BEPS BIOENVIRONMENTAL POLYMER SOCIETY

WORKING TO CREATE A SUSTAINABLE FUTURE

27th Bio-Environmental Polymer Society Meeting

June 23-25, 2021

Hosted by Rowan University

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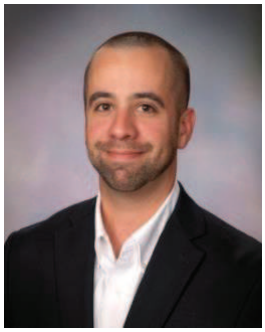
Message from the BEPS President



Dear Attendees:

It is my pleasure and honor to welcome you all to the Bio-Environmental Polymer Society (BEPS) 2021 27th Meeting. The 27th Meeting has been put together by the BEPS Executive Committee and dedicated folks within the Henry M. Rowan College of Engineering and the Advanced Materials & Manufacturing Institute (AMMI) at Rowan University (Glassboro, NJ, USA). As President of BEPS, I could not have created such a packed and impactful 3-day meeting without their tireless efforts and support. I cannot thank them enough. The meeting is entirely virtual; however, I am extremely excited about the program and I truly believe that knowledge will be exchanged, ideas will be created and discussed, and networking will still occur, despite us all not being physically present.

The BEPS meetings aim at bringing scientists and researchers from across the globe to present and exchange breakthrough ideas related to biobased and sustainable materials and technologies. This year's meeting theme is "Bridging Sustainability Gaps via Reshaped Polymers and Mindsets." Reshaped is utilized to describe redesigning all facets of plastics, from raw materials to processing to in-use and end-use properties to societal impacts to education. Over the next three days, more than 80 speakers will present their research related to the meeting's theme with topics divided into 6 tracks: (1) Biodegradability & Sustainability; (2) Synthesis of Bio-based Polymers; (3) Applications of Bio-based Materials; (4) Advances in Polymer Manufacturing; (5) Progress in Lignin Valorization; and (6) Bio-based Composites & Components. Each of these talks tackle critical challenges associated with their respective domain(s). I am sure that each one of you will identify subjects of his/her interest and will benefit from many fruitful and enriching discussions.

I would like to thank you for attending this year's meeting. I would like to also thank all the presenters, both confirmed invited speakers and open submitters, for putting together such wonderful abstracts. We could not have put together such an exciting meeting without your support and willingness to contribute. We are looking forward to your presentations and the conversations that result from them. Furthermore, I would like to congratulate this year's BEPS Award winners, all of whom are presenting and information about them and their respective awards highlighted in this program booklet. Additionally, I would like to thank Composites Part C: Open Access (JCOMC) for their support of this year's meeting through the creation of a Special Issue dedicated to BEPS. Information about this Special Issue, including the opportunity to contribute to it free of charge, can be found in this program booklet and on the BEPS and JCOMC websites. I encourage you to consider contributing to this Special Issue, which could not have been made possible without the support of Profs. Amar Mohanty and Manju Misra (University of Guelph, Canada). Thank you both! Lastly, I congratulate you all for your commitment and active participation, and wish you to stay healthy, safe, and positive!

I hope to see you in-person soon!

Sincerely,

Joe Stanzione, III, Ph.D.
Associate Professor of Chemical Engineering
Founding Director, Advanced Materials & Manufacturing Institute (AMMI)
Rowan University
Glassboro, NJ, USA

About BEPS

Mission & Scope: Biomass is the most readily implementable solution to manufacture sustainable materials, including polymers, to meet the increasing demand for global populace while tackling the growing risks of climate change. In this context, BEPS is a non-profit society that seeks to: (1) Advance fundamental knowledge of design, chemical/biochemical synthesis, processing, analyses & applications of polymers derived from readily renewable carbon; (2) Feature new technology and commercial successes presented by businesses; (3) Welcome biorefinery-related research that aims to develop and integrate individual biomass process streams with primary biomass components; and (4) Promote basic research, training and education, and facilitate exchange of information among researchers in areas of biology, chemistry, materials science, life-cycle analysis, agriculture, forestry, environmental policy and waste management.

