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https://www.acs.org/content/acs/en/acs-webinars/videos.html

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Whether you are just starting your journey, transitioning jobs, or looking to brush up or learn new skills, the **ACS Career Navigator** has the resources to point you in the right direction.

We have a collection of career resources to support you during this global pandemic:

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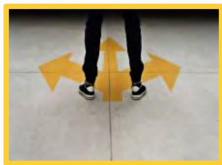

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ACS Chemistry for Life®

How to Survive a Life in Chemistry in a Post-COVID-19 World

Date: Wednesday, May 5, 2021 @ 2-3pm ET
Speaker: Joe Martino, American Chemical Society
Moderator: Tom Halleran, American Chemical Society

Register for Free!

What You Will Learn:

- How to approach networking and work after COVID-19, both in person and virtually highlighting virtual tools and how to re-think in-person networking for a post-pandemic world
- What was impacted by COVID-19 in the past year, focusing on industry and academia, and how that will impact the future
- How the workforce is gearing up to a return to in-person work that will be slightly different than before

Co-produced with: ACS Careers

How Industry is Driving Sustainability Through Innovation

Date: Wednesday, May 12, 2021 @ 2-3pm ET
Speakers: Peter Eckes, BASF / Gayle Schueller, 3M / Bob Maughon, SABIC
Moderator: Rebekah Paul, American Chemical Society

Register for Free!

What You Will Learn:

- The role of the chemical industry in driving sustainability
- How sustainable innovations can benefit the consumer, the chemical industry and the environment
- Opportunities for the next generation in the chemical industry

Co-produced with: ACS Industry Member Programs

Nanosafety Emerging Research Perspectives

Date: Thursday, May 13, 2021 @ 2-3pm ET
Speakers: Tilak Chandra, University of Wisconsin-Madison / Katie Kruszynski, University of Wisconsin-Madison / Markus Schaufele, Northwestern University
Moderator: Ralph Stuart, Keene State College

Register for Free!

What You Will Learn:

- The emerging concerns related to nanoparticle safety, both in the laboratory and in the environment
- How a "what if" method can be used for a hazard assessment to develop a safe operating procedure
- What research about nanoparticles in the environment tells us about potential hazards

Co-produced with: ACS Division of Chemical Health and Safety ACS Committee on Chemical Safety

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ACS Chemistry for Life®

Solving the Plastics Problem through Chemistry: Federal Research and Technology Programs

KATHRYN BEERS
Program Manager, Soft Matter & Circular Economy, National Institute of Standards and Technology

BRUCE GARRETT
Director of the Chemical Sciences, Geosciences and Biosciences, Division of the Office of Basic Energy Sciences, U.S. Department of Energy

CHRISTINA PAYNE
Program Director, Engineering Directorate's Division of Chemical, Bioengineering, Environmental, and Transport Systems, National Science Foundation

ANGELA WILSON
John A. Hannah Distinguished Professor and Associate Dean for Strategic Initiatives, College of Natural Sciences, Michigan State University and 2021 ACS President-Elect

Presentation slides are available now! The edited recording will be made available as soon as possible.

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This ACS Webinar is co-produced with ACS Committee on Science.

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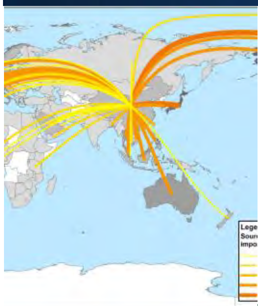
NIST, the Circular Economy and Solving Plastics Problems

Kathryn Beers, Ph.D.
Program Manager, Circular Economy

NIST National Institute of Standards and Technology U.S. Department of Commerce

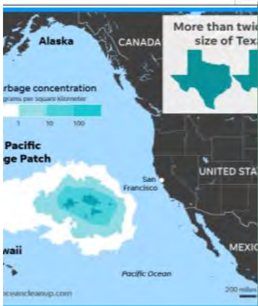
MEP MATTR Program
April 2021

Two Converging Issues with Plastic Waste



- Global trade disruption in plastic waste
- Markets increasingly limited for traditional methods of collection and sortation
- Opportunities for new mechanical pathways and new technologies (e.g. chemical processes)

Science Advances, **2018**, DOI: 10.1126/sciadv.aat0131



- Increasing awareness of environmental impacts of plastic debris, from macro- to micro-scale
- Quantification challenges and data scarcity problems

World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, *The New Plastics Economy – Rethinking the future of plastics* (2016)

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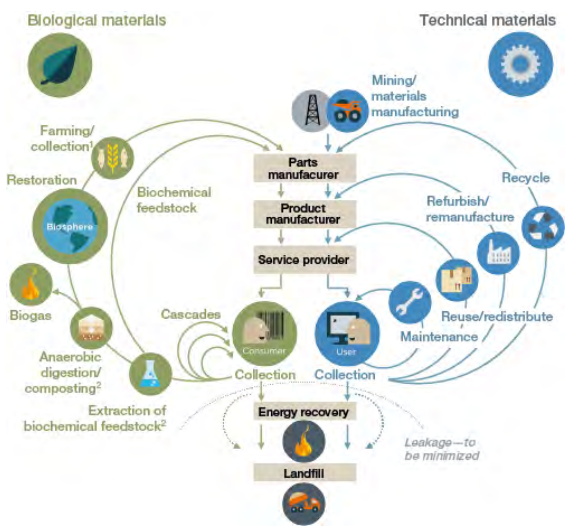
What is the Circular Economy?



Source: Ellen MacArthur Foundation circular economy team drawing from Braungart & McDonough and Cradle to Cradle (C2C)

Material goods (molecules and atoms) return to the supply chain over many cycles, possibly in many forms, generating value while minimizing waste and environmental impact.

NIST involvement initiated with current events related to plastics.

Goal is to include new activities in inorganics (e.g. solar, battery and eWaste), textiles, biomass, concrete….

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Supporting Decision-Making

- How are priorities weighted by stakeholders?
  - Current EPA language:
    - Reduce Contamination
    - Expand Markets
- What data and tools are available to support good choices in business and in governments?
  - Current DOE EERE and NSF ENG Center programs:
    - Research partnerships between materials science and economics
- *There are many gaps and needs*

Milliken's Zero Waste Hierarchy. Adapted in part from the European Commission's Waste Framework Directive.(23,24)

DOI: (10.1021/acsmacrolett.0c00437)

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NIST Capabilities

- Polymer science
- Environmental analytical chemistry
- Polymer and environmental SRMs
- Material weathering
- Economics and CoC Data Security
- Data/Informatics Management
- Cell biology and toxicology
- Molecular biology
- Uncertainty analysis
- Cryohomogenization reference material production facility
- Inter-laboratory comparisons

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Stakeholder Interfaces: Plastics

NIST

- Major Industries/Trade Associations
- Government(s)
  - Other US agencies (EPA National Strategy)
  - International (NMIs)
  - State and Local
- Small/regional Businesses (MEP)
- Research Communities
- Traditional Communities

- Policy and Legislative Activity:
  - OECD / Basel Convention
  - Multiple Hearings in 2020 (House and Senate)
  - **Save Our Seas 2.0: passed Dec. 18, 2020**
  - **Sustainable Chemistry: NDAA passed Jan. 2021**
  - *Plastics Waste Reduction & Recycling Act: H.R. 7228 2020*
  - *Break Free From Plastic Pollution Act: S. 3263 2020*
  - MICRO Plastics Act of 2020: S.3306/H.R.5902
  - America's Water Infrastructure Act of 2020: S.3591

