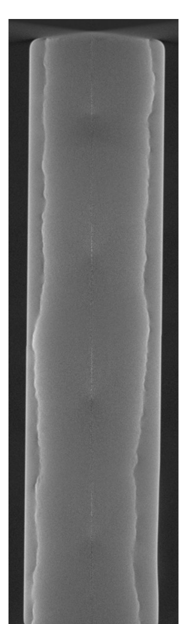


Image-processing algorithms like the one Srisukwattananan worked on help researchers use the information they collect from micro-CT to identify some of the causes of sample failure. A sample and various imaging results are shown at left.

The Nuclear Science and Engineering Research Center (NSERC) Summer Internship

In partnership with the Nuclear Science and Engineering Research Center (NSERC) and the Defense Threat Reduction Agency (DTRA), researchers in HEMI’s Materials Science in Extreme Environments University Research Alliance (MSEE URA) hosted interns at two participating universities. ROTC cadets supported research efforts aligned with DTRA’s mission, while simultaneously exposing the cadets to new research opportunities and career paths.

2023 Participants

CDT Evelyn Ayers, CDT Trevor Sumlin

Funding Sponsor

Defense Threat Reduction Agency

Website https://www.westpoint.edu/centers-and-research/nuclear-science-and-engineering-research-center/

“This experience was seemingly a culmination of all of my engineering knowledge thus far. ... The research conducted during this internship broadened my perspective of possible career fields. I am happy to have spent my time working to develop a meaningful and impactful project through an organization actively working to better the world.” — CDT Evelyn Ayers

CDT Evelyn Ayers

Georgia Institute of Technology
Faculty Host: Prof. Edward Dreizin
New Jersey Institute of Technology
Project Title: Gas Generating Reactive Materials

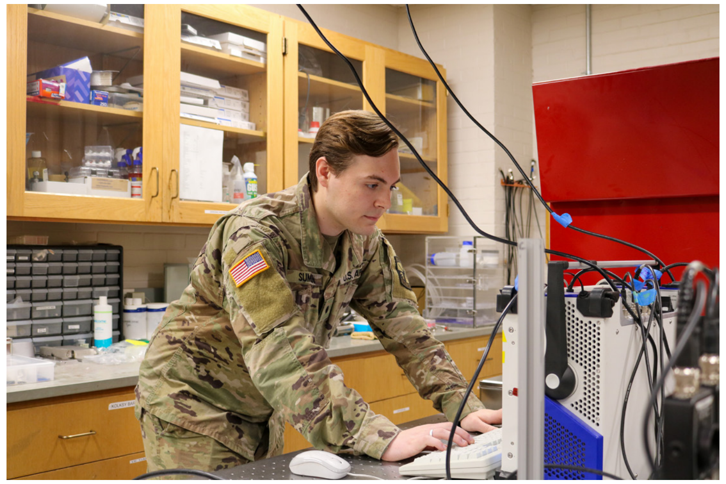
The presence and threat of chemical warfare is ever-present in the evolving landscape of global relations. In order to combat this threat in the most effective and safe manner, a new solution must arise. This was the focus of the research project Gas Generating Reactive Materials, hosted at New Jersey Institute of Technology through Defense Threat Reduction Agency (DTRA). The concept being researched was a way to neutralize a potential stockpile of chemical warheads containing nerve agents capable of ending human life. A liner consisting of compounds that would make the dangerous chemicals obsolete lies on the outside of an explosive charge, and once the charge detonates, the compounds would spread and neutralize the stockpile area.

This was modelled using a pressure chamber containing surrogate nerve agent housed above disc shaped cartridges filled with the neutralizing liner and reactive compounds, such as thermite. While the research was in the beginning stages, thus not using the surrogate material or liner, the model remained approximately the same. To proceed, a repeatable method maintaining approximately the same values of pressure, ignition charge, and explosion is being obtained. Regardless of the stage the study is undergoing, it remains a necessary and important topic to pursue.

"I enjoyed seeing all the collaboration between academic departments, agencies, and lab groups, as well as the state-of-the-art facilities here at Hopkins. I was particularly impressed by the HyFIRE and AXIOM devices, and the Materials Characterization and Processing Facility as well. The combination of world-class researchers and cutting-edge technology made the work environment unparalleled for a scientist-in-training, and the experience has been extremely valuable." — CDT Trevor Sumlin

CDT Trevor Sumlin

University of North Carolina Chapel Hill
Mentors: Kevin Hom and Brett Kuwik
Faculty Hosts: Prof. Todd Hufnagel, Materials Science & Engineering
Prof. Ryan Hurley, Mechanical Engineering
Johns Hopkins University
Project Title: Characterization and mechanical behavior of porous and competent geomaterials



The focus of this internship is to understand the dynamic response of geomaterials under high strain rate loading conditions. During my time here, I first learned the fundamentals of high strain rate loading of materials and experimental techniques by attending the Impact Research Workshop and Short Course. Hosted by the Materials Science in Extreme Environments University Research Alliance (MSEE URA) and the Hopkins Extreme Materials Institute (HEMI), this workshop brought together experts from academia, national and defense laboratories, and industry to demonstrate cutting-edge techniques and methods to observe and analyze the effects of the impacts on materials.

