

Challenges to Mechanical and Chemical Recycling of Textiles

Circular Polymers

- Formed in 2017, focusing on non-traditional feedstocks for chemical recycling.
- Built CA plant in 2018 (150,000 SQ'), doubled plant capacity to 50mm, further CA expansion planned.
- Disruptive technology for carpet, textiles and field turf.
- Providing product to PET, PP, and N6 chemical & mechanical recyclers. N66 upcycled for automotive.
- Building plants in States that have implemented Extended Producer Responsibility for carpet.
- Incubating textiles.



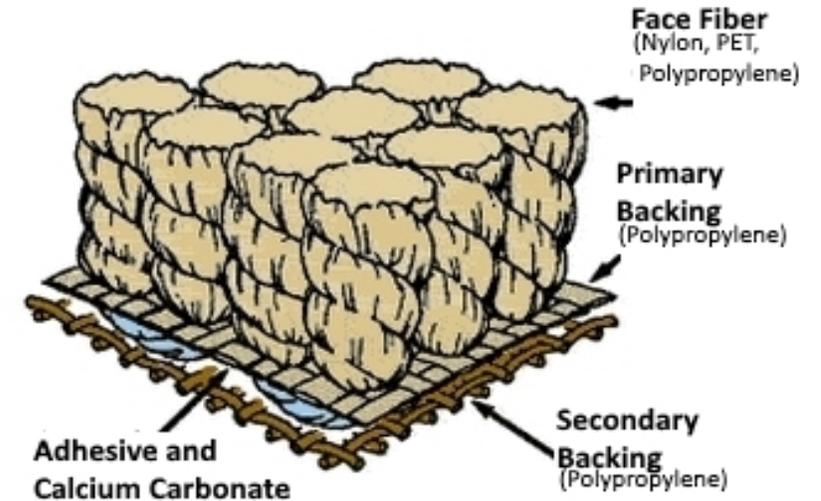
Alternative Feedstocks

Estimated Annual US Weight

- Textiles 17-25 Billion pounds
- Carpet 4-7 Billion pounds
- Field Turf 50 Million pounds
- Bottle Release Liner 60 Million pounds
- Agricultural Plastic 1 Billion pounds
- Composite Wood
- Automobile parts and acoustic dampening



How is Carpet Recycled?



- Carpet removed from use is collected and sorted by face fiber type prior to recycling.

- Reclaimed PET comes from the face fiber of post-consumer carpet.
- Calcium carbonate and polypropylene is collected separately and sold separately.

Circular Polymers Products

STANDARD AND OPENED FIBER



DENSIFIED AND MELT FILTERED PELLETS



Commercial Applications

PET, PP & N6 UPCYCLED THROUGH CHEMICAL RECYCLING

- Depolymerization
- Carbon Extraction
- Pyrolysis
- Glycolysis
- Hydrolysis

N66, N6, PP, PET, PTT & PU WITH FURTHER MECHANICAL PROCESSING

- Compounding for automotive (EV and ICE)
- Injection molding
- Composite wood
- Non-woven fiber

CALCIUM CARBONATE

- Fillers

Carpet and Textile Similarities

- Multi material structures
- Interwoven polymer fibers
- Labeling designed for consumer, not recycling
- Re-use opportunity prior to recycling
- Alternative collection required
- Mechanical and Chemical pre-processing required
 - Identification and Homogenization
 - Contaminant removal



Mechanical vs. Chemical Recycling

- Both have an important role in the future.
- High purity raw materials are better for mechanical recycling.
- Low purity, low cost plastic waste is better suited for chemical recycling.
- **Chemical recyclers still require pre-processing for most plastic raw materials to meet polymer specifications and material handling requirements.**

Feedstock Purity

- Chemical and mechanical recyclers are still sensitive to feedstock purity.
- The higher the feedstock purity, the lower the feedstock availability and/or the higher processing costs for reclaimers.
- The lower the feedstock purity, the higher the feedstock availability.
- Acceptance by chemical recyclers ranges from 80% purity to 95%+ purity requirements.
- Color agnostic increases feedstock availability.
- **Identification of textile fabric and polymer % is essential.**

Textile Challenges

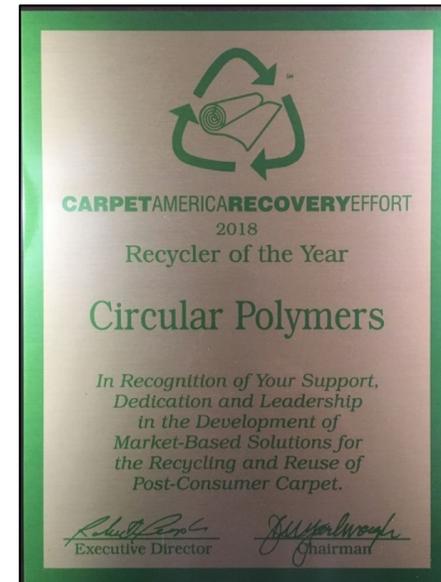
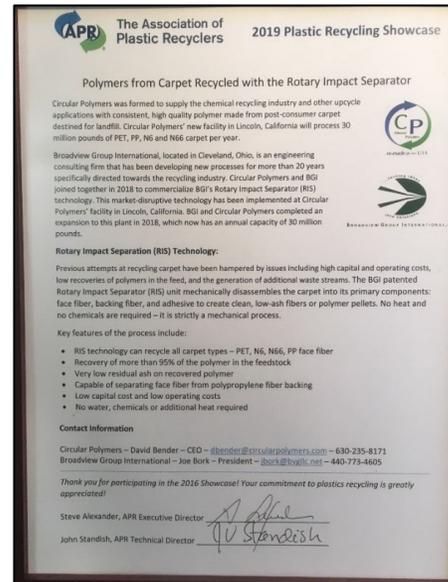
- Commercial
 - Recycling economics require subsidization.
 - Lack of polymer purity downgrades significant volumes of textiles into mixed polymer low end applications.
- Logistics
 - Collection infrastructure not established.
 - Reverse logistics challenge - “1st Mile.”
- Technology
 - FTIR Identification of polymer type and percentage in carpet.
 - 80%+ Polymer percentage required for chemical recycling specifications.

Textile Challenges

- Design
 - Design for performance/fashion AND design for recyclability required.
 - Labeling or Marker.
- Industry
 - Opportunity for coordinated collection, processing and design for recycling.
- Policy
 - Extended Producer Responsibility.
 - Mandatory post consumer circular content.

Circular Polymers Awards

- **2019** Plastics Industry Association — Sustainability Innovation Award
- **2019** Association of Plastic Recyclers — Innovation Showcase Award
- **2019** Carpet America Recovery Effort — Processor of the Year



Thank You to NIST

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