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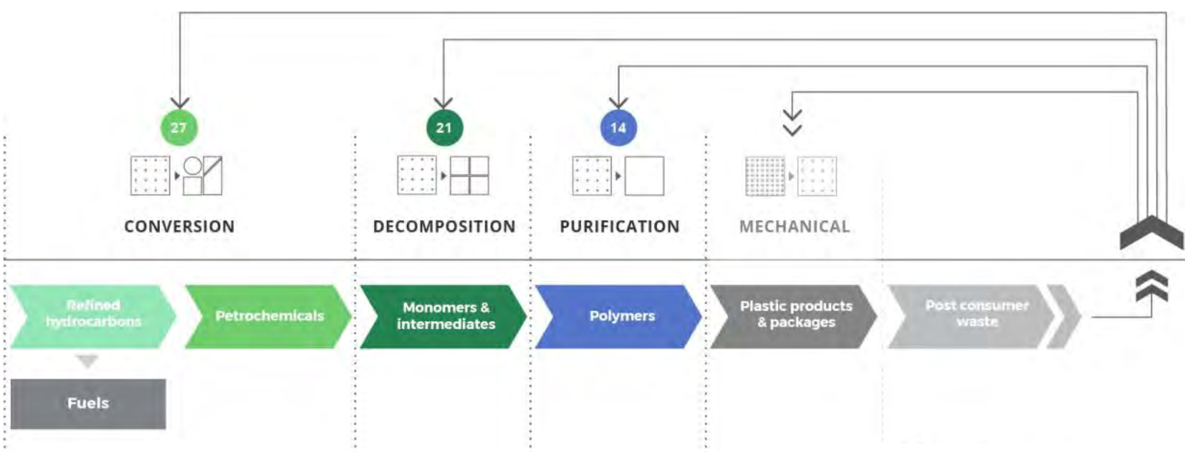
"True" Materials Circularity

NIST



"Accelerating Circular Supply Chains for Plastics"
Center for the Circular Economy @ ClosedLoopPartners.com

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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT

In 2011, Alabama paid $25M in disposal costs for recyclable materials valued at how much?

- $35M
- $52M
- $93M
- $139M
- $193M

** If your answer differs greatly from the choices above tell us in the chat!*

Plastic Recycling

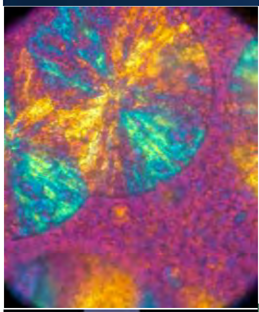
- In 2011, Alabama paid $25M in disposal costs for recyclable materials valued at $193M
  - $35M in PET and HDPE
  - $41M in corrugated cardboard
  - $27M aluminum cans
  - $25M in 'other ferrous'
  - $1.6M in glass
- In FY18-21, Congress funded NIST to establish an extramural program in Recycled Plastics

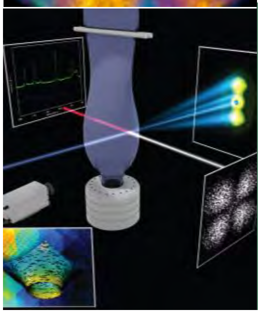
Stephanie Hooker

Alabama Department of Environmental Management, *Economic Impact of Recycling in Alabama and Opportunities for Growth* (2012)

KW Pittsburg State University TROY UNIVERSITY

Recycling of Mixed Plastics





- To develop strategies and measurement technologies for the efficient sorting and re-processing of thermoplastic waste
- Improvement in efficiency and performance recycled materials will lead to their increased demand, prices, and ultimately recycling rates

- Team Lead Kalman Migler (MML/642)
- Team Members : Debra Audus, Derek Huang, Anthony Kotula, Sara Orski, Jon Seppala (MML/642)

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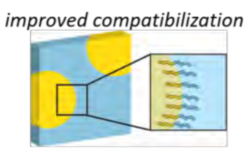
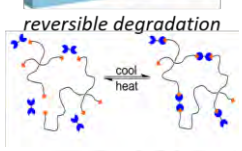
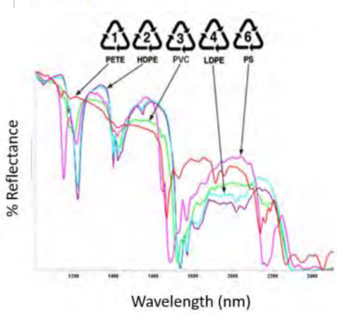
Macromolecular Architectures







- Primary Motivation: Systematically varied polymer families to determine accurate structure → property → performance relationships
- Improvements to Mechanical Recycling Metrology
  - Improved compatibilizer design for phase control
  - Reversible chemistries: impacts on processing, crystallization, microstructure, and possible optimization of chemical recycling routes

- Sara Orski (MML/ 642)
- Chase Thompson (642), Kate Beers (642) Aaron Burkey (642), Debra Audus (642), Robert Ivancic (642)
- Larry Sita (UMD), Li Piin Sung (EL), Jenn Lynch (MML, 646)

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Plastic Life Cycle Assessment Data and Modeling

NIST

Source: https://www.ncasi.org/technical-studies/sustainable-manufacturing/life-cycle-assessment/

- Primary Motivation
  - Evaluate existing Life Cycle Inventory (LCI) databases and Life Cycle Assessment (LCA) modeling tools
- How it contributes to the Circular Economy
  - Provides insights into the state of LCA data for plastics and potential roles for the federal government and NIST to improve quantification of the life cycle performance of plastics

- Joshua Kneifel (EL/AEO)
- External Partner
  - Troy Hawkins
  - Michael Wang

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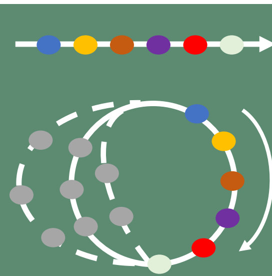

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Circular Economy Resource Registry

NIST

- Primary Motivation:
  - Develop and Deploy a Public Circular Economy Resource Registry
- How it contributes to the Circular Economy
  - Provides a rich catalog for discovery and exploration of key circular economy distributed expert resources: organizations, datasets, and tools, determined as highly relevant for Circular Economy analysis

- Team Lead: Gretchen Greene (MML, 641)
- Ray Plante, Ali Daoudi (MML,641); Kevin Brady, Ben Long (ITL, 775), Kelsea Schumacher, Kate Beers (MML, 642)

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External Engagement and Strategic Planning

NIST

Polymers

- Information gathering to inform planning
- Respond to Congress: Mass Balance Accounting Workshop (May 2021) and Report (SOS 2.0, Dec 2021)

Kate Beers / Kelsea Schumacher

High-Tech Products

- Identify NIST activities to facilitate a circular economy for high-tech products
- Circular Economy for High-Tech Products Workshop (Jan. 2021) and Report

Martin Green / Kelsea Schumacher

In Progress, TBD

Textiles

- Identify NIST activities to facilitate a circular economy for textiles
- Circular Economy for Textiles Workshop (planned late 2021) and Report

Amanda Forster / Kelsea Schumacher

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Thank You!

