HEMI | HOPKINS EXTREME MATERIALS INSTITUTE

Student Research Internships and Apprenticeships

Summer 2017

JOHNS HOPKINS UNIVERSITY

From the HEMI Director

Welcome to the Hopkins Extreme Materials Institute at Johns Hopkins University. Each summer, we offer a number of opportunities for high school, undergraduate, and graduate students to conduct research within HEMI and at partner institutions. These exciting opportunities expose students to state-of-the-art research techniques, laboratory facilities and individual mentorship. Students gain valuable insights into university-led research, which will hopefully inspire them to pursue a future career in a STEM-related field.

I am proud of the students and the research activities they conducted during this summer. I am also grateful to the faculty hosts, mentors and administrative personnel who ensured the students had the resources and guidance for a rich and rewarding experience. I would like to acknowledge the funding organizations: Army Educational Outreach Program, Army Research Office, Army Research Laboratory, Maryland Institute College of Art and The Whiting School of Engineering at Johns Hopkins University for providing the financial resources which make these opportunities possible. The summaries included (written entirely by the students) provide a glimpse of the hard work of these dedicated students. I hope this encourages students to apply in 2018!

Sincerely,

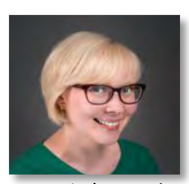
KT Ramesh
Director
Alonzo G. Decker Chair Jr. Professor of Science and Engineering

Contents

HEMI Administration Supporting these Programs

Lori Graham-Brady
Associate Director

Victor Nakano
Executive Prog. Dir.



Bess Bieluczyk
Sr. Admin. Coord.

Research and Engineering Apprenticeship Program (REAP)

REAP is a summer STEM program that places talented high school students, from groups historically under-represented and underserved in STEM, in research apprenticeships at JHU. REAP apprentices work under the direct supervision of a mentor on a hands-on research project. REAP apprentices are exposed to the real world of research, gain valuable mentorship, and learn about education and career opportunities in STEM. REAP 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 under-represented 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.

Funding Sponsor

Army Educational Outreach Program

Website Information

http://www.usaeop.com/programs/apprenticeships/reap/

2017 REAP Students with U.S. Army Guests

Edna Egal

Eastern Technical High School, Essex, Maryland
Mentor: JP Connors
Faculty Host: Professor Michael Shields, Department of Civil Engineering

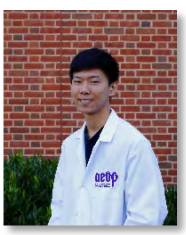
Project Title: Quantifying the Variability of Ductile Metals During Thermo – Mechanical Tensile Failure

In civil and mechanical engineering, there is an ever-increasing need to evolve structural materials, designing and optimizing them to be strong, lightweight, ductile, low-cost, and sustainable - yet resilient to a variety of natural and anthropogenic hazards. Aluminum alloys are attractive in this application because they provide a level of flexibility and customizability not afforded by other structural metals.
One major drawback of ductile metals, and structural aluminum in particular, is that their performance is significantly diminished at elevated temperatures, making them vulnerable to the effects of fire. These effects are even more prominent for aluminum

because it has a very low melting point (~660 C vs. ~1500 C for steel). Currently, aluminum design standards are deterministic and overly conservative due to the variability in its performance at high temperatures. At high temperatures, many of aluminum's benefits (high strength to weight ratio, low density, great corrosion resistance, excellent formability and weldability) are negated due to a lack of understanding of its uncertainty.

To quantify this variability, the team performed tensile tests and plane strain tests on 6060 - T6 at temperatures varying from 20 C to 300 C using the digital image correlation technique (DIC) to measure load deformation response. These experiments were used to determine yield strength, elastic modulus, ultimate stress, ultimate strain, and strain at failure as a function of temperature. Data collected during the tests was used to calibrate a material model and predict the response of full scale structural materials exposed to high temperature environments. Stress-strain curves constructed following data analysis in MATLAB showed great variability in its response between different temperatures and at the same temperature.

Preparing Material Samples



Steven Hu

Centennial High School, Ellicott City, Maryland
Mentor: Alex Sun
Faculty Host: Professor KT Ramesh, Department of Mechanical Engineering

Project Title: Pressure Shear Plate Impact on Granular Boron Carbide

Boron carbide is investigated in current work due to its excellent mechanical strength and low density, which are key features for structural application such as armor protection and penetration prevention. However, its plasticity is negligible making commercial boron carbide a very brittle material in which crack nucleation, crack propagation, fragmentation, and dynamic granular flow are the dominant deformation mechanisms, especially at high strain rates and complex stress states. Granular flow in communized zones has critical effects on ballistic performance of armor materials.