History: The Bio-Environmental Polymer Society was founded in 1992. Those involved in the formative stages included Richard Gross, Sam Huang, Dave Kaplan, Steve McCarthy, and Denise Rutherford. A critical meeting was organized in 1991, titled "*Symposium on Environmentally Degradable Polymers: Technical , Business and Public Perspectives*", involving ~ 140 scientists from major corporations, government laboratories and universities. This meeting ultimately resulted in the formation of a new society: Bio/Environmentally Degradable Polymer Society (BEDPS). Later, this name was modified to Bio-Environmental Polymer Society (BEPS) to reflect interest in synthetic, renewable (bio-based) and degradable polymers.

BEPS Activities: The primary mechanism of information exchange is through the BEPS website and participation at our Annual/Semi-Annual Meetings. These meetings are typically in June, August, or September and consist of scientific, marketing, and informational presentations over several days. A broad range of topics is presented at the meeting through both oral and poster presentations. Key topics included in the BEPS Meetings include:

- Progress on commercialization efforts of bio-based monomers, polymers, and corresponding materials;
- Green routes for polymer chemical or enzymatic recycling;
- Polymers used for application in foods, nutrition, and agriculture;
- Innovations in chemical and biocatalytic routes to monomers and polymers;
- Innovative chemical processes for conversion of lignocellulose to value-added products;
- Biopolyesters;
- Green chemical catalysts for bio-based monomer and polymer synthesis;
- Protein-based materials and carbohydrate-based materials;
- Biocatalytics routes to natural polymers;
- Modification of natural polymers to tune physical and biological properties;
- Metabolic and protein engineering to develop catalysts for green polymer chemistry;
- Bio-based composites, coatings, and structural materials;
- Biofibers;
- Life-cycle analysis of bio-based processes;
- Studies of polymer biodegradability (soil, marine, compost, anaerobic digestion) and other end-of-life options; and
- Process developments (*e.g.*, continuous bioprocesses, downstream aspects).

27th BEPS – Meeting Schedule

Day 1: 23 June 2021 (Wednesday)