Kelsea Schumacher
Sara Orski
Kalman Migler
Josh Kneifel
Gretchen Greene
Martin Green
Amanda Forster

Stephanie Hooker
KC Morris
Jennifer Lynch
Sam Stavis
LiPiin Sung
Elijah Peterson
John Schiel
Zach Trautt
Debra Audus
Tyler Martin
Peter Beaucage
Adam Pintar
Ray Plante
Ben Long

David Goodwin
Anthony Kotula
Jon Seppala

Aaron Burkey
Chase Thompson
Derek Huang
Robert Ivancic
Katy Shaw
Andrew Madison
John Giddens
Ana Barrios
Ali Daoudi
Kevin Brady

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beers@nist.gov

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U.S. DEPARTMENT OF ENERGY | Office of Science

Overview and Update on DOE Plastics Innovation Challenge

Solving the Plastics Problem through Chemistry:
Federal Research and Technology Programs

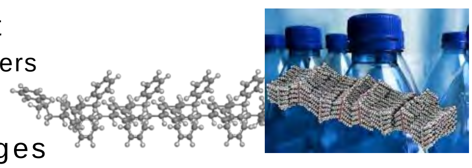
ACS Webinars | April 28, 2021

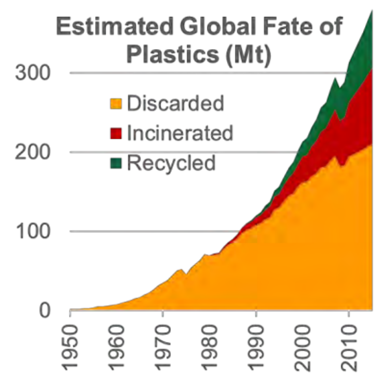
Bruce Garrett, Division Director
Chemical Sciences, Geosciences, and Biosciences
Basic Energy Sciences, Office of Science

Chemistry has a central role in plastics

- Plastics represent a 20th century achievement
  - Chemical conversions of fossil feedstocks to make polymers for lightweight, versatile, durable materials
- Plastics present growing 21st century challenges
  - Accumulation of discarded plastic
  - Consumption of fossil feedstocks and energy
  - Production of GHG emissions
- Chemistry accomplishments can enable an increased use of discarded plastics as a resource
  - Efficient processes to recover molecular components from plastics and create valuable products (upcycling)
  - Co-design of plastics and upcycling processes to enable circular lifecycle of polymer components

New chemistry to reverse the perspective on discarded plastic from waste to resource





Data from Geyer et al. *Sci Adv* **3(7)**, e1700782 (2017)
(Mt = Million metric tons)

2019: DOE Launched the Plastics Innovation Challenge

Strategic Aim: Position the United States as a leader in advanced plastic recycling technologies.

Scientific/technical challenges to improve plastic recycling:

- **Deconstruct** plastic wastes into useful intermediates
- **Upcycle** plastic wastes into higher value products
- Create plastics that are **recyclable by design**
- **Scale and deploy** new technologies broadly

Plastics Innovation Challenge: a DOE-Wide Effort, Engaging 4 DOE Offices, to Span R&D Stages

- Office of Science (SC)
- Energy Efficiency and Renewable Energy (EERE)
- Advanced Research Projects Office-Energy (ARPA–E)
- Fossil Energy (FE)

Coordinated DOE effort to deliver transformative solutions that reduce plastic waste and the energy and GHG impacts of plastic production and reuse

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Core team setting directions and coordinating activities for the Plastics Innovation Challenge

SC – Basic Energy Sciences
- Chris Bradley
- Bruce Garrett
- Craig Henderson
- Linda Horton*

SC – Biological and Environmental Research
- Dawn Adin
- Todd Anderson
- Boris Wawrik

EERE
- Jay Nathwani
- Rob Sandoli*

EERE – Advanced Manufacturing Office
- Joe Cresko
- Melissa Klembara
- Kathryn Peretti

EERE – Bioenergy Technology Office
- Gayle Bentley
- Kevin Craig
- Jay Fitzgerald
- Valerie Reed
- Joel Sarapas

ARPA–E
- Joseph King
- Jack Lewnard
- Doug Wicks

FE
- Jai-Woh Kim
- Amishi Kumar
- John Litynski

*Co-Chairs

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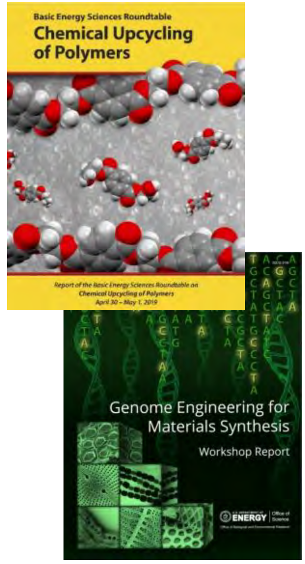
Office of Science (SC)

- The Office of Science supports research at the frontiers of science, including:
  - Chemical and materials research to understand, predict, and ultimately control matter and energy at the level of electrons, atoms, and molecules
  - Research to understand, predict, manipulate, and design biological processes that underpin innovations for bioenergy and bioproduct production
- Fundamental research directions for polymer upcycling:
  - Design chemical mechanisms for selective deconstruction and reassembly.
  - Advance data-driven design and synthesis of new polymeric materials.
  - Harness genomic and synthetic biology approaches to create organisms and consortia with designed biological processes to transform plastics.
  - Create data science tools to discover and control chemical and biological mechanisms.



https://science.osti.gov/-/media/bes/pdf/reports/2020/Chemical_Upcycling_Polymers.pdf
https://genomicscience.energy.gov/biosystemsdesign/gems/GEMS_Report_2019__low.pdf

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Energy Efficiency and Renewable Energy (EERE)

U.S. DEPARTMENT OF ENERGY

EERE seeks to create and sustain American leadership in the transition to a global clean energy economy through efforts to:

- Develop technologies that reduce direct and life cycle energy demands, drive energy productivity improvements, utilize abundant and available domestic energy resources, and support manufacture of clean energy products.
- Develop and demonstrate transformative and sustainable bioenergy technologies that reduce lifecycle greenhouse gas emissions, including the use of waste resources to make high-value bioproducts and biofuels.

Technology Development and Demonstration for Recycling/Upcycling:

- Optimize collection, sorting and mechanical recycling methods.
- Develop and scale biological, chemical and hybrid methods for plastics deconstruction and upcycling
- Develop and optimize bio-based plastics that are recyclable or compostable by design
- Develop tools and conduct analysis to quantify life cycle benefits of technological approaches and guide future investment towards approaches that reduce lifecycle energy and resource impacts of plastic materials.