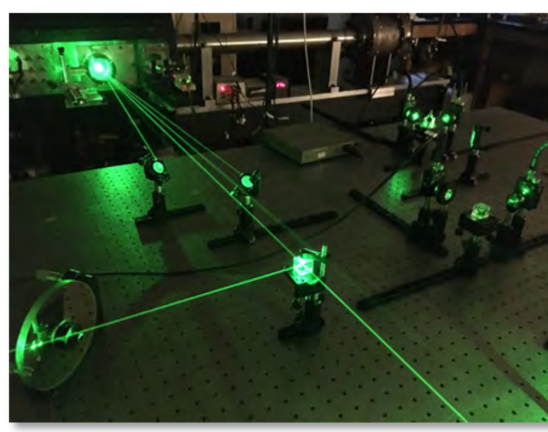


Plate Impactor Experiment on Boron Carbide

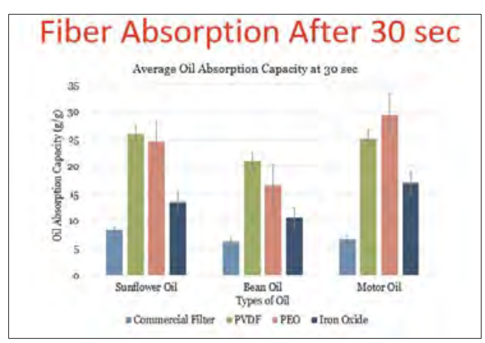
In this experiment, the granular boron carbide ESK3000F (with an average grain size of 0.7 microns) is subject to ultra-high-strain-rate loading conducted by pressure shear plate impact experiment. The granular boron carbide is deformed at a shearing rate of about $2x10^4 s^{-1}$ with a superimposed normal pressure at 1.74GPa. The obtained shear stress is around 270MPa. From the collected and analyzed data, the granular shear stress increases with increasing normal pressure. Also, by analyze shear strain rate, normal pressure has stronger effects than the shear strain rate on granular shear stress. Following the shot, recovered powder is analyzed and characterized to provide useful insights of mechanisms during the deformation.

Lilia Yousefian

North County High School, Glen Burnie, Maryland
Mentor: Santiago Orrego
Faculty Host: Professor Sung Hoon Kang, Department of Mechanical Engineering

Project Title: Fiberous Oil Absorbents

The millions of gallons of oil are imported into the US by boat every year. With all of this transportation of oil, there are bound to be incidents where oil is spilled. Oil spills cause significant damage to marine ecosystems, as well as to the economy. The US has yet to find an effective way to clean up oil spills in an inexpensive, safe, and universal way. Current filtration technologies used for oil cleanup are inefficient and expensive. Therefore, we propose to design efficient, inexpensive and scalable oil filters, utilizing hydrophobic and oleophilic properties. We fabricated three different types of filters using electrospinning to control the fiber nanostructure and tailor the fiber to have our desired properties. The first filter was made PVDF: which possesses hydrophobic properties. For the second filter, we improved the hydrophobicity via adding PEO, which created a porous PVDF fiber (increased roughness). The third filter acquired oleophilic properties since the PVDF fibers were infused with Iron Oxide nanoparticles. The efficiency of these filters were tested to evaluate their average absorption capacity and were compared to a commercially made filter. Results showed that the bulk and porous PVDF filters had the greatest oil retention (30 g/g) compared to iron oxide (15 g/g) and followed by the commercial (4 g/g). Additionally, observational image test was conducted to evaluate how hydrophobic and oleophilic the filters were. The mean fiber diameter was also calculated using imaging processing techniques. We found that the oil adsorption capacities were closely dependent on the fiber size and the porous morphology, which can be controlled by adjusting the compositions of polymer solutions. The prepared fibrous membranes were found to have a potential to be mass produced and uses as an effective oil absorbent.

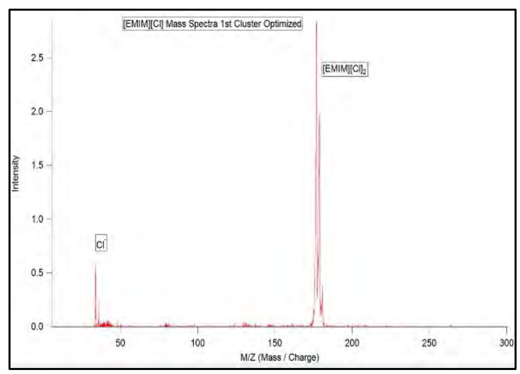


Luna Warren

Montgomery Blair High School, Silver Spring, Maryland
Mentor: Evan Collins
Faculty Host: Professor Kit Bowen, Department of Chemistry

Project Title: Obtaining the Mass Spectra of the Ionic Liquid [EMIM][Cl]

[EMIM][Cl] is an ionic liquid, which means it is a salt that is a liquid at room temperature. To make it into a solution that could sprayed, it had to be combined with acetonitrile (ACN) and have a concentration of 10mM. This required exactly 30µ of [EMIM][Cl]. My internship required that I make solutions of varying molarities, and it let me contribute to real research by using techniques I learned in school in a hands-on approach. Once the [EMIM][Cl] was properly mixed in the ACN, we could fill the needle with the solution in order to run it through the electrospray and collect its mass spectra. The [EMIM][Cl] was pushed from the needle tip and sucked into the entrance of the vacuum, where the ion guides moved the ions to the ion trap. The solvent (ACN) evaporated until the [EMIM][Cl] ions were isolated. Then, the ion trap ejected the ions once every 0.10 seconds, and a back plate attached to a voltage directed the ions down the flight tube. As the ions hit the detector at the end of the flight tube, their time of flight allowed us to determine their mass. The longer the time of flight, the more mass, and vice versa. Once the sample of [EMIM][Cl] had run its course, we consolidated the data into a graphed spectra. The spectra contained 10 different [EMIM][Cl] clusters, so we optimized a portion to be left with the spectra below.