I used HyFIRE, a two-stage light gas gun in the HEMI lab, to perform a hypervelocity impact test with a 3mm steel sphere on a block of sandstone at 1.5km/sec. I examined the microstructure of geomaterials using computed tomography (CT) imaging with the Advanced X-ray Imaging of Materials (AXIOM) device. Using the AXIOM, I imaged many samples of basalt and granite. To analyze these data, I investigated how 3D images can be reconstructed from 2D X-ray images and helped write a Python script to automate this process.

In addition to CT imaging, I also did a post-mortem analysis of the sandstone sample impacted inside of HyFIRE. From the post-mortem analysis, I analyzed the volume and dimensions of the crater left by the projectile, which provides insight into how the material responds under loading. Finally, I assisted with Kolsky-bar experiments to test the dynamic stress-strain response of geomaterials. This work is funded by the Defense Threat Reduction Agency (DTRA), and has many applications in the defense industry. For example, these data could be used to inform computer models to assist in the construction of hardened bunkers or to analyze the penetration ability of weapons.

During his internship, CDT Sumlin was able to use world-class facilities and attend events like the Impact Research Workshop and Short Course, allowing him to explore new research techniques, network with other scientists, and build upon his existing research skills.

Extreme Science Internships (ESI)

ESI provides opportunities for Morgan State University (MSU) students to participate in both internal and external internships associated with the Materials Science in Extreme Environments University Research Alliance (MSEE URA). These internships are STEM-focused with a particular emphasis on research efforts aligned with objectives of the Defense Threat Reduction Agency.

Program Benefits

- Opportunities for undergraduate/graduate students to gain research experience and present their findings;
- Opportunities for students to meet colleagues at majority institutions and develop research collaborations;
- Engage representatives from majority academic institutions to explore opportunities to pursue graduate degrees; and
- Expand their professional networks and further position students for future job opportunities.

Funding Sponsor

Defense Threat Reduction Agency

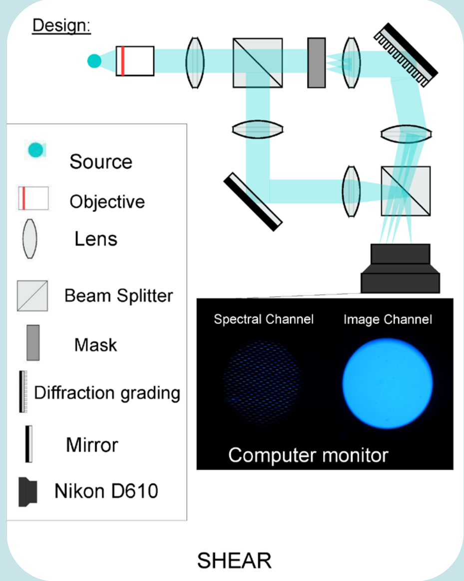
2023 Participants

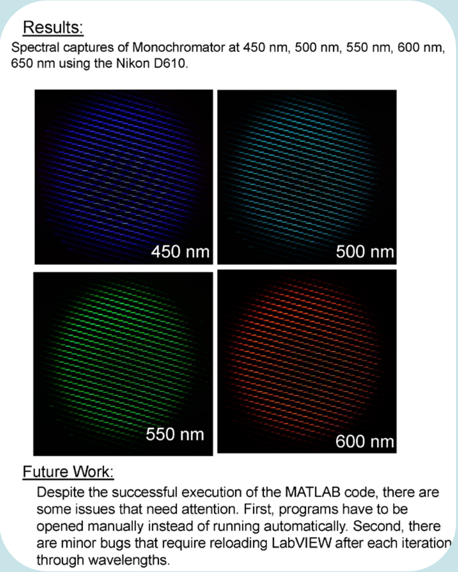
Alexander Aybar, Saad Nadeem

Alexander Aybar

Morgan State University
Faculty Host: Prof. Mark Foster
Department of Electrical and Computer Engineering
Johns Hopkins University
Mentor: Colin Goodman
Project Title: Automating the calibration of the Snapshot Hyperspectral Imaging System (SHEAR)

BACKGROUND: The research team has successfully developed an innovative hyperspectral imaging system named SHEAR. This cutting-edge system incorporates a high-speed camera capable of simultaneously capturing a standard image alongside a split spectrum image. This unique feature allows for the extraction of the scene's spectral response without the need for a conventional imaging spectrometer. Leveraging sophisticated image registration and reconstruction techniques, the system adeptly disentangles overlapping spectra from multiple burning particles, especially during combustion experiments. With its exceptional capability to operate at an exceptionally high frame rate, SHEAR proves to be highly suitable for various high-speed imaging applications.