June 23, 2021	Bioenvironmental Polymers Society (BEPS) 2021 27th Meeting (ALL TIMES Eastern Time)	
9:00-9:10 am	Welcome Remarks	
9:10-9:50 am	Plenary Session P1 (BEPS Outstanding Young Scientist Award Co-recipient Winner) Session Chair: Joe Stanzione P1.1 - Electrically Conductive Biobased Fillers and Composites **Cecily Ryan** Montana State University, USA	
9:50-10:00 am	Coffee Break	
10:00 am - 12:30 pm	**Concurrent Sessions**	
	S1 - Biodegradability & Sustainability **Session Chair:** John Chea	**S2 - Synthesis of Bio-based Polymers** **Session Chair:** Tristan Bacha
10:00-10:20 am	S1.1 - Data-driven Approach to Understanding Polymer Degradation in the Ocean **Invited Speaker: Robert Mathers** Penn State University, USA	S2.1 - From Eugenol to Biobased Polymers: A Platform Approach **Invited Speaker: Sylvain Caillol** Institut Charles Gerhardt Montpellier, France
10:25-10:45 am	S1.2 - Techno-Economic Analysis and Life Cycle Assessment of Lignin Fractionation and Valorization Via the Alpha Process: Upgrading to Value-Added Products **Invited Speaker: David Shonnard** Michigan Technological University, USA	S2.2 - Renewability is Not Enough: Sustainable Synthesis of Biomass-derived Monomers and Polymers **Invited Speaker: Michael Meier** Karlsruhe Institute of Technology, Germany
10:50-11:10 am	S1.3 - Microfibers Shed During Laundering and Their Interactions With The Environment **Invited Speaker: Richard Venditti** North Carolina State University, USA	S2.3 - Ocean Digestible Bioplastics **Invited Speaker: Stephen Miller** University of Florida, USA
11:15-11:35 am	S1.4 - Potential Microparticles Entering the Air and Water Environment from Nonwoven Products: Methodology Development and Initial Findings **Soojin Kwon** North Carolina State University, USA	S2.4 - Engineering Non-Isocyanate Polyurethanes to be 100% Biobased and Recyclable by Design **Invited Spekaer: Srikanth Pilla** Clemson University, USA
11:40-noon	S1.5 - Degradable and thermally Stable Spiro Polycycloacetals from Renewable Resources **Yanchun Tang** University of Houston, USA	S2.5 - Developing Betulin-Based Polyesters from Birch Bark **Invited Speaker: Melissa Gordon** Lafayette College, USA
12:05-12:25	S1.6 - Oxo-Biodegradable LLDPE Films Subjected to Gamma Irradiation and Accelerated Weathering **Tomas Madera-Santana** Resesarch Center in Food & Development, México	S2.6 - Biodiversification of Natural Rubber by Metabolic Engineering **Invited Speaker: Katrina Cornish** Ohio State University, USA
12:30-2:00 pm	Lunch Break	
2:00-4:30 pm	**Concurrent Sessions**	
	S1 - Biodegradability & Sustainability **Session Chair:** Alexandra Chong	**S2 - Synthesis of Bio-based Polymers** **Session Chair:** Jasmin Vasquez
2:00-2:20 pm	S1.7 - Poly(ethyleneterephthalate) (PET) Recycling: Current Strategies, Shortcomings, and Reinforced Composites **Michael Snowdon** University of Guelph, Canada	S2.7 - Progress in Sustainable Long-Chain Aliphatic Polyethylene Mimics **Invited Speaker: Chuanbing Tang** University of South Carolina, USA
2:25-2:45 pm	S1.8 - Sustainability Assessment, Process Development, and Life Cycle Analysis **Invited Speaker: Gerardo Ruiz-Mercado** US Environmental Protection Agency, USA	S2.8 - Glycerol Ketals as Building Blocks for a New Class of Biobased (Meth) Acrylate Polymers **Shailja Goyal** Iowa State University, USA
2:50-3:10 pm	S1.9 - Effect of Gliding Arc Plasma Treatment on Soil Degradation of Biodegradable Plastic Mulch Films **Invited Speaker: Christopher Lewis** Rochester Institute of Technology, USA	S2.9 - Chemoenzymatic Polymerization of L-Serine Ethyl ester without Side-Chain Protection of Monomer **Takumi Watanabe** Kyoto University, Japan
3:15-3:35 pm	S1.10 - Biodegradable Plastic Detected in Soil Two Years After Incorporation of Agricultural Plastic Mulch **Alexis Gillmore** University of Tennessee Knoxville, USA	S2.10 - A Green and Sustainable Platform for Biopolymers Production using a Marine Photosynthetic Purple Bacterium **Choon Pin Foong** Kyoto University, Japan
3:40-4:00 pm	S1.11 - Pathways for Isoflavone Extraction from Soybean Meal **Invited Speaker: Kirti Yenkie** Rowan University, USA	S2.11 - Genome-Engineered *Pseudomonas Alloputida* for Conversion of Lactose to mcl-PHA **Invited Speaker: Trevor Charles** University of Waterloo, Canada
4:05-4:25 pm	S1.12 - Effects of COVID-19 Pandemic on the Municipal Solid Waste Management **Poritosh Roy** University of Guelph, Canada	S2.12 - Self-catalytic Preparation of Epoxy vitrimers: Mechanical Performance, Adaptivity, and Recyclability **Invited Speaker: Jinwen Zhang** Washington State University, USA
4:30-5:00 pm	Q&A Session, Presentation of the James Hammar Memorial Service Award Recipient, and Closing Remarks	

27th BEPS – Meeting Schedule

Day 2: 24 June 2021 (Thursday)