Mass Spectra of [EMIM][Cl]
Graphical Output from Computational Software

Undergraduate Research and Apprenticeship Program (URAP)

URAP provides undergraduate students with an authentic science and engineering research experience alongside university researchers sponsored by the Army Research Office. Through this commuter program, students will develop skills in Army critical science and engineering research areas in a university lab setting to prepare them for the next steps of their educational and professional career.

The US Army established the Center for Materials in Extreme Dynamic Environments (CMEDE) to design, develop and test improved soldier protection materials. JHU leads the CMEDE collaborative research alliance, which includes 15 university and research institutions across nine states. Together these partners, in close collaboration with the Army Research Laboratory, serve a vital role as a materials-by-design capability for the US Army. URAP opportunities within CMEDE are available at universities performing research on this program.

Students receive an educational stipend and contribute to the Army's research in the laboratory while learning research methods, using advanced research equipment and becoming a part of an active research group. This authentic experience provides exposure to science and engineering research careers.

Program Goals

- Provide authentic science and engineering research experience to undergraduate students pursuing science and engineering majors;
- Introduce students to the Army's interest and investment in science and engineering research and the associated educational opportunities available through the AEOP and DoD;
- Provide participants with experience in developing and presenting scientific research;
- Provide participants with experience to develop an independent research program in preparation for research fellowships, graduate school, and careers in science and engineering research;
- Benefit from the expertise of a scientist or engineer as a mentor for professional and academic development purposes; and
- Develop students' skills and background to prepare them for professional and academic development purposes.

Funding Sponsor

Army Educational Outreach Program and the Center for Materials in Extreme Dynamic Environments

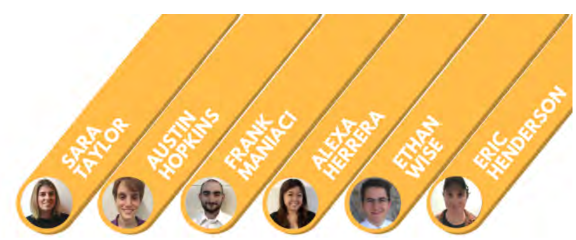
Website Information

URAP

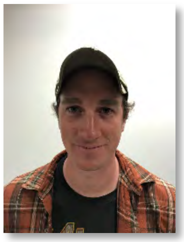
http://www.usaeop.com/programs/apprenticeships/urap/

CMEDE

https://hemi.jhu.edu/cmede/



2017 Undergraduate Research Apprenticeship Program (URAP) Awardees



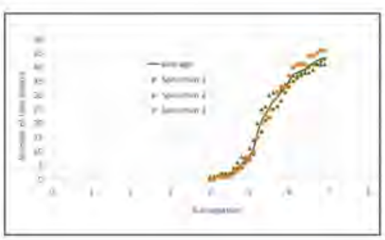
Eric Henderson

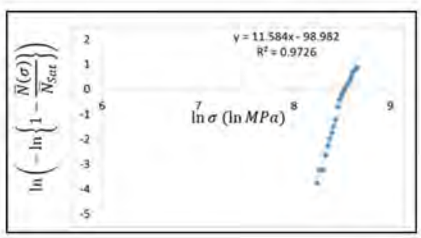
University of Delaware, Newark, Delaware
Faculty Host and Mentor: Professor Jack Gillespie and Mr. Raja Ganesh
Department of Mechanical Engineering
University of Delaware

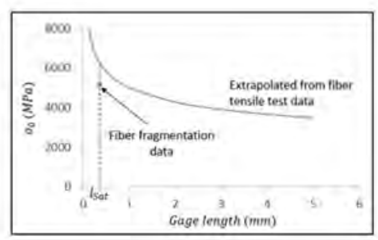
Project Title: Weibull Strength Distributions in S2-Glass Fibers

Fracture strength in glass fiber polymer matrix composites is dependent on defect occurrence. Since glass fibers are a brittle material, the strength is dependent on the strength of the weakest element. Thus, it is important to accurately characterize the strength distribution of the fiber to be able to model fracture mechanics in a multifiber composite structure. First, tensile tests were performed using a Diastron tensile tester to measure the fracture strengths of singe fibers at gage lengths of 4, 12, 20, and 30 mm. This provided the data to fit to a Weibull statistical distribution and to characterize the effect of surface area and gage length scaling effects. The scaling due to gage length and surface area were found to be insignificant, indicating that future experiments could be done without the time-consuming process of measuring individual fiber diameters. Weibull parameters were also determined using the single fiber fragmentation

tests. The resulting saturation length of 365 µm was found and when extrapolating the data from the tensile tests, the corresponding strength was found to be significantly different. This would suggest that a different model should be used for characterizing fracture strengths at gage lengths less than 1 mm. Different methods of testing smaller gage lengths to better characterize the fracture strengths are being explored including fracture due to bending over a radius on the order of 10-100 µm.







