RAMP ANNUAL SYMPOSIUM 2019

RAMP
ROCHESTER ADVANCED MATERIALS PROGRAM

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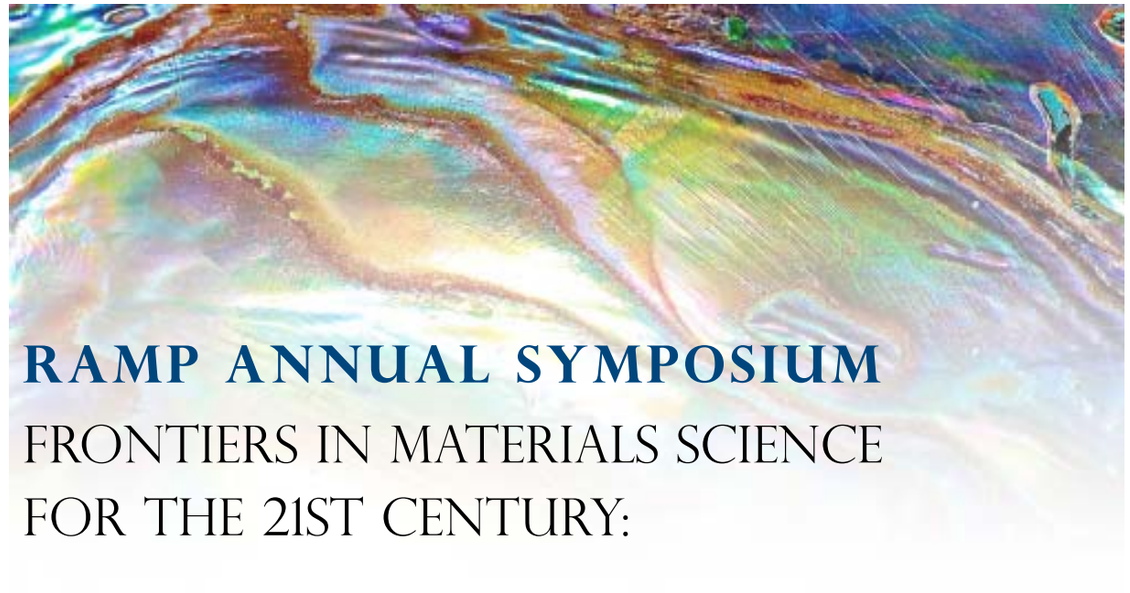

RAMP ANNUAL SYMPOSIUM

FRONTIERS IN MATERIALS SCIENCE FOR THE 21ST CENTURY:

Biologically Engineered Materials

GOERGEN HALL,
UNIVERSITY OF ROCHESTER
MAY 23, 2019

UNIVERSITY of ROCHESTER

RAMP
ROCHESTER ADVANCED MATERIALS PROGRAM

SCHEDULE

8:30-9:00am	Registration, Goergen Hall, Munnerlyn Atrium (Continental breakfast will be available.)
9:00-9:05am	Opening comments: Professor Anne Meyer, University of Rochester
9:05-9:45am	**Dr. Filipe Natalio** *"Towards material farming: where plant biology meets material sciences"*
9:45-10:00am	Discussion
10:00-10:45am	**Professor Iris V. Rivero** *"Disruptive Medical Technologies: Additive Manufacturing for the Achievement of Personalized Treatments"*
10:45-11:00am	Discussion
11:00-11:30am	Coffee Break and Poster Session
11:30am-12:15pm	**Professor Wil V. Srubar III** *"Building with Bacteria: Applications of Synthetic Biology to Architecture and Civil Engineering"*
12:15-12:30 pm	Discussion
12:30-1:00 pm	Lunch in Munnerlyn Atrium
1:00-1:30 pm	Poster Session
1:30-2:15 pm	**Professor Danielle Benoit** *"'Smart' to Biomimetic Materials: Taking cues from nature to enable RNAi delivery"*
2:15-2:30 pm	Discussion
2:30-3:15 pm	**Dr. Lynn Rothschild** *"Biomaterials for space"*
3:15-3:30 pm	Discussion
3:30-3:45 pm	Coffee Break and Poster Session
3:45-4:45 pm	**Lightning Talks**
4:45-5:00 pm	Awards and closing remarks: Professor Meyer, University of Rochester

SPEAKERS

Dr. Filipe Natalio

Kimmel Center for Archaeological Science
Weizmann Institute of Science

"Towards material farming: where plant biology meets material sciences"

Abstract:

Biological fabrication combines the ability of designing bioinspired molecules (chemistry) with nature's complexity and ingenious paths (biology) in order to produce new composite materials with emergent properties while being able to tailor the said materials' end-functionality or functionalities. And what is material farming? It is the possibility to implement alternative and sustainable methodologies of biological fabrication toward larger scales, real-life applications, and marketable products. The proof-of-principle was recently demonstrated for biological fabrication of fibers with tailored properties using an in vitro cotton culture and designed glucose derivatives yielding fluorescent and supermagnetic cotton fibers. This new "fabrication approach" will allow, in the future, to sustainably transform abundant raw materials into an innovative new class of composite functional materials, such as a new generation of smart textiles in the above case of cotton.

