Drive Toward Net-zero Injection Devices High-performance components made with Delrin® Polyoxymethylene (POM) support a sustainable and circular design approach

The stiffest and strongest unreinforced engineering polymer

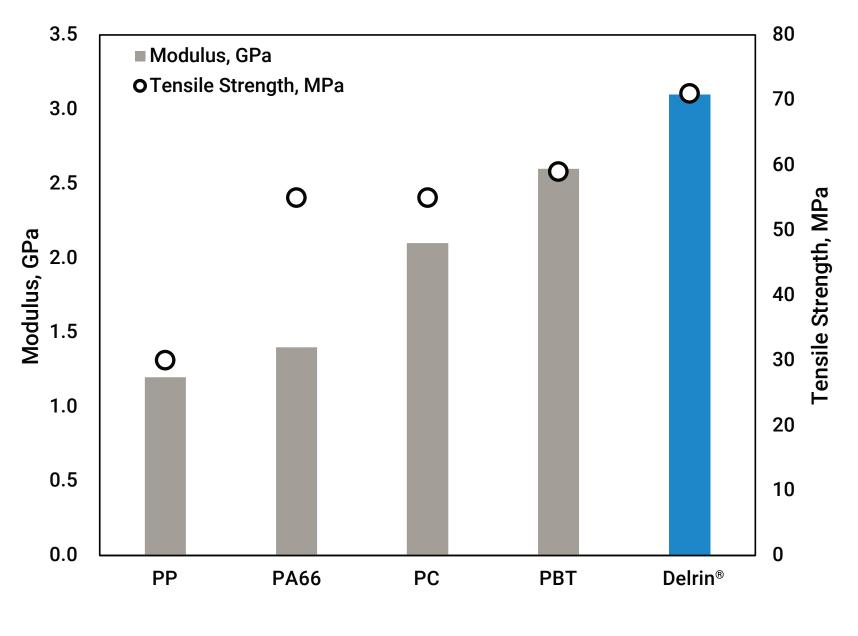
Delrin[®] acetal homopolymer generates superior environmental and financial benefits while demonstrating sustainable advantages.

Delrin[®]—an inherently resilient and self-lubricated polymer—enables:

- Low maintenance cost
- Longer service life
- Reduced lubricant and
- energy consumptionImproved safety
- Improved safety

Delrin[®] is available as Special and Premium Control grades with additional regulatory support designed specifically for healthcare applications.





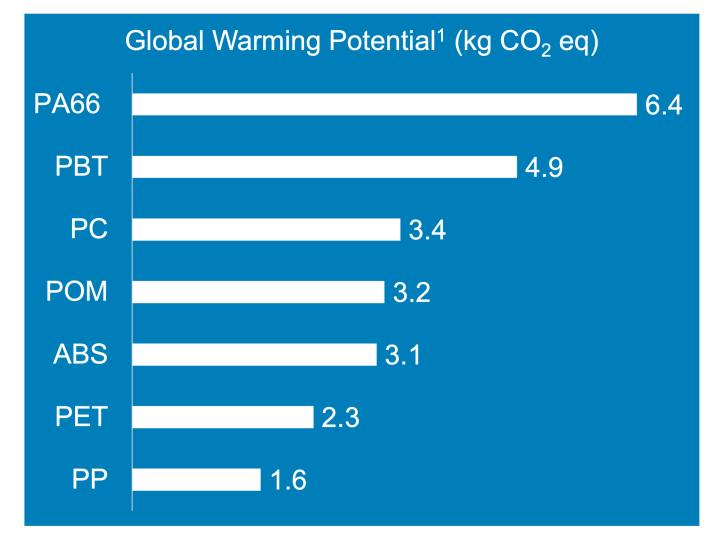
Consideration of a sustainable material

Polymers have an inherent GWP based on:

- Monomer preparation
- Energy required to polymerize

Factors that reduce a material's GWP:

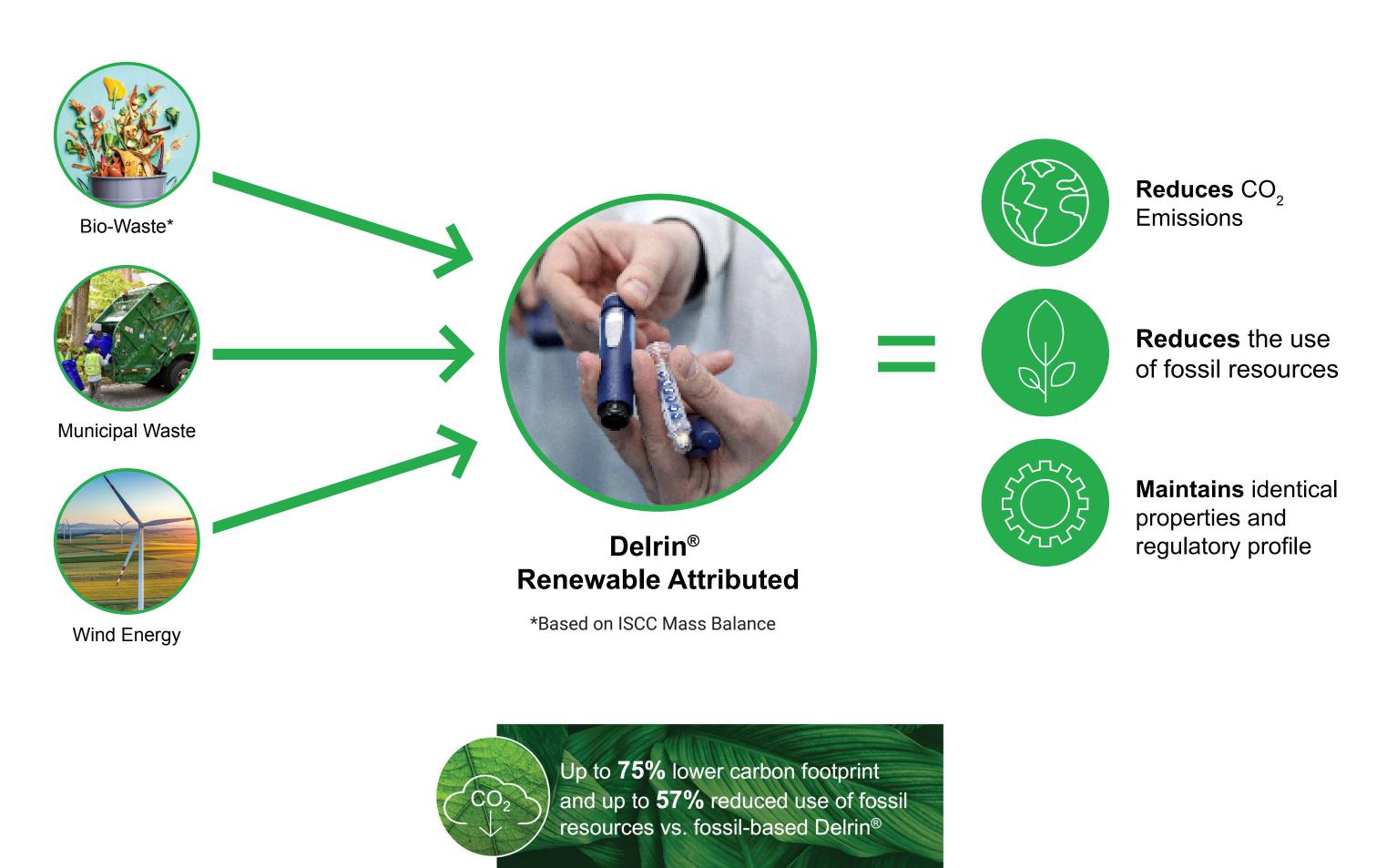
- Biobased monomer/feedstock
- Recycled content
- Green energy used during manufacturing



¹Plastics Europe.

PBT GWP value reflects an average from published sources.