$$\frac{\bar{N}(\sigma)}{\bar{N}_{sat}} = 1 - exp\left[-\left(\frac{\sigma}{\sigma_{lsat}}\right)^{\beta}\right]$$

$$\ln(-\ln(1-\frac{\bar{N}(\sigma)}{\bar{N}_{Sat}})) = \beta\ln\sigma - \beta\ln\sigma_{l_{Sat}}$$

$$\sigma_{lsat}=5153.8\ MPa\ @\ lsat=.365\ mm$$
$$\sigma_{lsat}=6260\ MPa\ extrapolated$$

Alexa Herrera

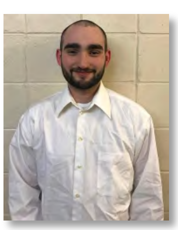
Rutgers University, Piscataway, New Jersey
Faculty Host and Mentor: Professor Richard Haber
Department of Materials Science and Engineering
Rutgers University

Project Title: Chemical Analysis of Hot Pressed Boron Carbide

During my time serving as an undergraduate apprentice for the URAP, I conducted chemical analysis on boron carbide powder samples. Boron carbide is a material of interest because of its high hardness and low density. It is the third hardest material, proceeding diamond and boron nitride, and it has a density of 2.53g/cm^3, making it ideal for lightweight armor. In addition, boron carbide can have different stoichiometries as well as boron and carbon substitutions within its unit cell. It is made up of a 12-atom cage structure and a 3-atom chain. Variants of boron carbide can include $(B_{12})CCC$, a boron cage with carbon chain, or $(B_{11}C)CBC$, an 11-boron, one carbon cage with a two carbon and one boron chain.

The boron carbide samples are hot pressed, then are crushed for chemical analysis. To perform chemical analysis with the powders, boron titration with mannitol is conducted. Sodium carbonate is used to break down the boron carbide into boron and carbon. The boron forms a boric acid, while the carbon reacts to become carbon dioxide. Then, a series of filtrations and heating is done to separate and remove the carbon dioxide and leave behind boric acid. Using the mannito-boric procedure, the solution is titrated to two endpoints using sodium hydroxide. The amount of base needed for the solution to reach its two inflection points would indicate the amount of boron in the sample powders. Commercial boron carbide samples with known boron content were initially tested and this method was determined to be within three percent accuracy. This method was deemed reliable and was used to determine the boron content of 11 other hot pressed samples. Analysis to find total Carbon and Oxygen content in the boron carbide samples was done using LECO CS230 C/S and LECO TC600 O/N analyzers, respectively. A combustion reaction would occur if carbon or oxygen was present, respectively, in a sample. The amount of oxygen can show how much surface oxides are in the samples, which can be minimized by washing the powders.

Performing Boron Titration on Boron Carbide Samples



Frank Maniaci

Rutgers University, New Brunswick, New Jersey

Faculty Host and Mentor: Professor Richard Haber and Mr. Mustafa Kanaan Alazzawi
Department of Materials Science and Engineering
Rutgers University

Project Title: Microstructure Evaluation of Ceramic Material

The processing of ceramic material can pose problems in the microstructure of the final product. The microstructural variability of the final product could have issues such as inhomogeneity and agglomeration. To visualize and evaluate these variations, two and three dimensional imaging and analysis techniques could be used. These techniques can be used for applications such as catalyst support and with pressed ceramics. The evaluated microstructure variations can be correlated to other products in terms of their performance and properties. The materials that were used in this project were a composition of titania, binder, and water to form a paste-like material. In assessing the extrudability of the paste, the rheological behavior of the mixture was monitored using a torque rheometer. A capillary rheometer was used to analyze the flow behavior of the paste. It was found that mechanical polishing caused scratches and pullouts on the ceramic samples. These can pose inaccuracies in the microstructural evaluation. However, ion milling produced a high quality surface that allowed for the microstructure to be properly analyzed. The microstructure was evaluated using a two dimensional approaches. Initially, the two dimensional visualization and segmentation technique was done extensively to understand the microstructural variations. The project will be continued to understand the microstructural variations in the three dimension and techniques will be developed to approach this objective.

Working with Ceramic Samples in the Laboratory

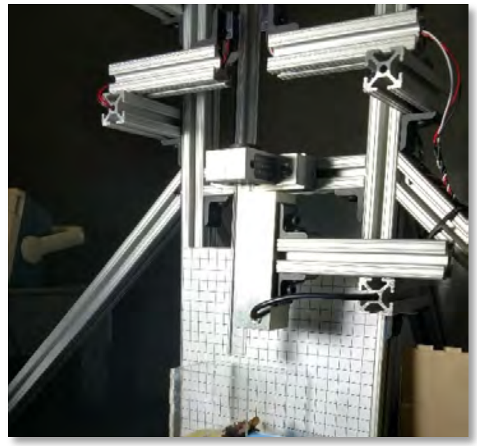
Sara Taylor

Loyola University Maryland, Baltimore, Maryland
Faculty Host and Mentor: Professor KT Ramesh and Mr. Jeremy Rosen
Department of Mechanical Engineering
Johns Hopkins University

Project Title: Mild Traumatic Brain Injury in the Mouse with Impact Acceleration

Currently there is a great push for research in head injuries, specifically traumatic brain injury (TBI), due to the prevalence of these head injuries in active duty military members, car accidents, and contact sports such as football or hockey. In this experiment mice were studied because they are more accessible than human brains and they are more available in post processing after TBI. The goal of the experiment was to cause mild TBI in these mice, which is also considered a concussion without fracturing the skull. In running the actual experiment a helmet is attached to the heads of the mice to ensure the right injury is obtained. To do so a 60 gram weight was dropped from 1 meter high on to the mouse's head, the mouse was laying on a foam pad that allowed the weight to bounce up after it hit the head. This caused an upward rotation of the mouse's head, simulating the whiplash effect that causes the mild TBI. Diffuse axonal Injury is the subinjury of TBI that was looked for, after the mice were injured. This is a result of the message signals clogging up in the axons creating what looks like small beads in the post processing images. During the course of the research the project had only got to the testing point and there are no post processing available yet, so the results are still to come. The test conducted this summer was the first of many to come.