Further Reading:

[1} Natalio, F., Fuchs, R., Cohen, S. R., Leitus, G., Fritz-Popovski, G., Paris, O., Kappl, M., and Butt, H. J. (2017) Biological fabrication of cellulose fibers with tailored properties, Science 357, 1118-1122.

[2] Natalio, F., Tahir, M. N., Friedrich, N., Kock, M., Fritz-Popovski, G., Paris, O., and Paschke, R. (2016) Structural analysis of Gossypium hirsutum fibers grown under greenhouse and hydroponic conditions, J Struct Biol 194, 292-302.

[3] Natalio, F. (2018) Future Perspectives on Biological Fabrication and Material Farming, Small Methods, 1800136.

Biography:

Dr. Filipe Natalio obtained his Ph.D. in tissue engineering and biomineralization, from the Medical School of the University of Mainz (Germany). He did his post-doc at Department of Inorganic Chemistry at the University of Mainz on biomimetic catalytic activity of metal oxide nanoparticles and hierarchical organic-inorganic composites. After, he became an Assistant Professor at the Martin-Luther University (Halle, Germany) with particular focus on development of sustainable materials and biological fabrication. Dr. Natalio has recently joined the Weizmann Institute of Science as Senior Scientist. His research interests include archaeological sciences and plant sciences where he developed the concept of material farming.

Professor Iris V. Rivero

Department of Industrial and Systems Engineering
Rochester Institute of Technology

"Disruptive Medical Technologies: Additive Manufacturing for the Achievement of Personalized Treatments"

Abstract:

Additive manufacturing (AM) provides the means for the efficient generation of three-dimensional objects. In particular, the ease of generation of contoured and customized geometries lends the technology to the idealization of its adaptation for the delivery of personalized bedside medical treatments. The potential that AM can bring to the medical field can positively disrupt current approaches to diagnostics, surgical planning, and the design of treatments for distinct ailments. However, significant constraints for the true development of AM as a personalized bedside treatment technology remain. In particular, limitations arise from the availability of material systems (or bioinks) that physiologically correspond to the treatment being sought, and the difficulty of adapting these technologies' production rates without sacrificing the repeatability of the geometrical designs. Tissue engineered constructs (TEC) generated by AM, which support the repair of tissues, currently hold the highest potential to incorporate some degree of personalization into medical treatments. Therefore, findings related to three AM design concepts for TECs will be discussed, 1) bioink design, 2) printability, and 3) biocompatibility and biodegradability of printed structures. Correlating bioink properties and AM parameters to attain repeatable structures will contribute to the realization of AM technologies becoming standard bedside clinical treatment.

Biography:

Dr. Iris V. Rivero is the Kate Gleason Professor and Department Head of Industrial and Systems Engineering at Rochester Institute of Technology (RIT). In addition, she directs the iMED (Interdisciplinary Manufacturing Engineering and Design) laboratory. Prior to joining RIT, she was a member of the faculty of the Department of Industrial and Manufacturing Systems Engineering at Iowa State University where she served as Director of Graduate Studies and Associate Chair emphasizing the development of programs for the recruitment of underrepresented minority students. Prior to her tenure at Iowa State University, Dr. Rivero spent ten years at Texas Tech University where she still holds an Adjunct Associate Professor position with the Department of Surgery of the Health Sciences Center. Dr. Rivero received her B.S., M.S., and Ph.D. in Industrial & Manufacturing Engineering from the Pennsylvania State University. Her research interests include additive and hybrid manufacturing processes, biomedical manufacturing, and design of additive manufacturing alloys. She has industrial experience in the fields of advanced manufacturing systems and materials at Detroit Diesel Corporation and Honeywell Engines & Systems. In addition, she participated as a faculty fellow at NASA's Marshall Space Flight Center. In 2009 Dr. Rivero was recognized with the Society of Manufacturing Engineers (SME) John G. Bollinger Outstanding Young Manufacturing Engineer Award. Moreover, she was the recipient of the 2015 Institute of Industrial and Systems Engineers (IISE) Manufacturing & Design Outstanding Service Award for her work leading to the revitalization of the IISE Manufacturing and Design Division. She currently serves as IISEs Technical Vice-President of the IE Body of Knowledge.

Professor Wil V. Srubar III

Civil, Environmental, and Architectural
Engineering University of Colorado Boulder

"Building with Bacteria: Applications of Synthetic Biology to Architecture and Civil

Abstract:

Recent advances in metabolic engineering have enabled autonomous, high-fidelity biomanufacturing of useful chemical, mineral, and polymer building blocks that can be leveraged in the design and fabrication of construction materials and living architectures at the human scale. This presentation will highlight the research efforts of a highly interdisciplinary and collaborative team at the University of Colorado Boulder that is integrating synthetic biology, microbiology, materials science, and structural engineering to design and fabricate useful minerals (e.g., aggregates for concrete production) and polymers (e.g., styrene) for materials with commercial applications to building design and construction. In one study, we demonstrate for the first time that calcium carbonate ($CaCO_3$) mineral aggregates for mortar and concrete can be tailored by modulating the precipitation kinetics through genetic engineering of ureolytic microorganisms. We also demonstrate that useful quantities of styrene for construction material manufacture can be biologically produced via microbial engineering. In this presentation, we will also show that engineered microorganisms can be leveraged in the design of hybrid living building materials that display both biological (i.e., living, regenerative self-healing) and structural (i.e., load-bearing) function. Finally, this talk will highlight the challenges that emerge working across length scales and disciplines, as well as the grand opportunity that exists for synthetic biologists and materials engineers to work together to create never-before-imagined material solutions for critical societal problems in energy, water, and the built environment.