ABSTRACT: The Snapshot Hyperspectral Imager for emissions and reactions (SHEAR) employed in the laboratory combines multiple devices for optics experimentation. Calibration of various parameters between the optical source and data acquisition equipment is crucial to ensure accurate data retrieval. Precise timing is imperative for this setup and is achieved through automation, facilitated by proficient computer programming skills for effective inter-device communication. The system incorporates a monochromator and Nikon D610 camera, enabling the projection of light at diverse wavelengths and capturing light within the visible spectrum. Control of the monochromator is managed through LabVIEW, while the Nikon D610 is governed by the Digicamcontrol program. MATLAB serves as the intermediary to enable seamless communication between the devices, thereby facilitating the automation of data acquisition sequences.

VƒOx: Venus Oxygen Fugacity Student Collaboration Experiment

Venus Oxygen Fugacity (VƒOx) is a Student Collaboration Experiment (SCE) component of NASA's DAVINCI (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging) mission. VƒOx interns contribute to DAVINCI by creating a sensor that will measure oxygen in the lowest part of Venus' atmosphere. The VƒOx program aims to train young engineers and scientists, particularly those interested in planetary science and engineering. The VƒOx academic program will begin its first course in the Spring 2024 semester.

Funding Sponsor

National Aeronautics and Space Administration (NASA)

2023 Participants

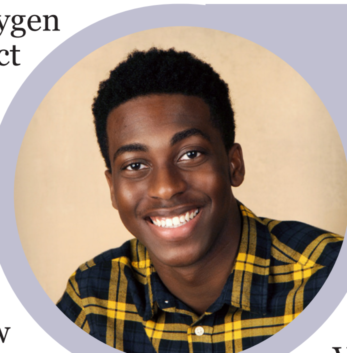
Andrew Ahn, **Sam Cohen**, **Kyle Dalrymple**, Rachel Fox, **Jacob Hammond**, Chris Hwang, Milla Ivanova, Sophia Phelan

Program Faculty

Prof. Sarah Hörst, Dept. of Earth & Planetary Sci.
Dr. Noam Izenberg, JHU APL
Prof. David Kraemer, Dept. of Mechanical Engr.

Website https://ssed.gsfc.nasa.gov/davinci/

"Over the summer, I augmented my knowledge about testing apparatus, including the complexity of selecting materials and operating conditions for aerospace missions. I was able to interact and engage in meaningful back and forth conversations with industry professionals regarding what is ideal and what is ultimately feasible. This experience only reinforced that I want to pursue a career in space exploration and development and that I enjoy effectively straddling both the science and the engineering missions and the interplay between them to achieve a better overall mission." — Kyle Dalrymple



Kyle Dalrymple

3rd year undergraduate
Department of Mechanical Engineering
Whiting School of Engineering
Johns Hopkins University

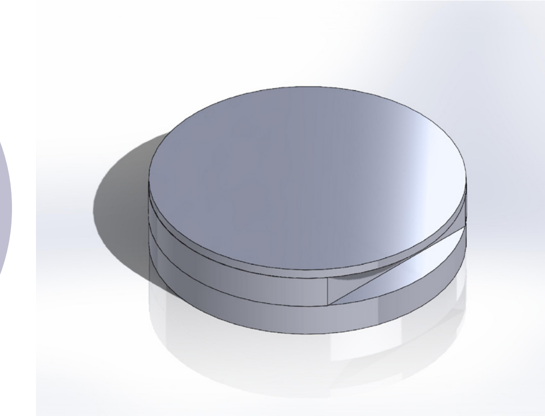
The primary objective of the Venus Oxygen Fugacity (VfOx) student collaboration project is to design and build a button-sized sensor capable of measuring the partial pressure of oxygen upon descent through Venus's atmosphere that will go aboard NASA's DAVINCI mission. VfOx itself contains multiple projects ranging from scientific analysis of past experiments to building the sensor and testing apparatus to understanding how best to garner support and drum up interest through outreach.