Drop Tower Experimental Set-up

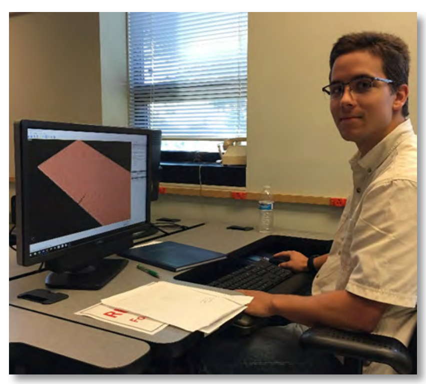


Ethan Wise

University of Delaware, Newark, Delaware
Faculty Host and Mentor: Professor Jack Gillespie and Dr. Sanjib Chowdhury
Department of Mechanical Engineering and
Center for Composite Materials
University of Delaware

Project Title: Modeling of glass fiber with surface cracks – A molecular dynamics simulation study

Theoretical strength of glass fibers is much higher than the experimental values. It is believed that nano-scale surface cracks, which are developed on the fiber during manufacturing and handling, deteriorate fiber strength. Effects of surface cracks on the mechanical properties (Young's modulus and strength) of glass fibers are studied through reactive, all-atom molecular dynamics (MD) simulations. Surface cracks of different lengths are created by deleting atoms. Two types of reactive force fields – ReaxFF and Tersoff, are considered to access their accuracy and computational expense. Simulation results indicate that surface cracks have no effect on glass fiber modulus. However, fiber strength is significantly reduced by the presence of surface cracks. With an increase in crack length, strength decreases. MD derived strength-crack length response is in good agreement with theoretical prediction.



Visua
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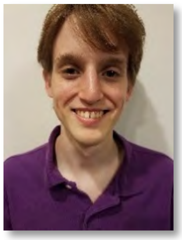
Analysis of S-glass Model with Surface Cracks



Austin Hopkins

Johns Hopkins University, Baltimore, Maryland

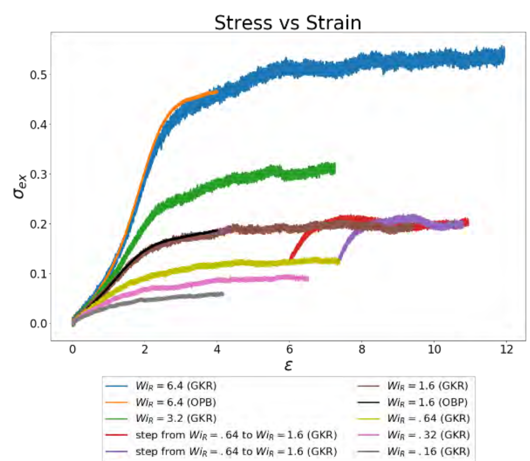
Faculty Host and Mentor: Professor Mark Robbins and Mr. Thomas O'Connor
Department of Physics and Astronomy
Johns Hopkins University

Project Title: Molecular Dynamics Simulations of Extensional Flow of Polymer Melts

Extensional flows are used extensively during industrial processing of polymer materials and in new applications like 3D printing. Recent experiments have cast doubt on current models of molten polymer dynamics during strong extensional flows. Improving models requires details about polymer motions that are inaccessible to current experiments. Molecular dynamics (MD) simulations can access these details, but traditional simulation techniques cannot sustain flows long enough to reach steady state. Over the summer we applied a recently developed simulation technique, Generalized Kraynik-Renault (GKR) boundary conditions, in molecular dynamics simulations to study the extensional flow of entangled polymer melts. The GKR algorithm allowed us to simulate flows for larger strains than any previous experiment or molecular simulation.

We simulated entangled polymer melts during startup elongational flow and during stress relaxation after flow was ceased. Our simulations were compared to experimental data and hydrodynamic continuum models. The MD results agree with available experimental data and provide new, detailed information about how chains conformations change as they approach steady state. Understanding these microscopic dynamics allowed us to critically examine current hydrodynamic models of molten polymers and assess what missing microscopic mechanisms they need to describe the experimental data.

A key result of our analysis is that the entanglement length scale, which dominates the stress response in weak flow, remains an important length scale in strong flows, even when the flow has completely destroyed the entanglement network. We plan to continue this project during the 2017-2018 academic period and extend our analysis to include entangled polymers diluted in solvents.



Extreme Science Internships (ESI)

ESI provides opportunities for Morgan State University (MSU) students to participate in both internal and external internships associated with the Center for Materials in Extreme Dynamic Environments (CMEDE). ESI are STEM-focused with a particular emphasis on providing research opportunities related to MEDE, a basic research program focused on designing, developing and testing improved soldier protection materials.