June 24, 2021	Bioenvironmental Polymers Society (BEPS) 2021 27th Meeting (ALL TIMES Eastern Time)	
9:00-9:10 am	Welcome Remarks	
9:10-9:50 am	Plenary Session P2 (BEPS Lifetime Achievement Award Winner) Session Chair: Joe Stanzione P2.1 - Single-use Plastics: Challenges & Alternatives **Manjusri Misra** University of Guelph, Canada	
9:50-10:00 am	Coffee Break	
10:00 am - 12:30 pm	**Concurrent Sessions**	
	S4 - Advances in Polymer Manufacturing **Session Chair:** Alexandra Chong	**S5 - Progress in Lignin Valorization** **Session Chair:** John Chea
10:00-10:20 am	S4.1 - Applications of Biodegradable Polymers for Fused Deposition Modeling 3D Printing **Invited Speaker: Adriána Kovalčík** Brno Univeristy of Technology, Czech Republic	S5.1 - Carbon Fibers Derived from Lignin-based Precursors **Invited Speaker: Amod Ogale** Clemson University, USA
10:25-10:45 am	S4.2 - Solution Blow Spinning of Polymer Solutions: Technology and Application **Invited Speaker: Greg Glenn** USDA ARS Pacific West Area, USA	S5.2 - Production and Characterization of Bio-oils from Solvent Liquefaction of Lignin **Invited Speaker: Charles Mullen** USDA ARS ERRC, USA
10:50-11:10 am	S4.3 - Understanding Stereotypical Implications in PLA Polymers for Manufacturing Performance and Processability **Invited Speaker: Ramani Narayan** Michigan State University, USA	S5.3 - Fractionating and Purifying Hybrid Poplar Lignins with Aqueous Renewable Solvents for Higher-value Applications: Fibers, Foams, and Carbons **Invited Speaker: Mark Thies** Clemson University, USA
11:15-11:35 am	S4.4 - Transforming Thermosets into Thermoplastics: Dynamic Covalent Bonds Enable Sustainable Chemical Recycling of Traditional Non-Recyclable Polymers and Composites **Invited Speaker: John Torkelson** Northwestern University, USA	S5.4 - Resolving the Discrepancies in the True Molecular Weight of Lignins with the Assistance of the ALPHA Process **Zachariah Pittman** Clemson University, USA
11:40-noon	S4.5 - Thermosetting Bio-Derived and Environmentally Friendly Polymers for Additive Manufacturing **Invited Speaker: John La Scala** US Army Research Laboratory	S5.5 - Exploiting the Liquid-Liquid Phase Behavior of Hybrid Poplar Lignin in Ethanol-Water Solutions to Produce Precursors for Value-Added Applications **Graham Tindall** Clemson University, USA
12:05-12:25	S4.6 - Modifying Polyethylene Terephthalate through Reactive Twin Screw Extrusion to Improve Enzymatic Degradation **Akanksha Patel** University of Massachusetts Lowell, USA	S5.6 - Life cycle Assessment of Lignin-containing Cellulose Nanocrystals (LCNCs) Isolation using Deep Eutectic Solvents (DES) **Shiva Zargar** University of British Columbia, Canada
12:30-2:00 pm	Lunch Break and BEPS Executive Committee Board Meeting (12:45-1:45 pm)	
2:00-4:30 pm	**Concurrent Sessions**	
	S3 - Applications of Bio-based Materials **Session Chair:** Matthew Schwenger	**S2 - Synthesis of Bio-based Polymers** **Session Chair:** Tristan Bacha
2:00-2:20 pm	S3.1 - Developing Highly Effective Polysaccharide Flocculants **Invited Speaker: Wim Thielemans** KU Leuven, Belgium	S2.13 - Enhancing Properties in Fatty Acid-Derived Thermoplastic Elastomers by Incorporating a Transient Network **Invited Speaker: Megan Robertson** University of Houston, USA
2:25-2:45 pm	S3.2 - Biobased Coating for the Rejuvenation of Old Asphalt Shingles **Invited Speaker: Nacu Hernandez** Iowa State University, USA	S2.14 - Performance Advantages for Bioproducts in Manufacturing, Performance, and End-of-Life **Invited Speaker: Nicholas Rorrer** NREL, USA
2:50-3:10 pm	S3.3 - Advances in Biopolymers for Environmental and Biomedical Applications **Invited Speaker: Xiuzhi (Susan) Sun** Kansas State University, USA	S2.15 - High Performance Epoxy-AmineThermosets Based on Furan Building Blocks **Invited Speaker: Giuseppe Palmese** Drexel University, USA
3:15-3:35 pm	S3.4 - The Adhesion and Thermal Properties of Hot Melt Adhesive-based Nature Rosin and Poly(butylene adipate-co-terephthalate) for Packaging **JiHyun Cho** Seoul National University, South Korea	S2.16 - High Strength Thermosets from High Functionality Bio-based Resins **Invited Speaker: Dean Webster** North Dakota State University, USA
3:40-4:00 pm	S3.5 - Adhesion Property of PBS Hot-Melt Adhesives by Rosin Type **Kwang-Hyun Ryu** Seoul National University, South Korea	S2.17 - Recent Advances in Cashew Nutshell Liquid Technology **Invited Speaker: Joseph Mauck** Cardolite Corporation, USA
4:05-4:25 pm	S3.6 - Shelf Life Extension of Postharvested Climacteric Fruits by Using Edible Coatings **Neelima Tripathi** IIT Kanpur, India	S2.18 - Polyester Technology for Greener Cosmetic Ingredients: Re-envisioning Classic Chemistry for Enhanced Performance and **Invited Speaker: Mike Fevola** Inolex, USA
4:30-5:00 pm	Q&A Session and Closing Remarks for the Day	