Over the summer I had the pleasure of working as a lead on two projects, Project 2 and Project 4. The goal of Project 2, the Glenn Extreme Environment Rig (GEER) Analysis, was to use material, environmental, and data science principles to firstly, understand how the voltage measurement of the sensor varied with the varying of oxygen containing molecules and secondly, to use model fitting and statistical analysis in Python to see what conclusions can be taken away from GEER to optimize the design of VfOx's sensor.

The goal of Project 4, Johns Hopkins Venus Environment Chamber (JVEC) was to solidify the specifications for a chamber, modeled after the APL Venus Experimental Chamber (AVEC), that simulates Venus's atmosphere that could be housed on the Johns Hopkins University (JHU) Homewood Campus. I worked closely with vendors such as Parr and Parker Autoclave/ Miller Energy to refine quotes based on science objectives, engineering constraints, and cost feasibility.

Jacob Hammond

3rd year undergraduate
Department of Mechanical Engineering
Whiting School of Engineering
Johns Hopkins University



I began the project this summer by reading papers and background materials regarding the lower atmosphere of Venus, ceramic oxygen sensors, and VfOx as it relates to the DAVINCI mission. This reading was independent to develop a technical and scientific background of the project.

I then became involved in the prototype construction of the sensor and worked with another intern to create CAD models of the sensor using SOLIDWORKS. The sensor design was essentially unchanged from the previous prototype, but the diameter was decreased from 10 mm to 8 mm. After the materials for the sensor had been procured, we communicated with a technician at APL to begin printing the electrode pattern and constructing the sensor. However, because there was a delay in material procurement and we could not use the equipment at APL, we could not construct a sensor prototype this summer or conduct any testing on prototypes.

Because several roadblocks prevented us from constructing prototypes, I shifted focus within the project. I helped another intern develop a top-level schedule, requirements, and risks for the project related to the DAVINCI mission so that VfOx does not harm the descent sphere or jeopardize the mission's success. At the end of the summer, another intern and I presented this work to 18 NASA Goddard engineers and scientists, who gave us important feedback on our work that students can implement in future semesters.

Finally, I worked with other interns to create an online presence for the VfOx student collaboration to get JHU students interested and engaged in this project. We discussed the potential to have an online presence on the JHU website domain and social media platforms such as Instagram and LinkedIn. In addition, we considered Campus Groups as a viable option to expose the JHU student body to the VfOx project. Although we could not publish anything live online, we created content that can be displayed on websites once we receive permission from NASA Goddard to post information regarding the project.

Sam Cohen

3rd year undergraduate
Department of Mechanical Engineering
Whiting School of Engineering
Johns Hopkins University

The project is a student collaboration between JHU and NASA Goddard Space Flight Center. The DAVINCI (Deep Atmosphere Venus Investigation of Noble gases, Chemistry, and Imaging) project is a NASA mission that's goal is to gain a deeper insight into Venus's atmosphere. Using this data, NASA hopes to gain a greater understanding of Venus and its history. The spacecraft will orbit Venus for two years using different imaging devices, and then drop a descent probe with various instruments, each testing something different in Venus's deeper atmosphere. Among those instruments is VfOx, an oxygen sensor with about half the diameter of a dime.

The student collaboration involved many different sub-projects, including prototyping, data analysis of previous tests, chamber testing, and web outreach. The prototyping project involved CAD modeling and making visits to the APL (Applied Physics Lab) in order to print the prototypes, as well as making certain design changes along the way. The data analysis was based off a previous test done, which needed to be analyzed so that the necessary changes could be made for the new test chamber. Finally, VfOx would eventually like to have an online presence and outreach website detailing the progress and goal of the project. Through the entirety of the project it is also important to make sure that everything that is done coincides with NASA's requirements for the mission so as to not endanger the greater mission.

HEMI/MICA Extreme Arts Summer Program

Extreme Arts is a joint program between HEMI at Johns Hopkins University and the Maryland Institute College of Art (MICA). The program brings faculty and students from both institutions together to explore unique perspectives on extreme events. The program aims to encourage collaboration among artists and researchers to examine data, interpret outcomes, and translate results from extreme events in new ways. It is our hope that this dialog will create a stronger community through a shared sense of curiosity and exploration.

The Extreme Arts Summer Program provides an opportunity for MICA students to spend a summer within HEMI. Students receive a stipend during the internship, which is co-advised by MICA and HEMI faculty members.

Program Goals

- To provide an opportunity for meaningful engagement among engineers, scientists, artists, and designers that sparks a creative dialog and leads to new outcomes;
- To explore systems of communication that translate ideas and provide platforms for engineers, scientists, artists, and designers to discuss concepts and develop a common understanding;
- To create programming between JHU researchers and MICA faculty/students that examine new approaches to HEMI-related materials research and data visualization; and
- To design a framework that serves as a model for sustained, long-term partnership between JHU and MICA.