ESI is open to undergraduate and graduate students. MSU's School of Computer, Mathematical, and Natural Sciences and the School of Engineering assist in administering the ESI program.

Internal ESI are hosted by MSU faculty on the campus of Morgan State University. External ESI are conducted at one of the 15 CMEDE university and research institutions located across nine states, the United Kingdom and Germany. ESI are paid internships in accordance with MSU policies and regulations.

Program Benefits

- Opportunities for undergraduate/graduate students to gain a research experience, and to present the findings of their research;
- Opportunities for students to meet colleagues at majority institutions to 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

Army Research Laboratory through the Center for Materials in Extreme Dynamic Environments

Website Information

Morgan State University ESI

http://www.usaeop.com/programs/apprenticeships/urap/

CMEDE

https://hemi.jhu.edu/cmede/

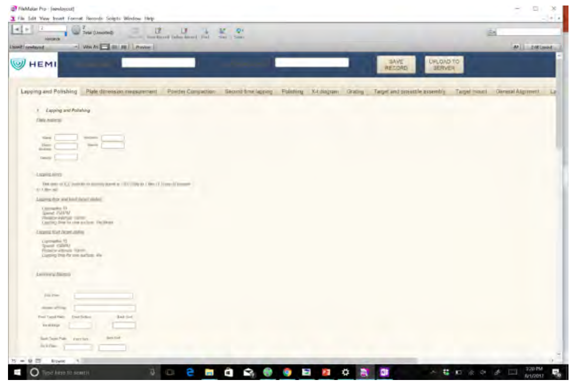
2017 External ESI Students

Oreoluwa Adesina

Morgan State University, Baltimore, Maryland
Faculty Host: Professor KT Ramesh
Department of Mechanical Engineering
Johns Hopkins University

Project Title: Electronic Lab Notebook Development

At the start of my ESI program, I was tasked with creating an Electronic Lab Notebook for the Ramesh group. The purpose was to reduce the error associated with taking down data. I conducted some research on the best Lab Notebook to use for this project. I had a lot of options but eventually ended up going with FileMaker Pro. After a few weeks of learning the software I created a lab notebook for one of the researchers in the lab which made the workflow of the student easier and more accurate.



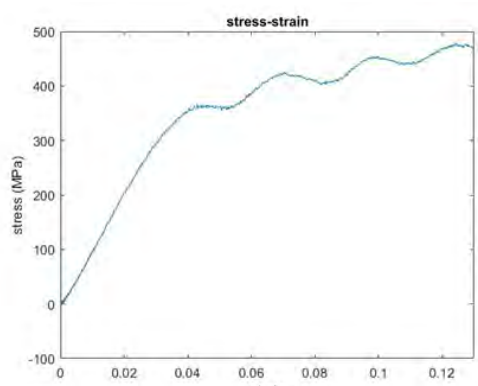
Screen shot of Electronic Lab Notebook

Joshua Samba

Morgan State University, Baltimore, Maryland
Faculty Host: Professor KT Ramesh
Department of Mechanical Engineering
Johns Hopkins University

Project Title: Uniaxial Compression of 6061-T6 Aluminum

My goal for the summer was to learn how to conduct an experiment from start to finish. Dr. Ramesh suggested that I use the conventional Kolsky bar to uniaxially compress 6061-T6 aluminum. I fired two Kolsky bar shots; the first aluminum specimen was a 6x4.75x4.3mm (length x width x height) cube and the second was 6x5x4.1mm. The tests were conducted at 20 psi and the strain rate achieved was around 3000 s^{-1}. Both shots resulted in the same stress-strain curve, so the test was consistent. The data collected was not corrected for dispersion.



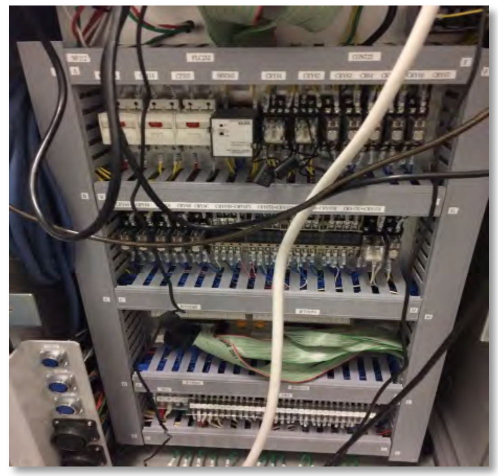
Stress-Strain Curve from Experiment

Fathima Hashmath

Morgan State University, Baltimore, Maryland
Faculty Host: Professor Tyrel McQueen and Dr. Adam Phelan
Department of Chemistry
Johns Hopkins University

Project Title: Electronic/Computer readouts on Induction Furnace

The Ultra – high induction furnace is used in crystallization process of chemicals. The furnace is ultra-high and had to be controlled in the lab. In order to read the readings and manage the furnace it has to be connected to computer using RS 232 serial cables. The each part of the furnace have separate software's and each part port has to be connected to the computer. After connecting the ports, downloading and updating the software was the next step. Checking the furnace temperature and controlling the temperature and output of other parts of the furnace is difficult as a person has to be there all time, in order to control furnace remotely it's connected over the internet. Connection through internet is been done on physical layer.