REMADE INSTITUTE®

Reducing Embodied Energy and Decreasing Emissions (https://remadeinstitute.org)

bottle

Bio-Optimized Technologies to keep Thermoplastics out of Landfills and the Environment (BOTTLE™) consortium (https://www.bottle.org)

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Advanced Research Projects Office-Energy (ARPA –E)

- ARPA-E's mission is to decrease our nation's dependence on foreign energy sources, reduce greenhouse gas emissions, improve energy efficiency across the board, and maintain or reestablish U.S. scientific leadership in the energy sector.
- ARPA-E supports plastic recycling/upcycling through the REcycle Underutilized Solids to Energy (REUSE) exploratory program:
  - Develop technologies to convert high-energy materials currently going to landfills to a high-energy content liquid product capable of displacing energy imports used for fuel or chemical production.
  - Investigate novel chemistry, equipment designs, and/or process configurations for robust processing that is adaptable to low-cost feeds with broad specifications.
  - Explore of the potential for regional, small-scale facilities to divert high-energy materials from landfills.
  - Collaborate with other DOE offices to coordinate TEA analysis for plastic conversion processes.

https://arpa-e.energy.gov/technologies/publications/white-paper-background-information-arpa-es-reuse-program

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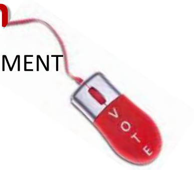
Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



How is Blue Hydrogen produced?

(Select all answers that apply)

- Electrolysis, using nuclear energy as its source of power
- Steam Methane Reforming (SMR), where CO2 is captured and then stored
- Auto Thermal Reforming (ATR), where CO2 is captured and then stored
- Electrolysis, only using solar energy as its source of power
- None of the above

** If your answer differs greatly from the choices above tell us in the chat!*

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Fossil Energy (FE)

- FE supports research, development, and demonstration efforts on advanced power generation; power plant efficiency; water management; coal to products; critical minerals; carbon capture, utilization, and storage technologies; and emission-control technologies.
- FE supports plastic recycling/upcycling through the FOA on Enabling Gasification of Blended Coal, Biomass and Plastic Wastes to Produce Hydrogen and Fuels for Net Negative Carbon Dioxide Emissions (Released September 2020), which has a focus on addressing technology gaps by generating lab-scale data and experience to further encourage the development of technologies and commercial approaches
  - Supports the DOE-FE Blue Hydrogen Strategy: Modular gasification systems to reduce capital investment; Distributed deployment near feedstocks; Integration/intensification of key processes including carbon capture

Blue Hydrogen:

- **Produced by Steam Methane Reforming or Gasification with Carbon Capture & Sequestration**
- Using fossil, biomass, and waste plastics

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R&D investments advancing plastics re/upcycling (1/2)

Funding Opportunity Announcements: FY 2020 and FY 2021

Office	Fiscal Year: Title/URL	Topic/Status
SC-BES	FY2020: Energy Frontier Research Centers https://science.osti.gov/-/media/grants/pdf/foas/2020/SC_FOA_0002204.pdf	Subtopic: Chemical upcycling of polymers Closed - 2 awards in subtopic area (https://science.osti.gov/-/media/bes/pdf/Funding/EFRC_Awards_July2020.pdf)
SC-BES	FY2021: Chemical Upcycling of Polymers https://science.osti.gov/-/media/grants/pdf/foas/2021/SC_FOA_0002462.pdf	Chemical Upcycling Closed
SC-BER	FY2021: Systems Biology of Bioenergy-Relevant Microbes To Enable Production of Next-Generation Biofuels And Bioproducts https://science.osti.gov/-/media/grants/pdf/foas/2021/SC_FOA_0002448.pdf	Subtopic: Biological plastic upcycling organism design Closed
EERE	FY2020: Bio-Optimized Technologies to Keep Thermoplastics out of Landfills and the Environment (BOTTLE) FOA https://eere-exchange.energy.gov/Default.aspx?foaId=8b941be9-94c4-4959-bfc2-0c7b6cec9794	Polymer redesign for recyclability and biodegradability; Chemical, biological, thermal and mechanical deconstruction and upcycling Closed

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R&D investments advancing plastics re/upcycling (2/2)

U.S. DEPARTMENT OF ENERGY

Funding Opportunity Announcements: FY 2020 and FY 2021

Office	Fiscal Year: Title/URL	Topic/Status
EERE	FY2020: Bioenergy Technologies Office FY2020 Multi-Topic FOA https://eere-exchange.energy.gov/Default.aspx?foaId=23bcb339-aa53-4821-9421-d109747cb168	Subtopic: Technologies to transform urban and suburban wastes including plastic into products Closed
ARPA-E	FY2020: Recycle Underutilized Solids to Energy https://arpa-e-foa.energy.gov/Default.aspx#FoaIde8647d89-1cac-4b58-8622-1b04de8958c4	Convert unrecyclable plastic and paper into liquid intermediates upgradable into fuels or chemicals Closed
FE	FY2020: Enabling Gasification of Blended Coal, Biomass and Plastic Wastes to Produce Hydrogen with Potential for Net Negative Carbon Dioxide Emissions https://www.netl.doe.gov/node/10129	Gasification of mixed carbonaceous materials Closed - 4 awards (https://www.netl.doe.gov/node/10573)
FE	FY2021: Fossil Energy Based Production, Storage, Transport, and Utilization of Hydrogen Approaching Net-Zero or Net-Negative Carbon Emissions https://www.netl.doe.gov/node/10444	Subtopic: Modular gasification-based H2 from waste plastics, industrial wastes, municipal waste, and waste coal Closed

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BES Energy Frontier Research Centers Advance Polymer Upcycling

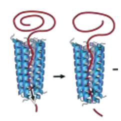
iCOUP

Institute for Cooperative Upcycling of Plastics (iCOUP)

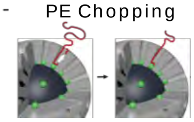
Aaron Sadow
EFRC Director

Goals:
1) Adapt methods for light hydrocarbons to polyolefins (PE, PP)
   - New approaches for C-H/C-C cleavage and introduction of functionality.
2) Design multiscale catalyst architectures for selective upcycling
   - Hierarchically-structured catalysts with control of active sites and microenvironments
   - Characterization of polymer-catalyst interfaces to understand the adsorption behavior and mobility of polymers on surfaces/channels.

Processive Enzymes



Processive Catalysts for PE Chopping



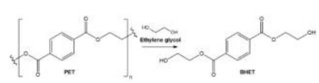
Ames Laboratory · Argonne National Laboratory · Northwestern University · UC Santa Barbara · Cornell University · University of South Carolina

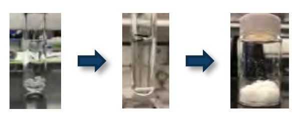
CENTER FOR Plastics Innovation

LaShanda Korley
EFRC Director

Goals:
1) Depolymerization
   - Deconstruction via microwave, pyrolytic, and other methods.
2) Plastics Upcycling
   - Chemical polymer functionalization (fluorination) and enzyme mediated plastics breakdown.
3) Characterization Tools
   - Automated tools (theory/experiment) for high throughput catalyst and upcycled product discovery.

Microwave Assisted PET Depolymerization





PET → Post-reaction → Recovered BHET

University of Delaware · The University of Chicago · Penn · UMass Amherst · Oak Ridge National Laboratory

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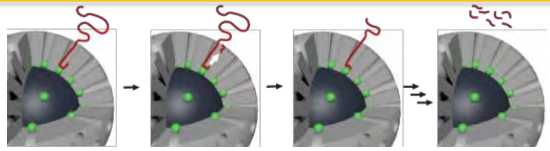
Design of a Processive Catalyst for Polyethylene Upcycling

Scientific Achievement

A mesoporous shell/Pt/core architecture catalyzes polyethylene (PE) hydrogenolysis into a narrow distribution of hydrocarbons centered at ~C_{16} through a processive process that mimics features of enzymatic deconstruction of polymers.