2023 Participants
Shan Deng
Mantis Harper-Blanco
Lianghong Ke

Funding Sponsors:

The Maryland Institute College of Art (MICA) and the Whiting School of Engineering at JHU

Website: *https://hemi.jhu.edu/academic-programs/hemimica-extreme-arts-program/*

Mycelium Material Characterization and Application
by Mantis Harper-Blanco

Maryland Institute College of Art
HEMI Faculty Host: Dr. Kenneth Livi
MICA Mentor: Giulia Livi

By carefully nurturing oyster and reishi mushrooms, sculpture artist Mantis Harper-Blanco strives to create WITH mycelium, transforming the bonds between an artist and their material into a collaborative relationship rather than one of ownership.

With help from HEMI Fellow Kenneth Livi, Harper-Blanco was able to take a more analytical approach to mycelium, quantifying the structural limits of mycelium as a material.

Harper-Blanco experimented with various cultivation methods. At right, the jagged pieces of a "failed" sculpture — one that broke as it clung to its silicone mold — bask in the sun alongside bricks of baked mycelium, a grow bag, and inocculated substrate.

The project under HEMI was an exploration of mycelium-based material alternatives for different applications. Mycelium, often referred to as the 'root system' of mushrooms, is proving itself to be a robust organism, let alone as a material. The project aims to understand mycelium as an applicable and versatile material. By putting mycelium under different characterization technologies and methods, I was able to gain a more intimate understanding of mycelium. Beyond its utilitarian value, there's a genuine relationship to be made with this other being. When we think of material research, the process is one of deliberate means to specific ends. But, how we collaborate needs to exist for more than its market value or for its anthropocentric aid, but for its value within itself. I want to, as Donna Haraway puts it, "make kin sym-chthonically, sym-poetically. Who and whatever we are, we need to make-with—become-with, compose-with—the earth-bound."[1] Growing mycelium, investigating it, and writing about it through HEMI has been essential to developing a language on how we communicate these dynamics and in turn, foster them.

The HEMI program was an insightful experience as it opened the doors to new ideas and prospects. I am interested in pursuing bio-fabricative-based practices, specifically methods that involve the collaboration between humans and other living organisms. The ultimate goal is to reframe where and how we create material, more importantly, from WHAT we create. Instead of extracting resources, we are symbiotically creating together and informing each other. The opportunity to work in the Material Characterization and Processing facility under Kenneth Livi gave me access to furthering my understanding of mycelium as a material for different applications. Through this experience, I am now interested in pursuing a career that is intersectional, bridging the gap between the reasons of science and the sentiments of art.

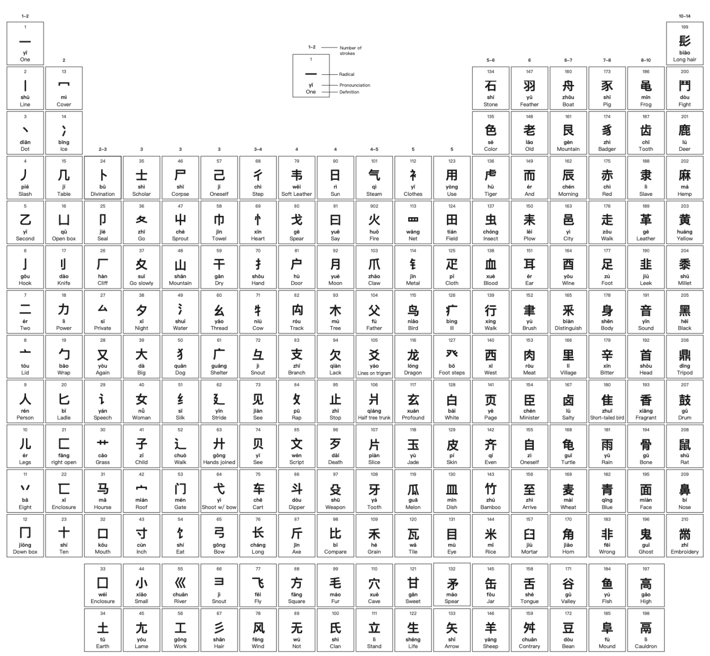
[1] Donna Haraway, "Anthropocene, Capitalocene, Plantationocene, Chthulucene: Making Kin" Environmental Humanities, vol. 6, 2015, pp. 159-165