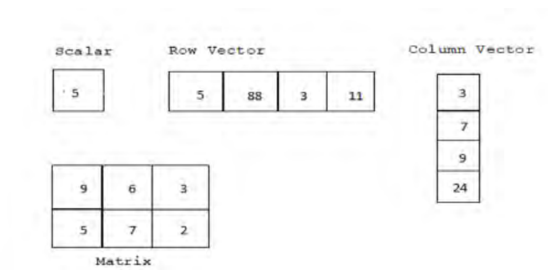
Computer Controls for Induction Furnace

Moses Kayondo

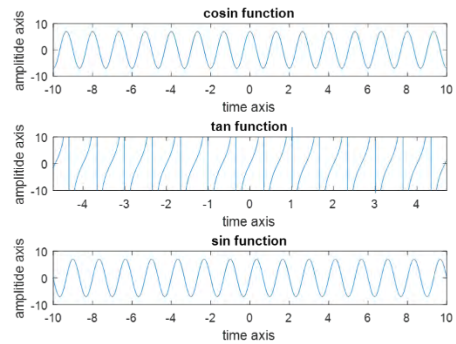
Morgan State University, Baltimore, Maryland
Faculty Host: Professor Lori Graham-Brady
Department of Civil Engineering
Johns Hopkins University

Project Title: Mastering Basic Functions in MATLAB for Scientists and Engineers

MATLAB is a high-performance language used by scientists and engineers to carry out computing. It involves computation, visualization by plotting graphs from data, and programming environment which involves writing scripts or creating functions with local variables and developing conditional statements designed to solve different sets of problems using well- known mathematical expressions. MATLAB means Matrix Laboratory and the software is built around vectors and matrices. A matrix can be visualized as a table of values along rows and columns and these rows and columns consists of scalars and vectors. A scalar is a physical quantity which can be described as a single element or a real number; whereas, a vector is physical quantity that has two independent properties: magnitude and direction which can be resolved using Cartesian coordinates. MATLAB software is used in various scientific fields and industry such as mathematics, physics, chemistry, Biological and medical sciences, social sciences and engineering. There are three functions in MATLAB that need to be mastered by scientists and engineers in their daily activities: (a) knowledge of how to create MATLAB variables for a given mathematical function. (b) Knowledge of how to write scripts (programming), creating M-files, importing data as well as using input and output functions. (c) Knowledge of using plotting function; for example, 2D plot (a simple x-y plot).



Matrices



Sub-plotting (using two or more graphs on one page)

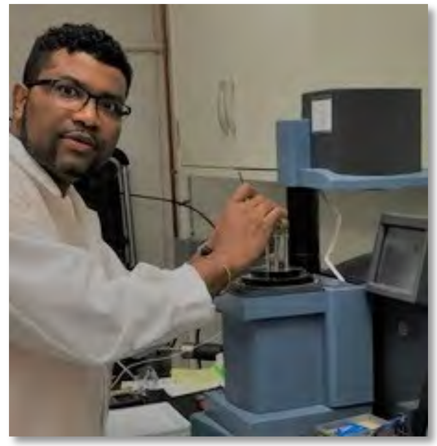
Yannick Williams

Morgan State University, Baltimore, Maryland
Faculty Host: Professor Vicky Nguyen
Department of Mechanical Engineering
Johns Hopkins University

Project Title: Characterization of the Structure and Properties of the Optical Nerve Head

Glaucoma is an optic neuropathy resulting primarily from the damage to retinal ganglion cell (RGC) axons as they exit the eye. The lamina cribrosa is a fenestrated, three-dimensional (3D) network of load-bearing trabeculae, which provides structural and nutrient support of the RGC axons as they leave the eye on their path to the brain. I observed the dissecting of pig eyes for preparation in viewing the lamina cribrosa with the confocal microscope. Lamina cribrosa strains are therefore very complex, arising from the interactions of multiple forces, all mediated by the 3D geometry and local stiffness of the lamina cribrosa trabeculae themselves. A poly(dimethylsiloxane) (PDMS) film was prepared by mixing the base elastomer and curing agent in ratios of 10:1, 20:1 and 50:1 and then solidifying by autoclaving. The PDMS was then cut into the desired shape. The technical requirements were 8mm* 15mm*1mm (width, length, thickness) suspended membrane on which cells adhere and proliferate making a liquid tight seal.

I performed mechanical testing using Dynamic Mechanical Analysis obtaining the young`s modulus of the 10:1, 20:1 and 50:1 samples. In the analysis of 1% and 10% strain of our PDMS samples, we noticed from the results of our experimental data, that there were not significant differences in true stress and strain compared to engineering stress and strain. Next steps of our project are to identify the PDMS response via spatial distribution of the fluorescent beads. The strain field in the flexible membrane can be envisioned by applying Green strain tensor to describe the position of embedded fluorescent beads during stretching. Utilizing numerical techniques, a script in MATLAB can be written to compute the Green strain tensor. A strain map can then be generated based on the beads tracking computation.



Preparing Specimen in Laboratory

HEMI/MICA Extreme Arts Summer Projects/Internships

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 projects/internships 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 examines 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.