Professor Danielle Benoit

Department of Biomedical Engineering
University of Rochester

"'Smart' to Biomimetic Materials: Taking cues from nature to enable RNAi delivery"

Abstract:

Small interfering RNA (siRNA) exhibits significant therapeutic potential, as it can target a broad range of targets but is hampered by delivery barriers associated with susceptibility to degradation and poor cell penetration. Delivery approaches have been developed to overcome these barriers; however, tissue/cell-specific delivery of siRNA remains a major hurdle. Systemic delivery of siRNA, often achieved using nanoparticle (NP)-based delivery systems, suffers from serum protein-mediated aggregation, which significantly diminishes siRNA delivery efficiency in vitro. Thus, we have taken two approaches to local delivery, which limits protein exposure and abrogates aggregation and tissue targeting hurdles, based on a highly successful NP delivery system formed from self-assembling cationic, and pH responsive diblock copolymers of poly(dimethylaminoethyl methacrylate) (DMAEMA)-b-poly(DMAEMA-co-propylacrylic acid-co-butyl methacrylate) (pDMAEMA-b-pDMAEMA-co-PAA-co-BMA). Significantly improved tendon and fracture healing as well as salivary gland radiation protection is achieved using these local delivery approaches. While NP-siRNA can be delivered locally, reducing non-specific protein-NP interactions is key to improving the systemic delivery of siRNA-NPs. Thus, current efforts focus on use of zwitterionic peptides (ZIPs) to reduce protein adsorption by emulating non-aggregating protein surface characteristics and improve systemic delivery of siRNA.

Dr. Lynn Rothschild

NASA

"Biomaterials for space"

Biography:

Lynn Rothschild is passionate about the origin and evolution of life on Earth or elsewhere, while at the same time pioneering the use of synthetic biology to enable space exploration. Just as travel abroad permits new insights into home, so too the search for life elsewhere allows a more mature scientific, philosophical and ethical perception of life on Earth. She wears several hats as a senior scientist NASA's Ames Research Center and Bio and Bio-Inspired Technologies, Research and Technology Lead for NASA Headquarters Space Technology Mission Directorate, as well as Adjunct Professor at Brown University. Her research has focused on how life, particularly microbes, has evolved in the context of the physical environment, both here and potentially elsewhere. More recently Rothschild has brought her creativity to the burgeoning field of synthetic biology, articulating a vision for the future of synthetic biology as an enabling technology for NASA's missions, including human space exploration and astrobiology. Since 2011 she has been the faculty advisor of the award-winning Stanford-Brown iGEM team, which has pioneered the use of synthetic biology to accomplish NASA's missions, particularly focusing on the human settlement of Mars, astrobiology and such innovative technologies as BioWires and making a biodegradable UAS (drone) and a bioballoon. Her lab is testing these plans in space on in the PowerCell synthetic biology secondary payload on a DLR satellite, EuCROPIS, launched in December 2018. She is a fellow of the Linnean Society of London, The California Academy of Sciences and the Explorer's Club. In 2015, she was awarded the Isaac Asimov Award from the American Humanist Association, and was the recipient of the Horace Mann Award from Brown University, and has been a NASA Innovative Advanced Concepts (NIAC) fellow three times, most recently in 2018. She frequently appears on documentaries, TV and radio, and lectures worldwide, including Windsor Castle, Comi Con, TechFestival and the Vatican.

About the Symposium

The topic of the 2019 annual RAMP symposium is “Biologically Engineered Materials”. Biological approaches for the production of materials is an emerging discipline that offers remarkable flexibility combined with environmental friendliness. Biological systems can carry out advanced chemical reactions to produce materials under ambient conditions, typically without using or producing toxic waste products. Natural biological materials additionally demonstrate the properties of: self-assembly from simple starting materials, the capability for on-site production, diverse chemical and physical properties, self-healing capacity, and the ability to sense and respond to environmental conditions. These natural abilities can be further enhanced through newly developed tools of synthetic biology to genetically engineer new properties into living organisms, or by applying 3D printing techniques to biological organisms or materials.

This symposium brings together distinguished researchers developing novel techniques to create, spatially pattern, or deliver biological materials for applications ranging from personal therapeutics to space colonization. The goal of the symposium is to learn about and foster expertise in biological materials within the existing work on materials at UR. This year’s symposium features both a poster exhibition describing student research in materials

Symposium Credits

Anne S. Meyer
Associate Professor of Biology
University of Rochester

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Web and Print Design.....Ana Vaquera, Melissa A. Vicente Pejay