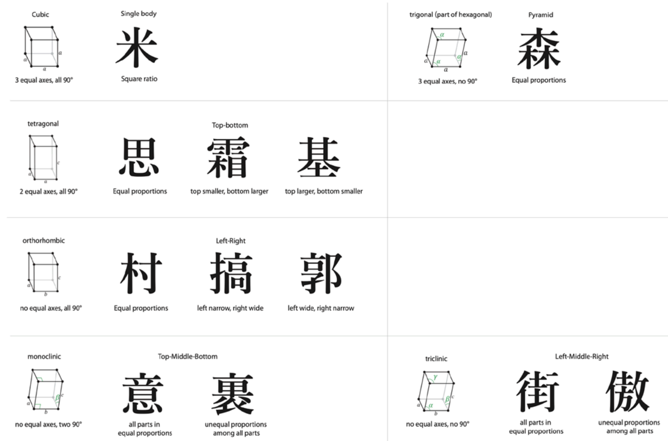
From Crystal To Hanzi

by Shan Deng
Maryland Institute College of Art
HEMI Faculty Host: Prof. Tyrel McQueen
MICA Mentor: Liz Ensz

I view my creative practice as a dialogue between myself and the materials I work with. Through the exploration of materials, I discover uncertainties and unpredictability that can serve as the starting point of my works. Much like Dr. McQueen's research, which delves into the chemical and physical properties of materials at a quantum level, I too find inspiration in the microscopic world, particularly in crystals which is a material studied in his laboratory. Experimenting with the substitution of elements within their atomic structure has the potential to unveil entirely new properties.

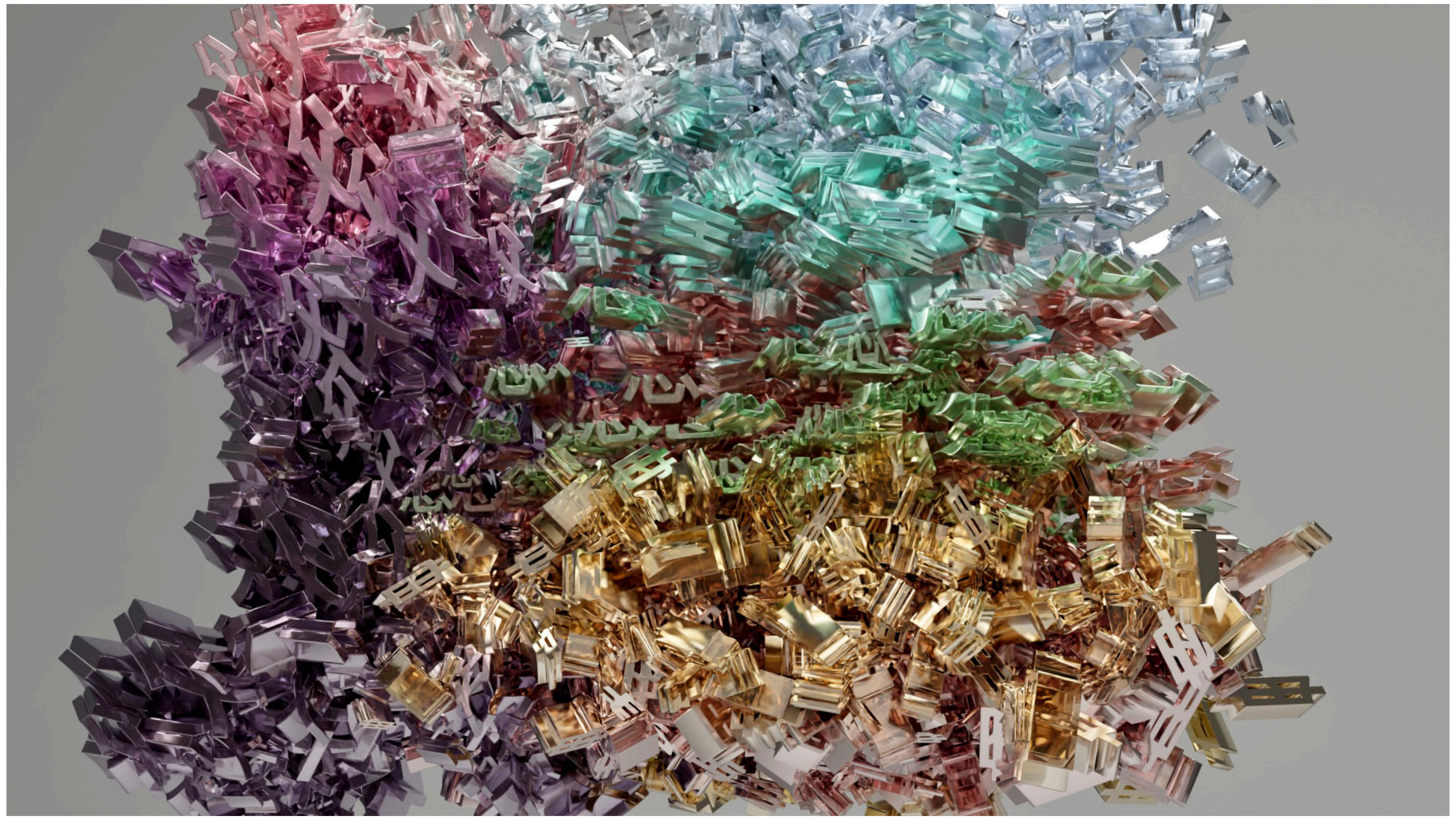
McQueen's approach of looking materials at minuscule scale resonates deeply with my artistic sensibilities. I drew a connection between his work and my exploration of the Chinese script, as both involve examining intricate structures that form the foundation of a larger whole. In the world of chemistry, the universe of materials is constructed from compounds, which are derived from molecules, molecules from elements and atoms.