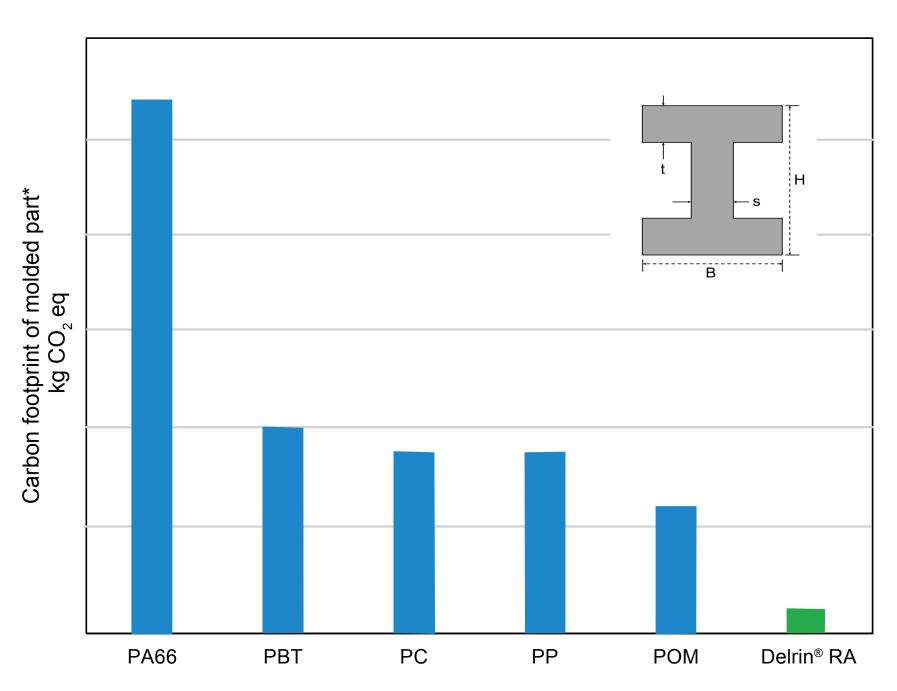
A base polymer made with 100% bio-feedstock from waste



Liz Stubbs (elizabeth.stubbs@delrin.com) Ian Wands (ian.wands@delrin.com) Ned LeMaster (ned.e.lemaster@delrin.com)

Optimize carbon footprint during design and manufacture

Leading eco-profile



*Values reflect the amount of conditioned material required to achieve a molded I-beam of equivalent stiffness

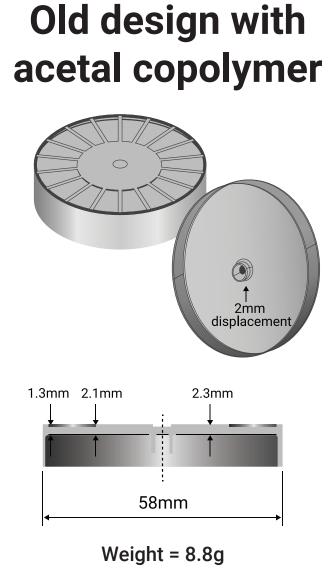
By optimizing design with high performance materials, such as homopolymer acetal, it is possible to produce parts that are:

- Thinner and lighter
- More durable
- Require less energy during molding

Combining this approach with Delrin[®] Renewable Attributed unlocks potential to achieve significantly lower GWP values.



Case Study: Acetal copolymer replaced by Delrin® RA



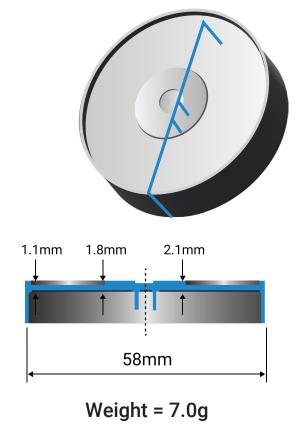
20% weight reduction11% molding time reduction12% cost/part reduction

