Research Experience for Undergraduates

Oral Research Presentations

Wednesday, July 27, 2022 8:30 am – Noon

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

Refreshments served

STUDENTS, FACULTY, STAFF and GUESTS INVITED

Ethyl Cinnamate Nanobead Sunscreen Characterization Using Mouse Skin NIH/3T3 Fibroblast Cells

Azaria Wagner, Senior – Biochemistry, Rose Hulman Institute of Technology, Terre haute, IN *(Dr. Vipin Paliwal)*

The purpose of this project is to synthesize a nanobead sunscreen from commercial ethyl cinnamate and Pluronic and evaluate the efficacy of the synthesized sunscreen in preventing ultraviolet B radiation damage to DNA in 3T3 mouse skin fibroblasts. Flash nano precipitation was used to synthesize the ethyl cinnamate nanobeads sunscreen, Neutral red dye assay and ELISA were employed to determine protective efficacy of the sunscreen on the DNA of the 3T3 mouse fibroblasts. The sunscreen is found to be significantly effective at dilutions ranging from 1x to 8x. The next step is to quantify the DNA damage being prevented by quantifying the 6-4 photoproducts formed.

Green Synthesis of Metallic Nanoparticles using American Ginseng and Upland Cress

Paige Bowman, Junior –Biomolecular Engineering, MSOE *(Dr. Wujie Zhang)*

The purpose of this project is to explore the viability of American ginseng as an agent for the green synthesis of metallic nanoparticles. American ginseng's different parts − leaf, stem, and root were analyzed. The results indicated that the American ginseng leaves contained the highest amounts of phenols and vitamin C, whereas ginseng roots and stems contained significantly lower but similar amounts to upland cress. Gold nanoparticles were successfully synthesized using all parts of American ginseng. Green synthesis of Alloy nanoparticle synthesis was also explored, and synthesized nanoparticles were characterized and tested using different methods, such as UV-Vis spectroscopy.

Investigation of Blister Formation in Post-Processing of Additively Manufactured Parts

Santiago Cartagena, Junior –Chemical Engineering, Univ. of Puerto Rico, Mayaguez, PR *(Dr. Vyas, Kumpaty, Weston)*

This work investigated blistering experienced by parts from Stratasys FDM 3D printer when subjected to ultrasonic cleaning with a sodium hydroxide solution. Variables such as solution temperature, time, position in tank, and model geometry have been experimented with to study their effects on the blister formation. Frequency has been identified as a necessary factor, as well as 24 hours being the time spent in tank needed for blister formation. These blisters appear to be formed by a thermal energy concentration within the object that starts to melt many small pockets until they coalesce into one big void. Dimensional analysis will be applied to identify relevant dimensional groups for blister formation phenomenon.

Diclofenac Cytotoxicity in 2- and 3-D Rat Hepatocytes

Alayna Willitzer, Senior – Biomedical Engineering, Trine University, Angola, IN *(Dr. Vipin Paliwal)*

The purpose of this project is to determine an optimal dosage of diclofenac to avoid liver damage. 2D and 3D cell cultures of rat hepatoma were used to study drug induced liver injury. A neutral red dye cytotoxicity assay was performed to determine an appropriate concentration range of diclofenac. This concentration range was administered within the cell cultures to analyze functionality of cells by quantifying albumin secretion, a marker of cell damage and total protein through ELISA and BCA assay, respectively. The cytotoxicity results from the neutral red dye assay illustrated that the 3D cell cultures were more sensitive to the diclofenac than the 2D cell cultures. Thus, 3D organoid cell cultures provide a more accurate representation of in vivo conditions for liver damage.

Biomedical Applications of Pectin Microspheres

Ryan Azzouz, Senior − Biology, Midwestern State University, Wichita Falls, TX *(Dr. Wujie Zhang)*

This project comprises two parts, the development of pectin-based microspheres to be incorporated in bioink for bioprinting vascularized tissues and the production of pectin microspheres around 3 µm for pulmonary drug delivery. Both projects use an electrospinning system to produce microspheres. Regarding the bioprinting part, microspheres were coated with gelatin and then crosslinked using either EDC or Transglutaminase. The results indicated that the coating and crosslinking were successful. Upon microsphere incorporation, density and viscosity of the bioink were not significantly altered. When it comes to the drug delivery portion, microspheres of around 3 µm were successfully produced, and the coating of microspheres using gelatin and chitosan was also explored.