Steps in the processive polymer deconstruction mechanism: (a) PE adsorption into a pore, (b) cleavage of a C-C bond via hydrogenolysis, desorption of the short hydrocarbon fragment, and repositioning of the adsorbed chain, (c) repeated cleavage, product release, and chain reorientation to convert the entire strand into a uniform distribution of shorter chains.

Significance and Impact

Processive catalysis can improve rates and selectivity in upcycling processes through the design of the mesoporous architectures to favor the synthesis of a targeted distribution of desired products.

The present work is the first demonstration of processive abiotic catalysis for plastic upcycling.

Research Details

- Solid-state ^{13}C NMR spectroscopy revealed the adsorption, conformational orientation, and dynamic behavior of PE in mesoporous silica, and guided the catalyst design.
- The catalytic deconstruction of PE shows the features of a processive mechanism: long polymer chains are converted into a short, uniform conversion-independent distribution of products, and intermediate length chains are not formed.

A. Tennakoon, X. Wu, A. L. Paterson, S. Patnaik, Y. Pei, A. M. LaPointe, S. C. Ammal, R. A. Hackler, A. Heyden, I. I. Slowing, G. W. Coates, M. Delferro, B. Peters, W. Huang, A. D. Sadow, F. A. Perras *Nature Catalysis*, **2020**, *3*, 893-901. DOI: 10.1038/s41929-020-00519-4

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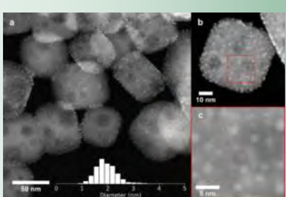
Transforming Plastic Waste into New Products

Basic Science



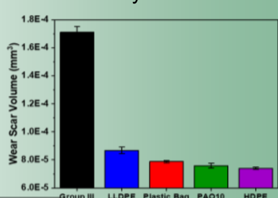
Electron micrographs of Pt NPs with an average size of 2.0 ± 0.5 nm, deposited by ALD on $SrTiO_3$ nanocuboids

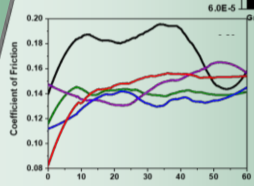
Platinum nanoparticles on a perovskite support catalyze *selective* hydrogenolysis of carbon-carbon bonds in polyethylene under mild conditions. Selective catalytic hydrogenolysis yields macro-molecules of uniform chain length that are ideal as lubricants and with negligible formation of undesired byproducts.

Celik et al., ACS central science 5 (11), 1795-1803 (2019)

Applied R&D

EERE-funding enabled the design and evaluation of the economic viability of a manufacturing process for converting polyolefin waste to premium synthetic lubricants. It is estimated this process will have a much lower product cost compared to that of the refinery-based counterpart.





Measured wear rate volume and coefficient of friction for ball-on-disk tests using various base oils and upcycled products from waste polyolefins.

Manufacturing/Commercialization

In 2021, EERE-supported work with Chevron-Phillips Chemical Company to improve carbon and energy efficiency to enable a circular plastic economy, by creating innovative deconstruction pathways for existing polymers that generate high value products, such as high-performance lubricants.

Argonne NATIONAL LABORATORY · Chevron Phillips Chemical Company LP · AMES LABORATORY · Northwestern University

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U.S. DEPARTMENT OF **ENERGY** | Office of Science

NSF Research Highlights and Funding Opportunities: Solving the “Plastics Problem”

Christina Payne, Program Director
National Science Foundation (NSF)
Chemical, Bioengineering, Environmental, and Transport Systems Division | Engineering Directorate

ACS Webinar | April 28, 2021

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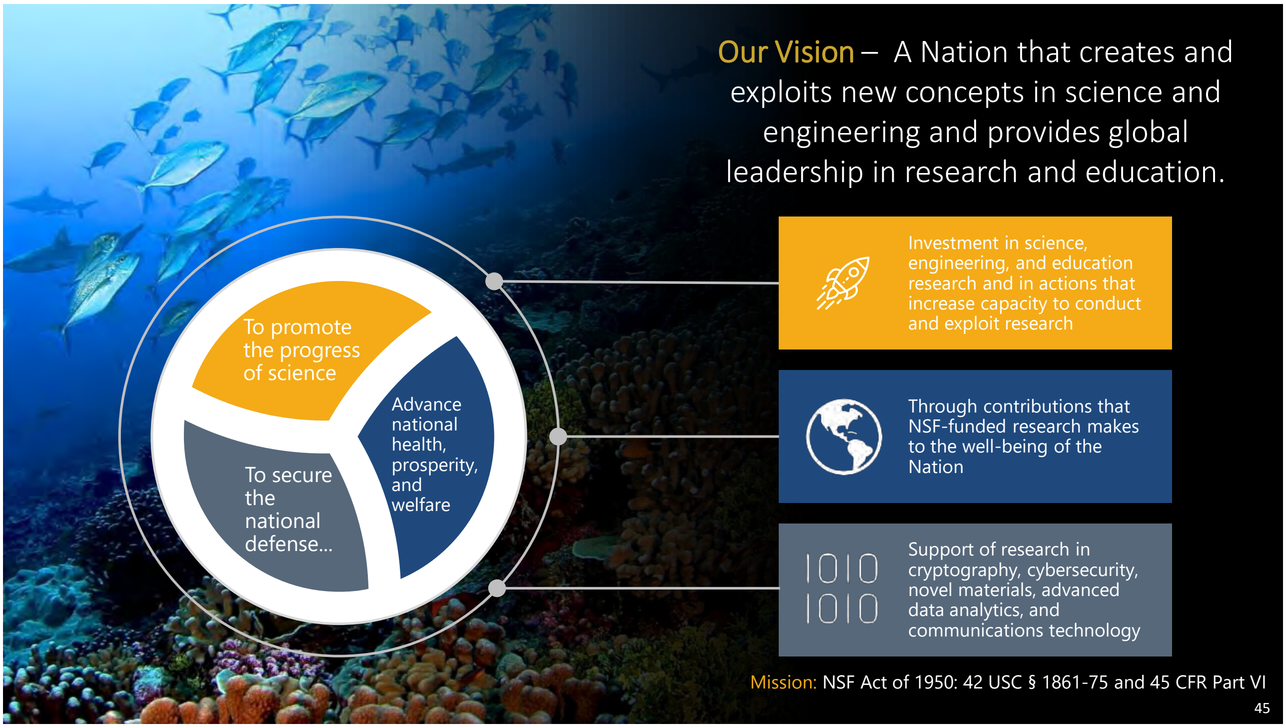
Our Vision – A Nation that creates and exploits new concepts in science and engineering and provides global leadership in research and education.
To promote the progress of science
Advance national health, prosperity, and welfare
To secure the national defense...
Investment in science, engineering, and education research and in actions that increase capacity to conduct and exploit research
Through contributions that NSF-funded research makes to the well-being of the Nation
1010
1010
Support of research in cryptography, cybersecurity, novel materials, advanced data analytics, and communications technology
Mission: NSF Act of 1950: 42 USC § 1861-75 and 45 CFR Part VI
45