27th BEPS – Meeting Schedule

Day 3: 25 June 2021 (Friday)

June 25, 2021	Bioenvironmental Polymers Society (BEPS) 2021 27th Meeting (ALL TIMES Eastern Time)	
9:00-9:10 am	Welcome Remarks	
9:10-9:50 am	Plenary Session P3 (BEPS Outstanding Young Scientist Award Co-recipient Winner) Session Chair: Joe Stanzione P3.1 - Novel Biopolymer and Biomineral Material Technologies for the Built Environment **Wil Srubar, III** University of Colorado, USA	
9:50-10:00 am	Coffee Break	
10:00 am - 12:30 pm	**Concurrent Sessions**	
	S4 - Advances in Polymer Manufacturing **Session Chair:** Tristan Bacha	**S6 - Bio-based Composites & Components** **Session Chair:** Alexandra Chong
10:00-10:20 am	S4.7 - Challenges in Formulating and Processing Charged Fiber-Based Materials **Invited Speaker: Blair Brettman** Georgia Institute of Technology, USA	S6.1 - High Cycle Fatigue Strength of Flax Fiber and Flax/Carbon Fiber Reinforced Thermoset Composites **Invited Speaker: Chad Ulven** North Dakota State University, USA
10:25-10:45 am	S4.8 - Highly Compostable High OleicSoy-Based Impact-Modifiers via Reactive Extrusion with Polyesters **Invited Speaker: Eric Cochran** Iowa State University, USA	S6.1 - Addressing Decreased Thermal Stability of Biodegradable Plastics with the Addition of Biochar and Biomass Filler Materials **Seth Kane** Montana State University, USA
10:50-11:10 am	S4.9 - Multicomponent Adsorption and Membrane Separations to Enable New and More Efficient Biopolymer Production Processes **Invited Speaker: Sankar Nair** Georgia Institute of Technology, USA	S6.3 - Strategic Assembly of Bio-Based Resins with Recycled Carbon Fibers: New Advances in Green Composites **Jasmin Vasquez** Rowan University, USA
11:15-11:35 am	S4.10 - Precision Compounding of Bioplastics via Twin Extrusion for 3D Filaments **Invited Speaker: Charlie Martin** Leistritz Extrusion, USA	S6.4 - Property Enhanced Biobased Packaging from Polybutylene Succinate and Nanocellulose Composites as a Sustainable Biodegradable Alternative **Anuradhi Liyanapathiranage** University of Georgia, USA
11:40-noon	S4.11 - Bio-Based Resins for Additive Manufacturing **Invited Speaker: Alexander Bassett** US Army Research Laboratory	S6.5 - Production and Physicochemical Characterization of Value-added Biocarbon Produced from Slow Pyrolysis of Waste Mixed Bio-oil **Ranjeet Mishra** University of Guelph, Canada
12:05-12:25	S4.12 - FDM 3D Printed Sustainable Biocomposites from Recycled Ocean Plastics and Soy Hull-based Biocarbon **Benjamin Maldonado-Garcia** University of Guelph, Canada	S6.6 - Physicochemical Characterization of Bio-Carbon Produced from the Slow Pyrolysis of Pine Nut Shells and Walnut Shells **Kikaoseh Agweh** University of Guelph, Canada
12:30-2:00 pm	Lunch Break	
2:00-3:40 pm	**Concurrent Sessions**	
	S1 - Biodegradability & Sustainability **Session Chair:** John Chea	**S6 - Bio-based Composites & Components** **Session Chair:** Jasmin Vasquez
2:00-2:20 pm	S1.13 - Micro-Nano Plastics in the Environment: Challenges and Solution Pathways **Poritosh Roy** University of Guelph, Canada	S6.7 - Natural and Waste Fillers in Biodegradable Polymeric Composites and Foams **Invited Speaker: Sarah Billington** Stanford University, USA
2:25-2:45 pm	S1.14 - Biodegradable Blends of Poly(3-hydroxybutyrate-co-3-hydroxyvalerate) and Poly(ε-caprolactone) by *in situ* Reactive Compatibilization) **Peter Zytner** University of Guelph, Canada	S6.8 - Statistical Design of Biocarbon Reinforced Sustainable Composites from Polyphthalamide (PPA) and with Polyamide 4,10 Blends **Mateo Gonzalez de Gortari** University of Guelph, Canada
2:50-3:10 pm	S1.15 - The Aquatic Biodegradation of Wood-based Bathroom Tissue, Cotton Microfibers, and Flushable Wipes in Wastewater Treatment Plant Sludge **Madilynn Smith** North Carolina State University, USA	S6.9 - Effects of Biochar Amendment in an In-pot Experiment for the Purposes of Growing *Glycine Max.* **Tara Allohverdi** University of Guelph, Canada
3:15-3:35 pm	S1.16 - Effects of Environmental Weathering on Particle Morphology Probed from Engineered Biodegradable Micro-and Nanoplastic Materials Used for Environmental Studies **Anton Astner** University of Tennessee Knoxville, USA	S6.10 - Poly(3-hydroxybutyrate-co-3-hydroxyvalerate)/Polypropylene Carbonate Based Green Composites with Distillers Dried Grains with Solubles (DDGS) **Akhilesh Pal** University of Guelph, Canada
3:40-4:00 pm	Q&A Session and Conference Closing Remarks	

