Source: Biomass R&D Technical Advisory Committee

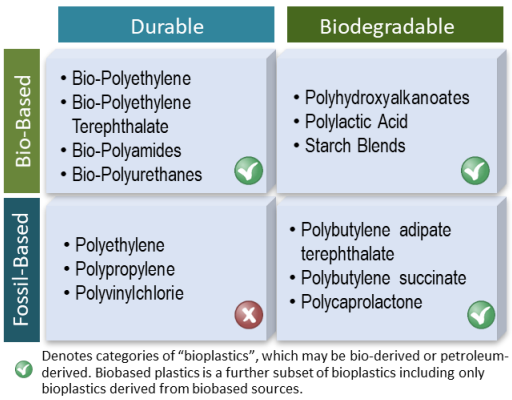
Advisory To: Biomass R&D Board

Report Date: 8/23/2018 (Q3 2018), issued 11/15/2018

Issue: ***Opportunities to Accelerate Growth in Biobased Plastics***

BIOMASS R&D TAC Technical Advisory Committee

Plastics have become an essential part of modern life and offer great economic and social benefits. While some plastics offer environmental and sustainability benefits (e.g., light-weighting to reduce fuel consumption and highly efficient insulation foams), conventional plastics are derived from non-renewable petroleum resources. Shifting the raw material base for plastics from petroleum to biobased feedstocks presents an appealing solution for many industries and applications, particularly when the biobased plastics are biodegradable. The term "bioplastics" includes plastics derived from biomass feedstocks instead of conventional petroleum feedstocks, as well as fossil-derived plastics that are biodegradable. The TAC has identified a sub-type of bioplastics, Biobased Plastics, as a category with near-term potential to accelerate maturity in the emerging bioeconomy, particularly those biobased plastics with similar property profiles and established recycling systems.



Biobased plastics can be further categorized in one of three ways: (1) Direct Replacements, where the bio-derived product and its petroleum counterpart are chemically identical (also known as drop-in replacements); (2) Functional Replacements, where the bio-derived product and petroleum-derived products are chemically different but with similar functions and/or properties; or (3) Novel Products, where the bio-derived product is unique from existing petroleum-derived products in structure and/or function, often with performance advantages.

The TAC has identified key technical, market and other hurdles for biobased plastics that are curbing growth, along with opportunities to address these challenges through research, development and related efforts.

1 Cost-Competitiveness of Direct Replacements (Drop-Ins)

Today's biobased direct replacement plastics (e.g., bio-PE, bio-PET, etc.) are not cost-competitive with their petroleum-based counterparts.

2 Insufficient Market Pull for Functional Replacements and Novel Chemicals

Biobased functional replacement plastics (PEF, PBS, etc.) currently don't have sufficient market pull to drive investment. Performance-advantaged biobased plastics are a hard sell with consumers (and investors) without extensive education, and require a lot of development compared to drop-ins.

3 Limited R&D

Focused R&D is needed across the value chain, from feedstocks through conversion to integrated product development. Application development has not been a priority of federal funding, i.e., monomer to polymer to material to application to brand. Research and funding are needed to build on pioneer biobased plastics efforts that are now reaching commercial production at scale but with limited commercial success.

1 Cost Competitiveness Opportunity

Exact replacements for petroleum derived plastics using biobased feedstocks are available today, but at a higher cost. Opportunities exist (near-term and long-term) to move toward cost-competitiveness for drop-in biobased plastics (bio-PE, bio-PET, etc.).

- ⇒ ***Focus R&D on readily available intermediate feedstocks rather than raw biomass; examples of well-characterized intermediate feedstocks further down the chain (in addition to simple sugar) include glycerol, lactic acid, ethanol, lignin***
- ⇒ ***Continue to focus on separations technologies, which offer potential to expand the range of suitable feedstocks and reduce costs***
- ⇒ ***Encourage and facilitate the use of plant biotechnology for expressing traits directly in plants for increased efficiency***
- ⇒ ***Pursue intermediate-level proof of concept to get to drop-in biobased plastics***
- ⇒ ***Encourage horizontal integration with existing infrastructure and development of complementary markets to de-risk and improve profitability***

2 R&D Opportunity

A few pioneer efforts have delivered commercial production of biobased plastics at scale and limited commercial success. Focused R&D spanning the value chain—from feedstocks to conversion to integrated product development—can accelerate commercialization. Novel functional replacements and performance-advantaged biobased plastics require extensive development compared to drop-ins.

- ⇒ ***Enable researchers to work backwards from known end-use targets and performance needs; develop and support databases, models, etc. that facilitate characterization and down-selection of platform molecules with desirable characteristics***
- ⇒ ***Continued work on separations technologies is especially critical for development and scale-up of novel molecules and products***
- ⇒ ***Exploit specific advantages of products from oxygenated molecules (e.g., biodegradability, cross-link capability)***
- ⇒ ***Continue to fund research on lignin-derived polymers and natural fibers***
- ⇒ ***Bridge the readiness assessment gap between academics/research vs. industry where products and markets and profitability drive commercial deployment (e.g., scalability, quality control, certifications, risk)***

3 Market Pull Opportunity

Biobased functional replacement plastics (PEF, PBS, etc.) currently don't have sufficient market-pull to drive investment. Performance-advantaged biobased plastics are a hard sell with consumers, investors, and brand owners without extensive education and effective communication of the value proposition.

- ⇒ ***Multi-agency RFI targeting brand owners to identify critical performance needs***
- ⇒ ***Build upon NSF's Industry-University Cooperative Research Center (IUCRC) model to stimulate growth and investment***
- ⇒ ***Support promotion and expanded adoption of USDA's BioPreferred Program by engaging states, local governments, universities, other institutions***
- ⇒ ***Develop and promote better and more consistent understanding of key value propositions (e.g., biodegradability, sustainability, LCA, regional closed loop systems) to connect research to industry to brands to consumers to product end-of-life sustainability***