NSF Funds Research and Education across all Fields of Science and Engineering
NSF
Biological Sciences
Engineering
Mathematical & Physical Sciences
Computer & Information Science & Engineering
Geosciences (including Polar Programs)
Integrative Activities
Education & Human Resources
Social, Behavioral & Economic Sciences
International Science & Engineering
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Engineering
Core Programs
Supporting Plastics Material Design, Processing, Deconstruction, and Fundamental Systems Behavior

Chemical, Bioengineering, Environmental, and Transport Systems (CBET)

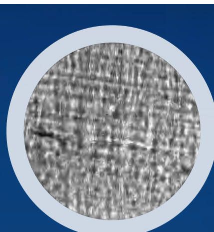
- Catalysis
- Cellular and Biochemical Engineering
- Interfacial Engineering
- Process Systems, Reaction Engineering, and Molecular Thermodynamics
- Environmental Sustainability
- Nanoscale Interactions
- Particulate and Multiphase Processes
- Thermal Transport Processes
- Environmental Engineering

Civil, Mechanical, and Manufacturing Innovation (CMMI)

- Advanced Manufacturing
- Mechanics of Materials and Structures

ENG/CMMI – 1653830 (Oswald)

Novel coarse-grained simulations to study relationships linking morphology and plastic resistance in semi-crystalline polymers

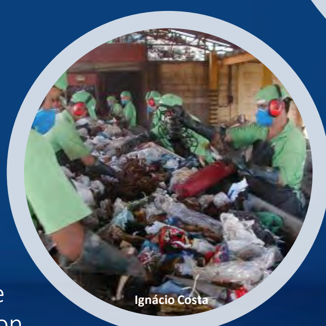


ENG/CBET - 1930594 (Gross)

Engineering increased activity of cutinase toward poly(ethyleneterephthalate) for recycling of plastic

ENG/CMMI – 1928448 (Dollar)

Shared autonomy for the dull, dirty, and dangerous: exploring division of labor for humans and robots to transform the recycling sorting industry



Engineering supports projects that explore the frontiers of engineering science, foster innovation and technology transfer, address national needs and improve quality of life, and prepare future engineering leaders, entrepreneurs, and visionaries.

Mathematical and Physical Sciences Core Programs Supporting Plastics Synthesis, Depolymerization, Characterization, and Design

Chemistry (CHE)
- Chemical Synthesis
- Chemical Catalysis
- Chemical Measurements and Imaging
- Environmental Chemical Science
- Macromolecular, Supramolecular, and Nanochemistry

Materials Research (DMR)
- Condensed Matter and Materials Theory
- Condensed Matter Physics
- Polymers

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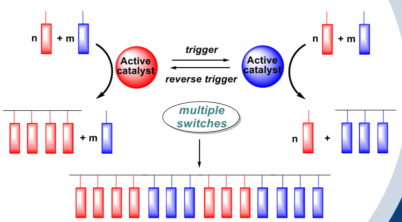
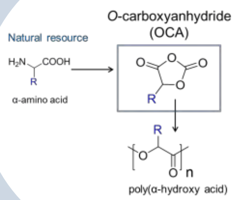


MPS/CHE – 1809116 (Diaconescu)

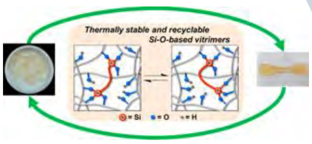
Switchable Catalysis as a Tool for the Synthesis of Novel Multiblock Copolymers

Mathematical and Physical Sciences supports projects that explore the frontiers of chemical and materials science, develop the foundations for future technologies and industries that meet changing societal needs, and prepare the next generation of researchers.



MPS/CHE – 1807911 (Tong)

Photoredox Polymerization of O-Carboxyanhydrides for Functionalized Polyesters



MPS/DMR – 1810217 (Guan)

Silyl Ether Metathesis for Universal Vitrimer Design

50

Support of Plastics and Polymer Research Through Solicitations and Centers

Mathematical and Physical Sciences Directorate

- Critical Aspects of Sustainability (PD 19-9102)
- Designing Materials to Revolutionize and Engineer our Future (NSF 21-522)
- Centers for Chemical Innovation (NSF 20-574)
- Materials Research Science and Engineering Centers (NSF 19-517)

Engineering Directorate

- Emerging Frontiers in Research and Innovation (NSF 20-614) | Engineering the Elimination of End-of-Life Plastics
- Environmental Convergence Opportunities in CBET (NSF 21-527)
- Future Manufacturing (NSF 20-522)
- Engineering Research Centers (NSF 20-553)

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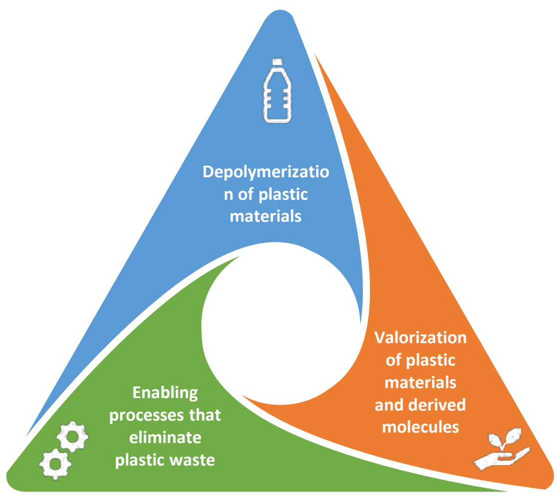
EFRI FY21 (NSF 20-614): *Engineering the Elimination of End-of-Life Plastics*

Supporting the development of robust, economical chemical and biodegradation routes for plastic disposition and valorization

- Novel industrial biotechnology (bioengineering and synthetic biology)
- Effective chemical catalysts
- Process system design (process systems, reaction engineering, manufacturing, materials processing)
- Deploying remediation technologies in sustainable and ecological sound manner



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EFRI E3P: Sustainable and Circular Engineering for the Elimination of End-of-life Plastics: A Framework for Assessment, Design, and Innovation (2029397 | Bhavik Bakshi)

EFRI E3P: Massive Microplastics Remediation using Novel Microcleaners and Microbiome Processing Accelerated by Artificial Intelligence (2029327 | Carol Hall)

EFRI E3P: Valorization of Plastic Waste via Advanced Separation and Processing (2029375 | Paschalis Alexandridis)

EFRI E3P: End of Life Plastics as Starting Materials for Filtration and Barrier Applications (2029387 | Steven Weinman)

EFRI E3P: Sequestering Microplastics Using Upcycled Plastic Waste (2029251 | Anne McNeil)

EFRI E3P: Reincarnation of Polymers for the Circular Economy (2029374 | John Dorgan)

EFRI E3P: Engineering Suspension Feeder Systems for Separation and Elimination of Microplastics from Water (2029428 | Leslie Shor)

EFRI E3P: Tuning Catalyst Design to Recycle Mixed Polymer Streams (2029394 | Steven Crossley)

EFRI E3P: Plastics Recycling Processes by Integrating Mechanocatalytic Depolymerization, Monomer Purification, and Consumer Behavior (2028998 | Carsten Sievers)

National Science Foundation

NSF Center for Sustainable Polymers

Marc Hillmyer | Univ. Minnesota | CHE-1901635

- Efficient and sustainable conversion of biomass to polymer ingredients
- High-performance sustainable plastics and elastomers
- Sustainable polymer degradation, chemical recycling, and compatibilization

