

New 100% Post-Consumer Recycled Nylon 6

June 7, 2023

A cost-effective, recycled content solution for food packaging

AdvanSix At A Glance

Leading Producer of Nylon Solutions, Chemical Intermediates, and Plant Nutrients



Nylon's Contribution to Packaging

A much-needed sustainable product for brand owners with demanding applications



- Flexible packaging is inherently more sustainable vs. rigid packaging for many applications
- Packaging is typically 3-3.5% of total product/package carbon footprint*
- Nylon provides critical durability to protect food & minimize food waste (30-40% in the U.S.)**
- Nylon is <2% of the market but enables packaging that consumers prefer & purchase

Nylon delivers:

- Thermoformability
- Shrink
- Ovenability
- Toughness
- Retortability

Barrier



Plastics News, 2019

* Designing Packaging to Prevent & Divert Food Waste," SPC report (2022) ** "United States 2030 Food Loss and Waste Reduction Goal," https://www.epa.gov/

Surveying the Sustainable Landscape

Plenty of aspirational goals and challenges

- 90% of brand owners not expected to meet 2025 goals;
 might move target date or shift focus to carbon reduction*
 - Recycled content demand will continue to outstrip supply
 - Flexible recycling rate is only ~2%
 - Carbon footprint not included in ERP language
- APR is lobbying against PIR, advanced recycling, and mass balance for on-package labeling
 - Post-industrial (PIR) is already 60% of recycled content and is defined as "recycled content" by both the FTC's Green Guides and ISO**
 - Advanced recycling and mass balance are important tools in a circular economy
 - Need to expand the sustainability discussion beyond packaging
- Rather than picking winners and losers, we should be leveraging multiple solutions to meet the true end-goals:
 - Reduce virgin resin usage
 - Minimize landfill

AdvanSix

- Curtail global warming



Increased share of PCR across all packaging for signatories from "The Global Commitment 2022 Progress Report," Ellen MacArthur Foundation



Plastics News research by Hollee Keller, 2023; graphic by Amy Steinhauser

* John Blake (Gartner) in "*What's next if 20% of companies shift 2025 plastic targets?*" Packaging Dive (March 30, 2023). ** ICIS Recycling Supply Tracker, 2/2022

Recyclability of Nylon

Balancing nylon's benefits with its challenges



• Nylon is...

- Used where food waste or a worse overall environmental footprint would otherwise result
- Sometimes viewed as contamination in the PE recycling stream
- Nylon-containing structures are more recyclable in <u>both</u> mechanical and chemical processes than those containing BOPET*
- Apply design strategies when utilizing nylon:
 - PE/PA blends containing up to 10% nylon have adequate mechanical properties and are recyclable, based on APR protocol
 - Optimum tie layer selection and use of compatibilizer help to retain mechanical properties with up to 15% polyamide in PE blends
 - Nylon copolymer (PA6,66) is more recyclable than homopolymer (PA6) in PE films

Λ dvanSix

* "*More sustainable packaging: 5 common questions*," Gerald Rebitzer, Amcor website (Feb. 2023)

It all starts with...the total package.

Nylon 6 packaging made from 100% recycled content



- AdvanSix launched 100% Aegis[®] PIR-PA6 resin & Capran[®] PIR-BOPA films in 2021
- AdvanSix now has a new line of Aegis® PA6 resin products that are certified as <u>100% Post-Consumer Recycled</u>*
- Recycled content nylon 6 can be an important part of the circular economy, serving as a major source of clean recycled feedstock
- In process of obtaining ISCC+ certification for our facilities
- With this approach, there is...
 - No costly re-qualification process
 - ✓ No compromise in physical or mechanical properties
 - No food contact concerns
 - ✓ **No** impact on brand owners' FFS throughput
 - ✓ Reduced virgin resin content
 - Increased recycle content
 - Favorable carbon footprint
 - Immediately available, drop-in sustainable solution

Λ dvanSix

Environmental **AdvanSix's New 100% PCR-Grade Nylon 6** Claims VALIDATION by SCS GLOBAL SERVICES **Circular solution for demanding applications** 100% RECYCLED CONTENT POST-CONSUMER System Allocation verified based on AdvanSix's allocated use of Post-Consumer recycled caprolactam calculated as a percent of output of total PCR PIR grade nylon 6 resin. **Material Flowchart** SCS-SEC-00058 PCR **Mass Balance & Allocation System** Unreacted • 100% Virgin Virgin Caprolactam Nylon 6 caprolactam CHa PIR 100% PIR monomer is Caprolactam 00000 Nylon 6 purified, then PCR 100% PCR Caprolactam Nylon 6 Hopewell Chesterfield Customer returned to Feedstock Caprolactam **Resin Plant** (film/fiber (cumene, sulfur, the system Monomer Plant manufacturer) natural gas) Recycled content • PCR allocated to PCR PIR Caprolactam specific 100% PIR Washwater Caprolactam grades* (water, caprolactam, Washwater oligomers) Industry **Recovery System** Washwater (water, caprolactam, oligomers) Landfill

AdvanSix

AdvanSix's PCR and PIR PA6

New complementary and additive loops for the circular economy

- Our PCR and PIR nylons are part of the circular economy, but do not conflict with the other recycling loops.
- AdvanSix's monomer recovery avoids disadvantages associated with other recycling technologies.
 - Low yields: Both mechanical and chemical recycling technologies*
 - Lack of food compliant grades at required MFI: Most mechanical recycling**
 - Problematic chemicals: Solventbased recycling
 - Emissions concerns: Energyintensive pyrolysis technologies[†]



 Λ dvanSix

* "Plastic flexibles: Design and recycling in the formal sector," Ellen MacArthur Foundation 2022
** "Considerations to Make the Switch to Recycled Food Packaging," Panel discussion at AMI's 2023 SPC Impact

† "Study: GHG emissions from pyrolysis are nine times higher than in mechanical recycling," Recycling Magazine (9/27/2022)

AdvanSix's PCR/PIR-PA6 Combines Sustainability and Value

Delivering the biggest bang- for-the-buck to brand owners

Reduced carbon footprint

- ~60% reduction in carbon footprint vs.
 PlasticsEurope's virgin PA6 values
- Nylon's inherently larger footprint vs.
 PE becomes an advantage when optimizing the overall package footprint
- Cost-effective recycling approach
 - AdvanSix's recycling process is lowenergy and high-yield
 - Competitive pyrolysis-based rPE price premiums have been noted at 2-3x virgin PE

Based on PCR-PA6's reduced carbon footprint and a typical film structure with 30% nylon, improvement in overall package footprint is shown below.



ΛdvanSix

Summary

Sustainable and actionable nylon solutions

- Nylon containing films can be recycled, with optimized resin and tie-layer formulation.
- PCR and PIR nylon 6 can be an important part of the circular economy, serving as a major source of clean recycled feedstock
- 100% recycled content Aegis[®] PA6 and Capran[®] BOPA films are readily available sustainable options
 - <u>Increased</u> recycle content
 - <u>Reduced</u> virgin content
 - Meets food contact requirements
 - **No** compromise in mechanical or optical properties
- Any standard AdvanSix grade can be available in a PIR or PCR version
- Cost-effective method to significantly reduce carbon footprint





AdvanSix