NIST Climate Portfolio Update:
Circular Economy

Keeping atoms and molecules inside the economy, producing value, and out of unwanted sinks such as the environment (air, water, soil, etc).
What is the Circular Economy?

The Circular Economy transforms our throwaway economy into one where waste is eliminated, resources are circulated, and nature is regenerated.

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

Definition for NIST:
Keeping atoms and molecules inside the economy, producing value, and out of unwanted sinks such as the environment (air, water, soil, etc)

Organization
We are structured roughly around materials classes

Beginning with Polymers/Plastics

UN Draft Language (9/21): products and materials are designed so that they can be reused, remanufactured or recycled and therefore maintained in the economy for as long as possible along with the resources they are made of, and the generation of waste, especially hazardous waste, is avoided or minimised, and greenhouse gas emissions are prevented and reduced

SOS 2.0: system of economic activities that is restorative to the environment, enables resources to maintain their highest values and aims for the elimination of waste through superior design
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

Circular Polymers

“Accelerating Circular Supply Chains for Plastics”
Center for the Circular Economy @ ClosedLoopPartners.com
NIST Discretionary Start-Up: Polymers

Data & Decision Tools
- Supply Chain Resilience
- Life-cycle Data and Economics
- Material Flows/Mass Balance
- Reference Data Sets, Data Infrastructure & Documentary Standards

New Processes & Materials
- Mechanical, Biological and Chemical cycling routes
- Fit-for-Purpose design rules
- Automated synthesis / AI platforms
- Reference materials & data

Environmental Impacts
- Marine Debris
- Nano- and Micro-plastics
- Sampling methods
- New Measurements (Characterization)
- Reference materials

Opportunities for all parts of NIST!
Polyolefin Compatibilization

- NIST developed rheo-Raman-microscope provides unprecedented view of hierarchical kinetics in mixed polyolefins, leading to strategies to enhance mechanical properties.
- MCR allows quantification of % crystallinity of both HDPE and iPP simultaneously during process.

Kalman Migler, Derek Huang (NRC)
Materials Science and Engineering Division, MML
Model Nanoparticles for Dynamic Studies

- Goal: both stationary and released, uniform nanoparticles (100 nm to 1 µm) for standards and calibrations
- Arrays of nanoplastic in phenolic resin fabricated
- Raman microspectroscopy complete (spectra shown for thin films)

Electron scattering  Fluorescence emission  Rayleigh scattering  Raman scattering

Sam Stavis, Andy Madison (NRC)
Microsystems and Nanotechnology Division, PML
Circular Economy Resource Registry

- Platform on CDCS framework (w/ ITL)
- Draft Schema (XML), Complete
- Test Site active
- Core data set being implemented
  - shared resource types, CE specific metadata
  - search & faceted browsing
  - custom CE web views
  - Publishing
  - API access supports interoperability

Gretchen Greene, Ray Plante, Kelsea Schumacher, Ben Long (ITL), Ali Daoudi

Office of Data Informatics, MML
Circular Economy in the High-Tech World:
- eWaste
- Solar waste
- Battery waste

Assessment of Mass Balance Accounting Methods for Polymers:
- Basis of congressional report mandated by SOS 2.0

Facilitating a Circular Economy for Textiles:
- Technical challenges
- Environmental impacts
- Government viewpoints

Kelsea Schumacher and Marty Green
Kelsea Schumacher, Kate Beers, Kalman Migler, KC Morris and Josh Kneifel
Kelsea Schumacher and Amanda Forster
Relationships and Future Opportunities: Domestic

- 3 Department of State working groups: Plastic Waste, Circular Economy, and UNEP/UNEA preparations
  - Increasing DOC coordination w/ ITA and NOAA
- EPA National Recycling Strategy (expected Sept 2021)
  - SOS 2.0 studies (Innovative Uses of Plastic Waste, Minimizing Creation of New Plastic Waste)
- MOU with NSF on Emerging Frontiers Research Institutes
  - 5 NSF Workshops in 10 months (Convergence Accelerator, DMR and CBET)
- Multiple partnerships with industry, academia and other National Labs
  - Chevron Phillips, Braskem, Dow, Eastman, Argonne National Lab, Brookhaven National Lab, Hawai’i Pacific University, Johns Hopkins University, University of Maryland, Woods Hole Oceanographic Inst.
- Trade associations engaged across multiple projects
  - ACC, APR, BIO, The Vinyl Institute, etc
- Early discussions with FDA, USDA and NSTC Sustainable Chemistry working group
Joint & International

- JRC-NIST Virtual Workshop on Nanoplastics Research (Jenn Lynch, et al.)
- APEC (Jenn Lynch) and ASTM workshops (KC Morris)
- ISO/TC 323 Circular Economy
  - 5 working groups (NIST on US TAG)
- Policy & Government (Plastic Pollution/CE):
  - UNEP negotiations coincide with similar discussions and negotiations within OECD, WTO, G7 and G20
  - Plans for symposia (PacifiChem, ACS, etc) and conferences (GRC)
  - US-France bilateral + joint meeting with the French embassy
  - SIM working groups on waste management and circular infrastructure in the Americas
Related Priorities / Opportunities

• Carbon Capture
• Resilience
• Infrastructure
  • Physical
  • Societal
• Supply Chain
  • CHIPS Act / NDAA
• Bioeconomy, Biomanufacturing
• Equity and Environmental Justice
• Proposed expansions of AMO, MEP
• New NSF Technology Directorate

CE expansion plans
  • High-Tech/Critical Minerals
  • Textiles
  • Concrete/Built Environment
  • Biomass/Food Waste
  • Expansion of plastics activities

mobilizegreen.org
Thank You!

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