The mission of the NSF Center for Sustainable Polymers (CSP) is to transform how plastics are made, unmade, and remade through innovative research, engaging education, and diverse partnerships that together foster environmental stewardship

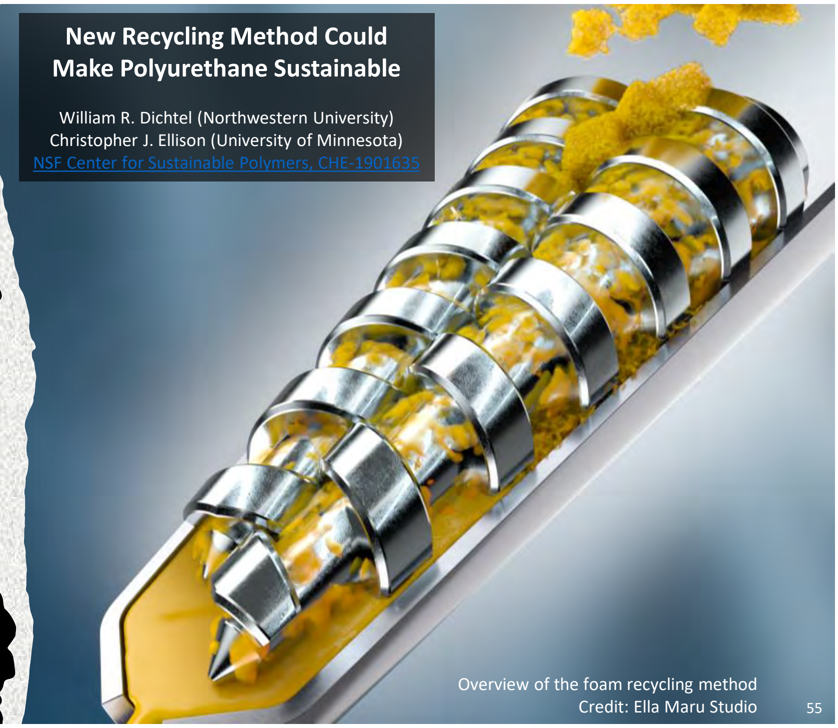
Centers for Chemical Innovation (NSF 20-574)

- By embedding an industrially relevant catalyst, post-consumer polyurethane foam can be remolded into rubber or plastic using twin-screw extrusion at elevated temperatures.
- The resulting recycled material maintains its mechanical properties after the process is complete.
- Air present in the initial foam waste is removed during the screw mixing process producing rubber or plastic.
- Since this process was demonstrated on commercially sold material, this method has the potential to enable the recycling of the vast amounts of polyurethane foam waste into rubber or plastic products.

Sheppard, D. T.; Jin, K.; Hamachi, L. S.; Dean, W.; Fortman, D. J.; Ellison, C. J.; Dichtel, W. R. Reprocessing Postconsumer Polyurethane Foam Using Carbamate Exchange Catalysis and Twin-Screw Extrusion. *ACS Cent. Sci.*, **2020**, *6*, 921–927.

New Recycling Method Could Make Polyurethane Sustainable

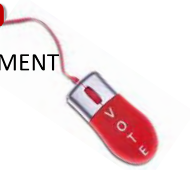
William R. Dichtel (Northwestern University)
Christopher J. Ellison (University of Minnesota)
NSF Center for Sustainable Polymers, CHE-1901635



Overview of the foam recycling method
Credit: Ella Maru Studio

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



Through which of these activities does the National Science Foundation invest in discovery and innovation? (Select all answers that apply)

- Grants for basic research projects
- Grants and contracts for applied research and development
- Graduate fellowships in the sciences and engineering
- Support for instrumentation and facilities
- None of the above

** If your answer differs greatly from the choices above tell us in the chat!*

Support for Translational Research and Technology Development and Catalyzing Partnerships

- Partnerships for Innovation (NSF 19-506)
- Industry-University Cooperative Research Centers (IUCRC) Program (NSF 20-570)
- Small Business Innovation Research (SBIR) Program (NSF 21-562)
- Small Business Technology Transfer (STTR) Program (NSF 21-563)

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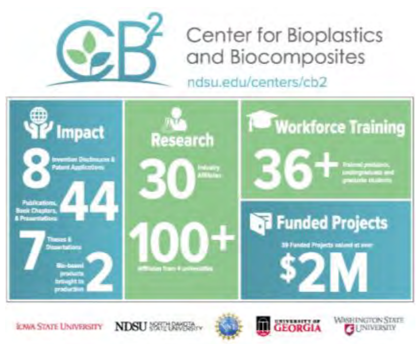
Center for Bioplastics and Biocomposites

FY 20

- Towards Biobased ABS
- Investigating Root Cause and Reduce Fogging Behavior of Natural Fiber Filled Thermoplastics
- Pen Polymers - Next Generation Bottles and Packaging Materials

https://cb2.iastate.edu/ IIP-1916564



- Moisture Sensitivity of PLA/PBS Blends During Ultrasonic and FDM welding
- Unlocking the Potential of Biodegradable Xylan-based Polymer Materials
- Lignin-Derived Compounds for the Production of Polyurethane Plastics and Foams

- Investigation of the Enzymatic Degradability of Glycolic Urethane Linkages Using Chromophore Probes
- Plant Oil-Based Latex Adhesives
- Performance Evaluation of Natural Fiber-Basalt Hybrid Composite Panels

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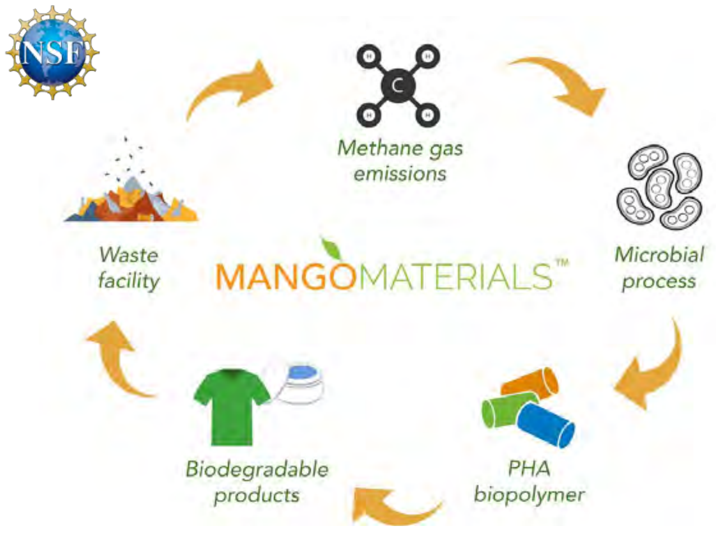

Process: Engineered bacterial strains produce PHA using corn-based sugar as a carbon source. PHA is separated and pelletized.

