Research Experience for Undergraduates

Oral Research Presentations

Wednesday, July 28, 2021 8:30 am – Noon

Diercks Hall Auditorium at MSOE, 1025 N. Milwaukee St.

Refreshments served

STUDENTS, FACULTY, STAFF and GUESTS INVITED

Manufacture of a Head Phantom for MRI Machine Calibration

Levee Callahan, Senior – Mechanical Engineering, Northern Illinois University, DeKalb, IL *(Dr. Subha Kumpaty)*

3D Printing has allowed creation of complex surfaces such as the human brain in the past; in this effort, a control phantom was created accommodating the concept of uniform grey matter ribbon surrounding the inner white matter of the brain. Then a tolerant altered phantom was created by changing the thickness of the grey matter and the density of the white matter at identifiable locations. These phantoms can be filled with tissue mimicking material to imitate the paramagnetic and dielectric properties of grey and white matter to create the contrast necessary for accuracy calibrations of MRI machine.

Creation of Three-dimensional Pedagogical Models of Genetic Mutations

Megan Cohan, Senior – Biomolecular Engineering, MSOE *(Dr. Vipin Paliwal)*

This research incorporated use of 3D Printing (Selective Laser Sintering) to create models that capture the genetic mutation concepts which are otherwise difficult to grasp. Three DNA mutations- point, frameshift and insertion models were created such that the individual nucleotide bases could be removed from the DNA and mRNA backbone and moved around easily using magnets embedded into the pieces. Cyclobutane Thymine-Thymine (T-T) dimer formed due to UVB exposure was also modeled. The printed models will serve as pedagogical tools in K-12 education.

Biosynthesis of Gold Nanoparticles Using Upland Cress: Process Optimization and Characterization

Noah Hutchinson, Senior –Biomedical Engineering, MSOE *(Dr. Wujie Zhang)*

This research focuses on the optimization of a plant-mediated biosynthesis process using upland cress (*Barbarea verna*). Various biomolecules within the upland cress act as both reducing agents capable of reduction of gold ions to zerovalent gold atoms as well as capping agents which stabilizes the nanoparticle. Gold nanoparticles were produced through the utilization of an optimized process and the resultant nanoparticles were confirmed using UV-Vis spectroscopy. The results indicated that gold nanoparticles synthesized using Upland Cress were found to have an absorption peak of around 535 nm. The success of this optimized biosynthesis process provides a sustainable, environmentally conscious approach to producing stable gold nanoparticles for biomedical/ nanotechnology applications.

Synthesis of a Nano-bead Sunscreen and Testing its Efficacy

Katsiaryna Kantarovich, Senior – Biomedical Engineering, Georgia Tech., Atlanta, GA *(Dr. Vipin Paliwal)*

Prolonged unprotected exposure to the sun can cause damage to the skin's layers and their DNA. Commercially available nanoparticle sunscreens use physical blockers; this study explored the formulation of a chemical blocker sunscreen. An ethyl cinnamate sunscreen was synthesized followed by characterization of the product to assess the efficacy and quality of the synthesis. The sunscreen was synthesized into a nano-bead form linking the ester functional group to the core. The efficacy of the nano-bead sunscreen was compared to the unbonded sunscreen initially synthesized. The sunscreens' abilities to block UVB radiation was quantitated through comparison to a control sample where no sunscreen was used. Time related decay of the sunscreen after exposure to UVB was investigated.

Creation of Three-dimensional Pedagogical Models of Genetic Mutations

Efrem Dana, Senior –Mechanical Engineering, MSOE *(Dr. Subha Kumpaty and Mr. Jordan Weston)*

The purpose of this research is to develop new materials and establish their mechanical properties as part of the beta testing at the Rapid Prototyping Center. Elastomeric polyurethane (EPU 40) and Rigid polyurethane (RPU 70), resins developed by Carbon3D and used in its 3D printing (Digital Light Synthesis), are employed for this research. Various combinations of these resins were used to print specimen for determination of tensile properties and hardness. The hardness of the samples was measured employing a durometer (Shore A and Shore D scales). The results provide valuable insight into beta materials for use in AM industry.

Development of Pectin Microspheres as a Novel Component of Bioink

Muskan Kanungo, Senior –Biomolecular Engineering, MSOE *(Dr. Wujie Zhang)*

Microspheres have been shown to promote vascularization which is critical in tissue engineering. This study focused on optimizing the fabrication process of pectin microspheres to produce positively charged microspheres. Design Expert® software was used to optimize the process using the four identified significant parameters: pectin solution concentration, voltage, flow rate, and distance between the needle tip and the surface of the gelation bath ($CaCl_2$). The response variables selected were microsphere size (< 200 µm), roundness, and uniformity. Results show that the optimal parameters were a pectin concentration of 6%, a voltage of 21 kV, a flow rate of 8 mm/h, and a distance of 10 cm. These microspheres show great potential for incorporation into a novel bioink.

Characterization of Additively Manufactured Metals from ADDere Printing

Joshua Foster, Senior – Mechanical Engineering, University of Memphis, Memphis, TN *(Dr. Subha Kumpaty)*

Midwest Engineered Systems created a novel laser wire metal deposition process, ADDere, which has a much higher deposition rate than powder bed fusion, making it ideal for printing large components. In this project, Ti-6Al-4V printed in a single printing direction in inert atmosphere was cut into samples using a water jet cutter and machined into tensile bars at Perkins Engineering. The tensile strength was 133 ksi, the Vickers microhardness was 332±6 and the microstructure indicated high grain density and was homogenous throughout; all in compliance with ASM standards. Also, samples of 17-4 PH stainless steel and Ti64 were printed in a cross-hatched pattern and tested to compare the results with data for samples printed in a single direction. ADDere optimization is the overarching goal.