In the context of Chinese script, radicals serve as the "atoms" or "elements," characters as the "molecules," series (sentences) as the "compounds," and the collective body of characters as the "world" or "material." This parallel fascinated me. Furthermore, crystals exhibit seven structures which determine their shape and growing directions, mirroring the structure of Chinese characters. This observation led me to create a novel "periodic table" of radicals, like the periodic table in chemistry. I took this idea and re-designed a Chinese character based on my current experience with my family.

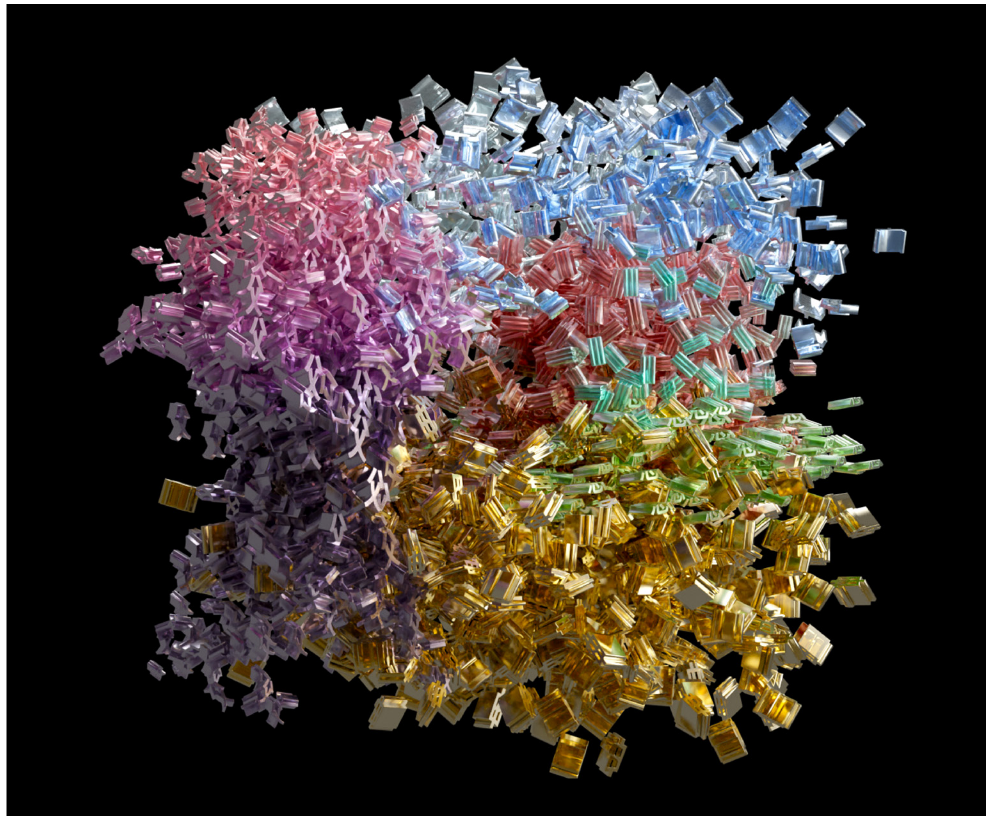
Just as Dr. McQueen aims to redefine synthetic capabilities to achieve the true materials, I sought to reinterpret a Chinese character based on my personal experiences within my family. To bring my vision to life, I chose virtual 3D sculpture as my medium. This choice allows me to simulate the growth of crystals under extreme conditions, conditions I wouldn't otherwise have access to. Virtual reality provides the ideal environment for this artistic metamorphosis to occur. Within the process of crafting my own Chinese script, a predictable structure emerges from the initial unpredictability, with intricate sculptures evolving from just a few strokes and radicals.