Challenge: Agricultural land usage, competition with food supply

Innovation:

- Developed and applied fermenter-grown bacteria consortium that transform methane and oxygen into poly-3-hydroxybutyrate
- End-of-life PHA degrades anaerobically, producing methane gas and closing the loop
- Tunable PHA properties

Mango Materials

Commercialization of a process for converting waste methane to poly-hydroxyalkanoate

NSF Small Business Innovation Research Phase I and II Awards 1142566 and 1256623

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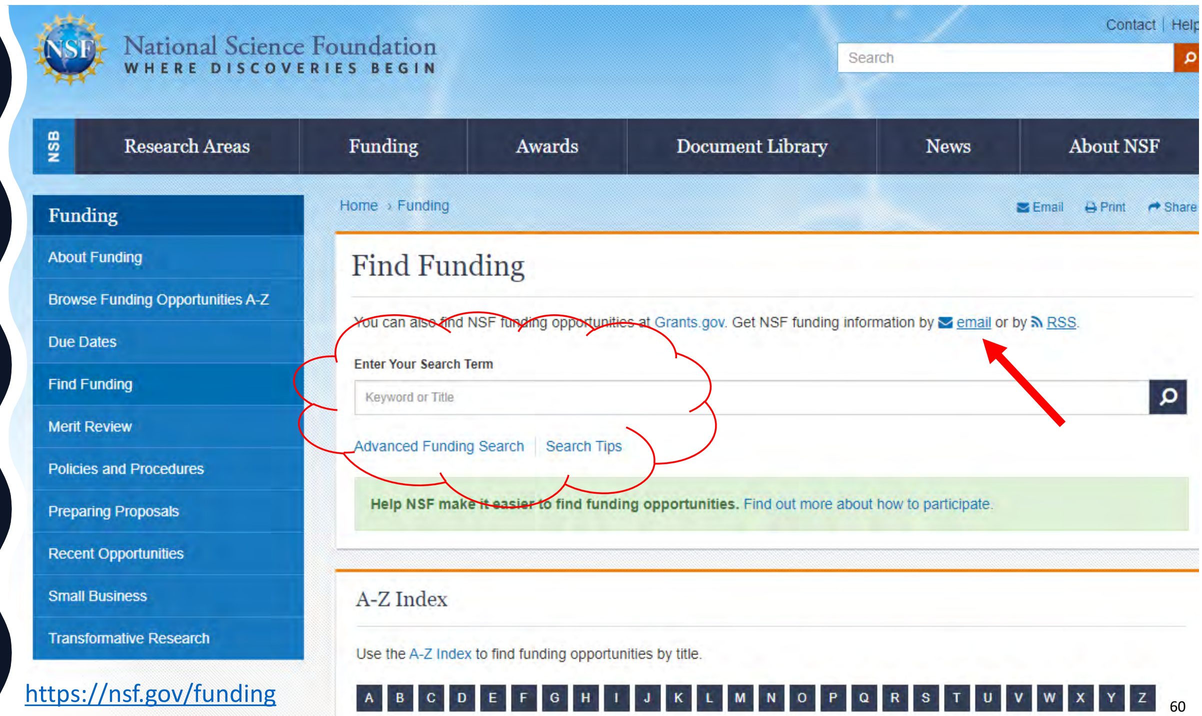

https://nsf.gov/funding

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ACS Committee on Science (COMSCI)

"The ACS Committee on Science aims to ***engage the global chemistry enterprise to build a better tomorrow*** by identifying new frontiers of chemistry, examining the scientific basis of, and formulate public policies related to, the chemical sciences, and recognizing outstanding chemical scientists."

Martin G. Kociolek
Chair, COMSCI

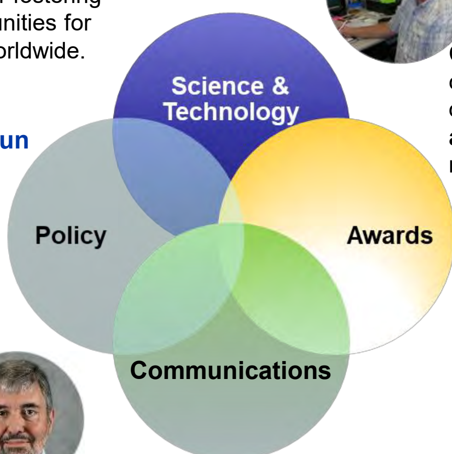
Mary Kirchhoff
Staff Liaison

https://www.acs.org/content/acs/en/about/governance/committees/science.html

ACS Committee on Science

Identify emerging multidisciplinary science that holds promise for fostering innovation and growth opportunities for chemistry-related scientists worldwide.

Young-Shin Jun



Steve Bonser

Collaborate with ACS divisions and committees to recommend distinguished scientists for **national and international awards** in recognition for their contributions

Examine the scientific basis of **public policies** related to chemistry and make recommendations to appropriate ACS entities.

Matt Fisher

Diana Gerbi

Inform ComSci's stakeholders about its activities in science and technology, policy, and awards.

https://www.acs.org/content/acs/en/about/governance/committees/science.html

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ACS Chemistry for Life®

Solving the Plastics Problem through Chemistry: Federal Research and Technology Programs

KATHRYN BEERS
Program Manager, Soft Matter & Circular Economy, National Institute of Standards and Technology

BRUCE GARRETT
Director of the Chemical Sciences, Geosciences and Biosciences, Division of the Office of Basic Energy Sciences, U.S. Department of Energy

CHRISTINA PAYNE
Program Director, Engineering Directorate's Division of Chemical, Bioengineering, Environmental, and Transport Systems, National Science Foundation

ANGELA WILSON
John A. Hannah Distinguished Professor and Associate Dean for Strategic Initiatives, College of Natural Sciences, Michigan State University and 2021 ACS President-Elect

Presentation slides are available now! The edited recording will be made available as soon as possible.

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This ACS Webinar is co-produced with ACS Committee on Science.

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ACS Chemistry for Life®

How to Survive a Life in Chemistry in a Post-COVID-19 World

Date: Wednesday, May 5, 2021 @ 2-3pm ET
Speaker: Joe Martino, American Chemical Society
Moderator: Tom Halleran, American Chemical Society

Register for Free!

What You Will Learn:

- How to approach networking and work after COVID-19, both in person and virtually highlighting virtual tools and how to re-think in-person networking for a post-pandemic world
- What was impacted by COVID-19 in the past year, focusing on industry and academia, and how that will impact the future
- How the workforce is gearing up to a return to in-person work that will be slightly different than before

Co-produced with: ACS Careers

How Industry is Driving Sustainability Through Innovation

Date: Wednesday, May 12, 2021 @ 2-3pm ET
Speakers: Peter Eckes, BASF / Gayle Schueller, 3M / Bob Maughon, SABIC
Moderator: Rebekah Paul, American Chemical Society

Register for Free!

What You Will Learn:

- The role of the chemical industry in driving sustainability
- How sustainable innovations can benefit the consumer, the chemical industry and the environment
- Opportunities for the next generation in the chemical industry

Co-produced with: ACS Industry Member Programs

Nanosafety Emerging Research Perspectives

Date: Thursday, May 13, 2021 @ 2-3pm ET
Speakers: Tilak Chandra, University of Wisconsin-Madison / Katie Kruszynski, University of Wisconsin-Madison / Markus Schaufele, Northwestern University
Moderator: Ralph Stuart, Keene State College

Register for Free!

What You Will Learn:

- The emerging concerns related to nanoparticle safety, both in the laboratory and in the environment
- How a "what if" method can be used for a hazard assessment to develop a safe operating procedure
- What research about nanoparticles in the environment tells us about potential hazards

Co-produced with: ACS Division of Chemical Health and Safety ACS Committee on Chemical Safety

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