Concurrent Session S4 – Advances in Polymer Manufacturing: 10:00 am – 12:30 pm (Eastern Time)

Session Chair: Alexandra Chong (Rowan University)

S4.1: 10:00 – 10:20 am (Eastern Time) (**Invited Speaker**)

Applications of Biodegradable Polymers for Fused Deposition Modeling 3D Printing

Adriana Kovalcik

Institute of Food Chemistry and Technology, Faculty of Chemistry, Brno University of Technology, Purkynova 118, 612 00 Brno, Czech Republic

Over the last several years additive manufacturing technologies, specially fused deposition modelling (FFM) has gained popularity in several industries including aerospace and defence, healthcare, automotive, electrical and electronics and even in households. It was estimated that the global 3D printing filament market generated revenue of USD 739 million in 2020. It is supposed that the outbreak of COVID-19 also contributed to diverse applications of 3D printed materials in the medical segment. One of the priorities of the 21st century is to develop and use such technologies and products that would systematically contribute to the improvement of the health of our planet and people. The principle of FDM is an extrusion of the molten filament and gradual deposition of layers and their solidification resulting in a 3D object. In order to meet the criteria for a green deal strategy, it is necessary to develop biobased and biodegradable filaments with physical properties required by individual industrial sectors. Our study aims in the biotechnological conversion of food waste into biodegradable polymers and biocomposites with applicability as a matrix material for filaments production. This work summarizes the applicability of polyhydroxyalkanoates (PHA) and poly(lactic acid) (PLA) as thermoplastics for FFM with respect to their thermal, rheological and mechanical properties. The fabrication of 3D models on the base of PLA is common but the use of PHAs is limited to the specific copolymers or blending with PLA [1]. The focus of our research is on the development and implementations of biodegradable and biocompatible filaments in the pharmaceutical and medical fields [2].

Acknowledgement
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References
[1]. A. Kovalcik, Recent Advances in 3D Printing of Polyhydroxyalkanoates: A Review, The EuroBiotech Journal 5(1) (2021) 48-55. https://doi.org/10.2478/ebtj-2021-0008.
[2]. A. Kovalcik, L. Sangroniz, M. Kalina, K. Skopalova, P. Humpolíček, M. Omastova, N. Mundigler, A.J. Müller, Properties of scaffolds prepared by fused deposition modeling of poly (hydroxyalkanoates), International Journal of Biological Macromolecules 161 (2020) 364-376. https://doi.org/10.1016/j.ijbiomac.2020.06.022.