"There has always been a myth about how different art and science are, yet through this experience, I received a whole new perspective of seeing things conceptually based on logical discoveries. Also, in this internship, I had a great opportunity to have conversations with myself and explore the relationship with my experience through text since it has been a central idea of my art practice. I think connecting my art practice to science research opened up so many possibilities for ways of working. I truly believe that visual art could become the language that communicates to individuals to understand scientific discoveries."
— Shan Deng

Artist Shan Deng draws parallels between crystal geometry and Chinese script. By developing a novel "periodic table" of radicals (opposite, left), Deng devises a new way to process her personal history and express her feelings about family relationships — all while maintaining a barrier between her innermost thoughts and her audience.

Although her crystalizing characters (above and at right) grow along a predictable path, the true meaning behind the characters remains illegible to speakers of any language.



Spiral

by Lianghong Ke

Maryland Institute College of Art
HEMI Faculty Host: Prof. Paulette Clancy
MICA Mentor: Jay Gould

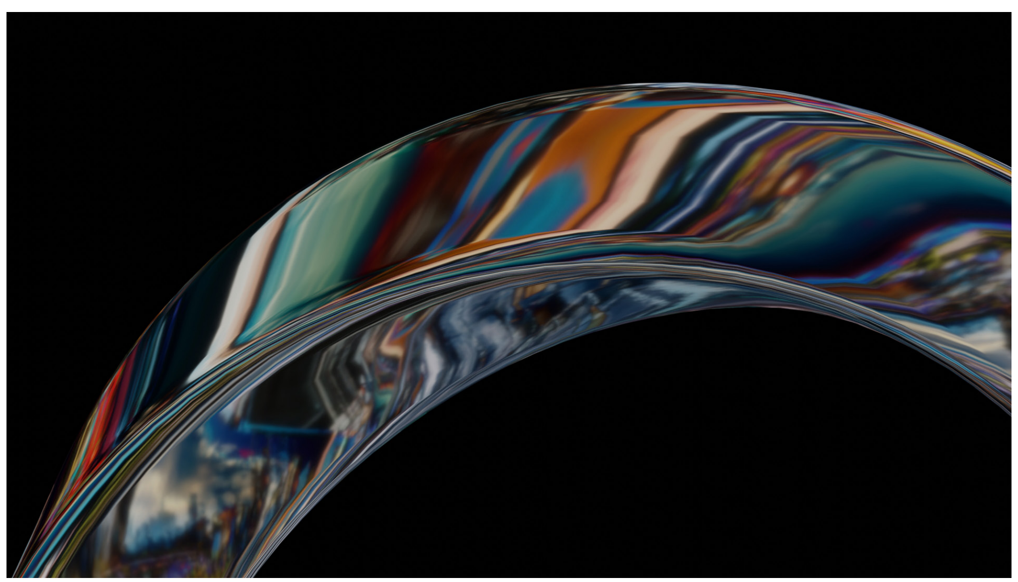
Initially, I envisaged creating a photo book to express my perspectives on the potentialities and pitfalls of science and technology in human progress. However, a Korean research team's groundbreaking discovery of the superconductivity material LK-99 in August significantly influenced my conceptual direction.

Through reflective discussions with my mentor Jay, I discerned that the essence of various pursuits across fields is the human aspiration towards a state of infinity, facilitated through technological advancements, with artificial intelligence serving as a critical catalyst in this journey towards a 'godlike' state. Subsequently, I opted for a more abstract representation of this concept.

I utilized Blender to craft a Möbius strip, integrating the photographs I created to form the texture on the strip's surface. This Möbius strip stands as a symbolic canvas depicting humanity's ceaseless quest for knowledge and power, portraying a continuous cycle that alternates between creation and destruction, reflecting both our lofty aspirations and dangerous impulses. As viewers navigate the Möbius strip, they are drawn into a complex landscape of intertwining technology and infinite desires, a visualization of our relentless pursuit for progression and dominion, yet underscored with caution, representing the dangers inherent in wielding boundless power akin to holding the Sword of Damocles.

Artist Lianghong Ke causes his audience to explore what the world might look like as humans continue their pursuit towards infinite knowledge and power.

He conjures a warped, abstract reflection of the consequences — perhaps unintended — of our ceaseless march toward technological advancement.



"My internship at Dr. Clancy's lab has been a wellspring of knowledge and inspiration, nurturing my understanding of the intricate weave of science, technology, and human endeavors. It has been an enriching journey translating these sophisticated concepts into a work of art that invites contemplation on the intertwined paths of scientific development and human aspiration. I would love to stay in touch and work with more groups to continue my journey of searching for the truth and understanding the correlation between technology and humanity."
— Lianghong Ke