Additive-Subtractive Hybrid Manufacturing Machine (ASHMM) Software Toolchain

Kaitlyn Yeakley, Senior – Computer Engineering, Penn. State University, University Park, PA *(Dr. Nathan Patterson)*

The ASHMM currently places preformed blocks of material, adheres the blocks together, and subtractively machines a refined surface before moving onto subsequent layers. This project focused on the creation of a new software toolchain that will be able to streamline the software used previously to operate the ASHMM while also planning out a toolchain compatible with multiple additive and subtractive approaches and machines. The proposed program will be able to accept a 3D model file, interweave additive and subtractive toolpaths generated through shared data transfer points, and output Computer Numerical Control codes to operate the ASHMM.

Additive-Subtractive Hybrid Manufacturing

Andrew Gray, Junior –Mechanical Engineering, Trinity University, Allen, TX *(Dr. Nathan Patterson)*

This project focused on finding a fast set, reproduceable, and strong adhesive that can be incorporated into the Additive Subtractive Hybrid Manufacturing Machine, which was created as an end-to-end solution for the patternmaking industry depositing preformed blocks of material and adhering them to neighboring blocks. Lap shear tests were performed on the chosen adhesives, where the force at the break point was recorded and used to determine their overall strength. Each adhesive was tested with varying compression times and combination joints were tested with multiple adhesives. Different non-compressed set times were also tested to determine the influence set time on the adhesive overall strength. The results of this research provide critical data for the final machine.

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Anticipated Speaking Schedule

8:30 – 8:40 am	**Dr. Subha Kumpaty**	Welcome; Greetings from Executive VPA and Dean of Applied Research
8:40 – 8:58 am	**Levee Callahan**	Manufacture of a Head Phantom for MRI Machine Calibration
8:58 – 9:17 am	**Megan Cohan**	Creation of Three-dimensional Pedagogical Models of Genetic Mutations
9:17 – 9:35 am	**Noah Hutchison**	Biosynthesis of Gold Nanoparticles Using Upland Cress: Process Optimization and Characterization
9:35 – 9:50 am	*Break*	
9:50 –10:09 am	**Katsiaryna Kantarovich**	Synthesis of a Nano-bead Sunscreen and Testing its Efficacy
10:09 –10:27 am	**Efrem Dana**	Characterization of Additively manufactured Beta Materials
10:27 –10:45 am	**Muskan Kanungo**	Development of Pectin Microspheres as a Novel Component of Bioink
10:50 – 11:00 am	*Break*	
11:00 –11:18 am	**Joshua Foster**	Characterization of Additively Manufactured Metals from ADDere Printing
11:18 –11:36 am	**Kaitlyn Yeakley**	Additive-Subtractive Hybrid Manufacturing Machine Software Toolchain
11:36 –11:54 am	**Andrew Gray**	Additive-Subtractive Hybrid Manufacturing
11:54 –Noon	**Dr. Subha Kumpaty**	Honoring Dr. Marsha Watson, Evaluator of Prior MSOE REU Sites

RESEARCH EXPERIENCE FOR UNDERGRADUATES (REU)

Research Experience for Undergraduates is an innovative, interdisciplinary program funded by the National Science Foundation and Milwaukee School of Engineering, providing hands-on experience to participants in applications of additive manufacturing and nano engineering at MSOE Research Centers in collaboration with industry.

Nine undergraduate students were recruited from all parts of the country with diverse experiences at small and large universities, skill levels, personal interests and science and engineering backgrounds. Their 10 weeks at MSOE are spent working closely with a faculty advisor with expertise in a particular research area. REU participants explore research topics through library and internet research, webinars, problem solving with advisors, teammates and other resources, poster sessions, group discussions, research documentation, learning new software, making presentations, building models, designing and completing experiments, and writing research papers.

MSOE was awarded its sixth REU grant in 2021. 200 participants have passed through this REU program since 1997. REU programs are established at universities across the United States in all fields of science, mathematics and engineering. MSOE is one of 110 universities sponsoring an REU program in engineering. The current REU site has K-12 outreach component as the participants engage in MSOE STEM Center programs. The current cohort also interact with prior MSOE REU alumni in various settings.

Participant Qualifications

- Completed the sophomore year of an engineering, pre-engineering or a science-based curriculum
- Enrolled in a university for the fall term as a full-time student
- Earned a GPA of 3.00 or greater
- A U.S. citizen or permanent resident of the United States
- Have an interest in research and in learning about additive manufacturing applications
- Women, minorities and persons with disabilities are especially encouraged to apply

2021 Advisors

Dr. Subha Kumpaty	Professor-Mechanical Engineering, Program Director M.S. Engineering
Ms. Betty Albrecht	Assistant Dean of Students/Residence Life
Dr. Vipin Paliwal	Associate Professor – Physics, Chemistry and Math
Dr. Nathan Patterson	Associate Professor - Mechanical Engineering
Dr. Wujie Zhang	Associate Professor – Physics, Chemistry and Math

2021 Collaborators

Northwestern University (Dr. Todd Parrish)
Midwest Engineered Systems (Mr. Scott Woida)
Accurate Pattern
INNIO Waukesha Gas Engines (Mr. Liam Coen)
Perkins Engineering

More Information

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