Funding Sponsor

The Whiting School of Engineering at JHU and MICA

Website Information

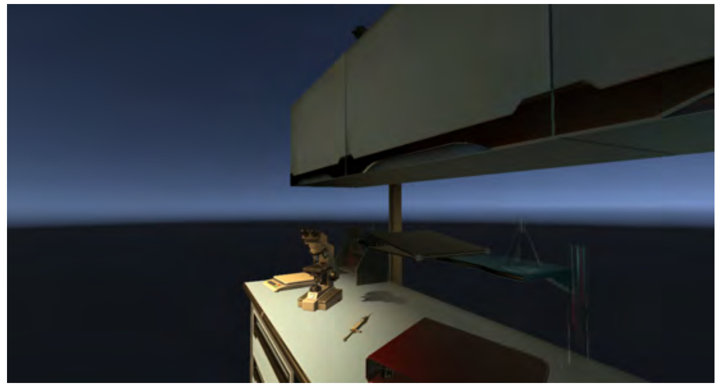
https://hemi.jhu.edu/academic-programs/hemimica-extreme-arts-program/hemi-micasummerinternship/

Joshua Gleason

Focus Area: Interactive Arts and Animation
MICA Advisor: Branden Rush, Animation/Interactive Arts Technician
HEMI Advisor: Professor Mark Robbins
Department of Physics and Astronomy

Project Title: A World Of Its Own

A World Of Its Own is interactive Virtual Reality experience that combines the artist's love of games and innovative technology with the concepts and ideas that resonated with him during his time learning more about the research done at HEMI. Specifically the study of polymers and the way they behave in either the average or extreme environments both found in nature or 'under the microscope' so to speak. There are several different environments in AWOIO and each inspired by different interactions and molecular phenomenon.



Screenshot of a workspace in A World of Its Own

Nilam Sari

Focus Area: Sculpture and Graphic Design
MICA Advisor: Ryan McKibbin, Digital Fabrication Studio
HEMI Advisor: Professor Lori Graham-Brady
Department of Civil Engineering

Project Title: Accordion Paper Structure

For the HEMI extreme art project I did a study on a foldable honeycomb paper structure, inspired by Professor Schafer's thin-walled structures project. I took the design from the different 3D printed prototypes of the cold-formed steel beams, and turn it into a repeatable pattern that could be build by pieces of paper. The goal of the study was to create a lightweight foldable strong accordion structures, that could be easily produced, transported, and stored. However, the production process did not go the way I planned it to. The assembly of the structures did not go as easily as I thought it was going to be. In the end, I managed to create multiple possible patterns but unfortunately, I could not finish the production and test the strength of each different structures. I did not have enough time to pursue more exploration of the new structure I just discovered, but I definitely learned a lot of things and created something even more intriguing to work on for the future.

Final accordion structure (top view)

Army Educational Outreach Program (AEOP) Strategic Outreach Initiative (SOI)

In 2016-2017, AEOP in collaboration with Battelle awarded HEMI and the Center of Educational Outreach (CEO), a strategic outreach initiative grant. The grant focused on expanding student participation in enriching science, technology, engineering and math (STEM) exploration and learning, particularly for underserved students. AEOP offers students and teachers Army-sponsored programs that effectively engage, inspire and attract the next generation of STEM talent.

Through AEOP's suite of programs (http://www.usaeop.com/), students from elementary school to college, representing all proficiency levels and ethnic, economic and academic backgrounds, participate in real-world experiences involving STEM disciplines. Scientists, technology experts, engineers and mathematicians, who act as mentors and guides, introduce students to the various opportunities in STEM fields through hands-on experiences and provide advice for technical skill development and career planning.

AEOP's Homepage

Through CEO's multiple STEM programs, AEOP was promoted to over 2,300 elementary, middle and high school students annually in the greater Baltimore City in which 80% of these students are in the underserved/ underrepresented populations. CEO also utilized its Maryland teachers' newsletter to distribute AEOP opportunities across the state of Maryland. From 2016 to 2017, nearly all AEOP programs in Maryland saw a significant increase in the number of applications.

In addition to promoting AEOP opportunities, the SOI grant provided 10 full and 5 partial scholarships to high school students from underserved/underrepresented groups in STEM backgrounds to participate in the JHU Engineering Innovation (EI) summer program. Engineering Innovation is a hallmark, four-week, college-level program for high school students to explore a variety of engineering fields. It is a rigorous course based on a class offered at JHU to our freshman engineering students. EI students who earn an A or B receive three JHU college course credits.

Images from events supported by the AEOP SOI grant:

A. Women in Science and Engineering (WISE) internship students from Garrison Forest High School

B. Engineering Innovation final bridge building competition

C. Promoting AEOP at a local STEM career fair in Baltimore

D. Hopkins Robotics Cup competition at Johns Hopkins University

On behalf the Hopkins Extreme Materials Institute at Johns Hopkins University, we would like to thank the support from the sponsors and organizations that made these student opportunities possible:

ARMY EDUCATIONAL OUTREACH PROGRAM

ARMY RESEARCH OFFICE

ARL

MARYLAND INSTITUTE COLLEGE OF ART

MORGAN STATE UNIVERSITY

JOHNS HOPKINS WHITING SCHOOL of ENGINEERING