A Realistic Brain Phantom for Advanced Neuroimaging Quality Assurance

Thomas Behling, Junior − Physics, University of Toledo, Toledo, OH *(Dr. Subha Kumpaty, Dr. Todd Parrish)*

This project focuses on creating a more accurate calibration phantom for use with modern MRI machinery. This phantom will replicate many physical and dielectric properties of the brain that are unrepresented in currently available calibration tools. This phantom is constructed from an Agar-based gel doped with nickel nitrate, sodium citrate and PEG, and this gel is formed will using silicone rubber molds. Once set, the phantom will be rested inside a 3D-printed housing filled with water. This project has so far validated the use of platinum-cure silicone as a molding material and has determined the relative effectiveness of different concentrations of Agar gel.

Medical Applications of Additive Manufacturing: Anatomical Modeling

Sarah Gonu, Senior − Nursing, College of DuPage/Benedictine University, Glen Ellyn/Lisle, IL *(Dr. Subha Kumpaty)*

The purpose of this project is to create anatomical models for educational purposes for both students and patients. In this research, several DICOM files were reviewed, specifically computer tomography scans, to obtain images of the spine, process file conversions and print via additive manufacturing. A pediatric spine model made of PA-12 Nylon was successfully printed using selective laser sintering which can be used pedagogically. The next step is to work on a soft tissue, and plans are underway to 3D print a model of the kidney using digital light synthesis.

Material Development – Attaining New Properties with Filled Polymers

David Reyes, Senior –Mechanical Engineering, MSOE *(Dr. Anand Vyas, Dr. Subha Kumpaty and Mr. Jordan Weston)*

The purpose of this research was to investigate the effects of adding filler materials to polymers produced by additive manufacturing. This was done by filling PEBA 4755 with 0 wt%, 20 wt%, and 40 wt% glass beads and subjecting them to tensile, Izod impact, and Shore D hardness testing. Results show that while elastic modulus increased, the elongation at rupture and the tensile strength decreased as more glass beads are added to the polymer. Fracture toughness for the 0 wt% and 20 wt% samples were classified as non-breaks. The hardness of PEBA remained practically unaffected by addition of glass beads.

Methods of Creating Fiber-based Brain Phantom for Diffusion Tensor MRI

Max Jancich, Soph./Junior − Chemistry, Indiana University, Bloomington, IN *(Dr. Subha Kumpaty, Dr. Todd Parrish)*

Diffusion tensor MRI allows medical professionals to get a better understanding of the connections within the brain. To ensure proper calibration and testing, a standard and realistic representation of the brain, or brain phantom, is needed. This research showed Dyneema ® is an accurate replacement for fibers within the brain due to its ability to guide the diffusion of water in one direction, or anisotropically. Initial testing involves making various sizes of Dyneema ® fiber bundles from different manufacturers and enclosing them in brain-like orientations to be tested in an MRI machine. Currently, two full test phantoms using the Dyneema ® fibers which are 10 microns in diameter, are completed and readied for MRI imaging.

Research Experience for Undergraduates

Wednesday, July 27, 2022

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

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	**Azaria Wagner**	Ethyl Cinnamate Nanobead Sunscreen Characterization Using Mouse Skin NIH/3T3 Fibroblast Cells
8:58 – 9:17 am	**Paige Bowman**	Green Synthesis of Metallic Nanoparticles using American Ginseng and Upland Cress
9:17 – 9:35 am	**Santiago Cartagena**	Investigation of Blister Formation in Post-Processing of Additively Manufactured Parts
9:35 – 9:50 am	*Break*	
9:50 –10:09 am	**Alayna Willitzer**	Diclofenac Cytotoxicity in 2- and 3-D Rat Hepatocytes
10:09 –10:27 am	**Ryan Azzouz**	Biomedical Applications of Pectin Microspheres
10:27 –10:45 am	**Thomas Behling**	A Realistic Brain Phantom for Advanced Neuroimaging Quality Assurance
10:50 – 11:00 am	*Break*	
11:00 –11:18 am	**Sarah Gonu**	Medical Applications of Additive Manufacturing: Anatomical Modeling
11:18 –11:36 am	**David Reyes**	Material Development – Attaining New Properties with Filled Polymers
11:36 –11:54 am	**Max Jancich**	Methods of Creating Fiber-based Brain Phantom for Diffusion Tensor MRI
11:54 –Noon	**Dr. Subha Kumpaty**	Closing Remarks (and Announcement of Poster Session next Wed)

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 (EEC-2045738). Over 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

2022 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. Anand Vyas	Instructor − Mechanical Engineering
Mr. Jordan Weston	Manager of Operations – Rapid Prototyping Center
Dr. Wujie Zhang	Associate Professor – Physics, Chemistry and Math

2022 Collaborators

Northwestern University (Dr. Todd Parrish)	MSOE Center for Biomolecular Modeling
INNIO Waukesha Gas Engines (Mr. Liam Coen)	MSOE Rapid Prototyping Center

More Information

Dr. Subha Kumpaty
MSOE
kumpaty@msoe.edu 414-277-7466