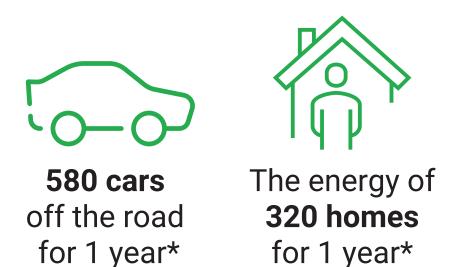
For an acetal consumption of 1000 ton/ year, when parts are redesigned in Delrin[®] Renewable Attributed, you save potentially:

2600 Tons of CO₂

*https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator

Improved design with Delrin[®] Renewable Attributed





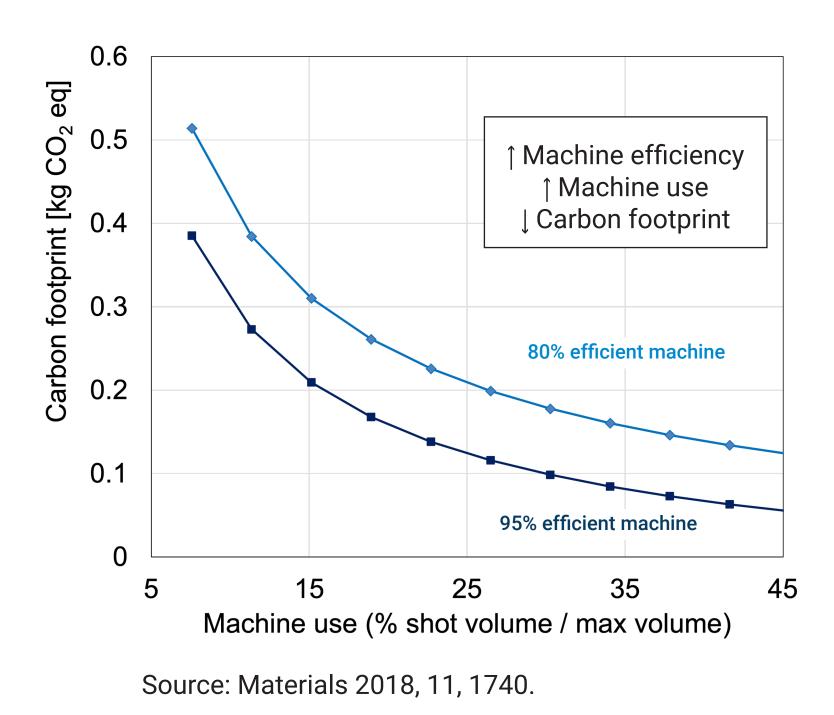
Optimize manufacturing

Low GWP materials require accurate modeling of the energy consumed during manufacturing.

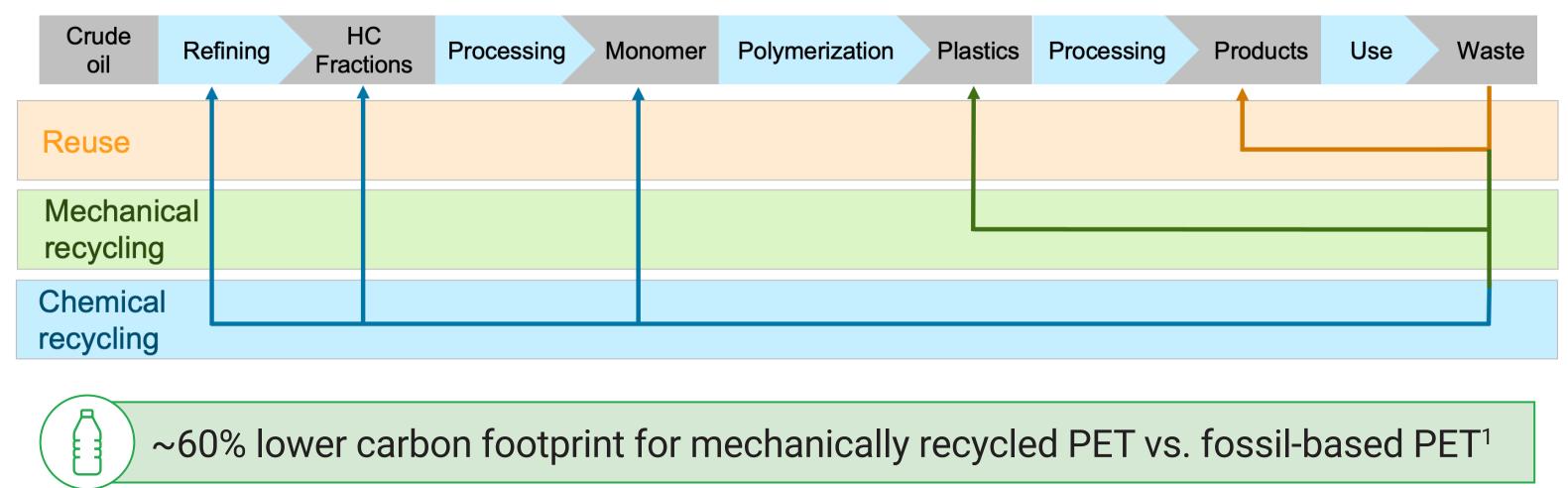
Factors that contribute to energy consumption:

- Polymer type
- Machine specifications
- Machine use
- Cycle time
- Part weight

Understanding the critical factors allows for optimization of molding to achieve lower carbon footprint.

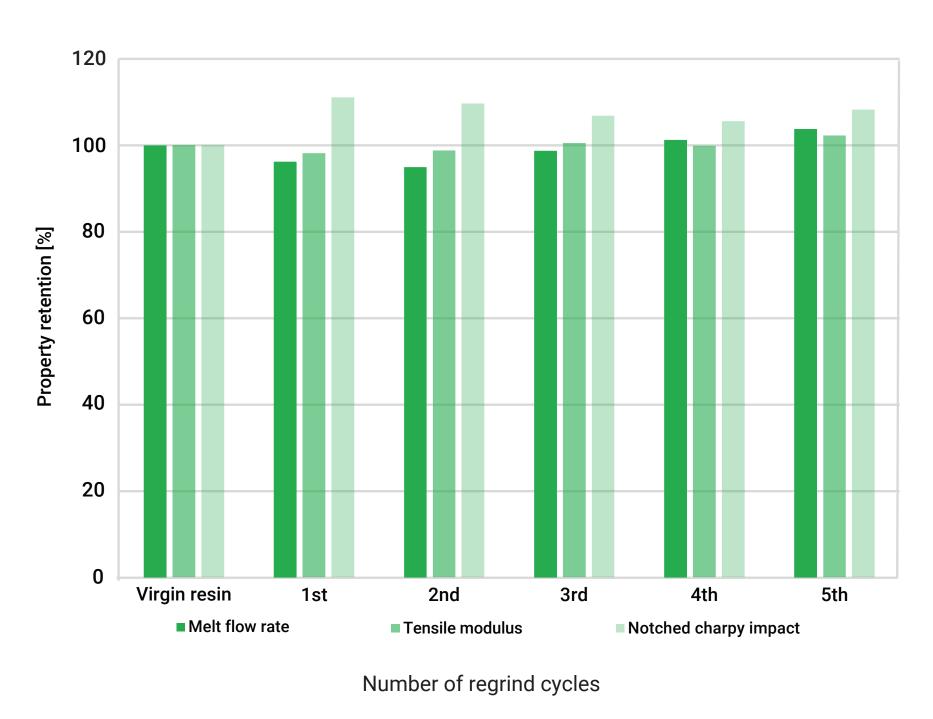


Circular opportunities at the end of a plastics' life cycle



¹National Association for PET Container Resources

Property retention is possible by mechanical recycling with Delrin[®]



100% mechanical properties retention after five passes of 100% regrind

Reduce material used and waste Increase internal recycling of material with financial and environmental benefits

Challenges are associated with the transition to post-consumer recycle

UNCERTAINTY

Chemical contamination associated with daily use or drug contact

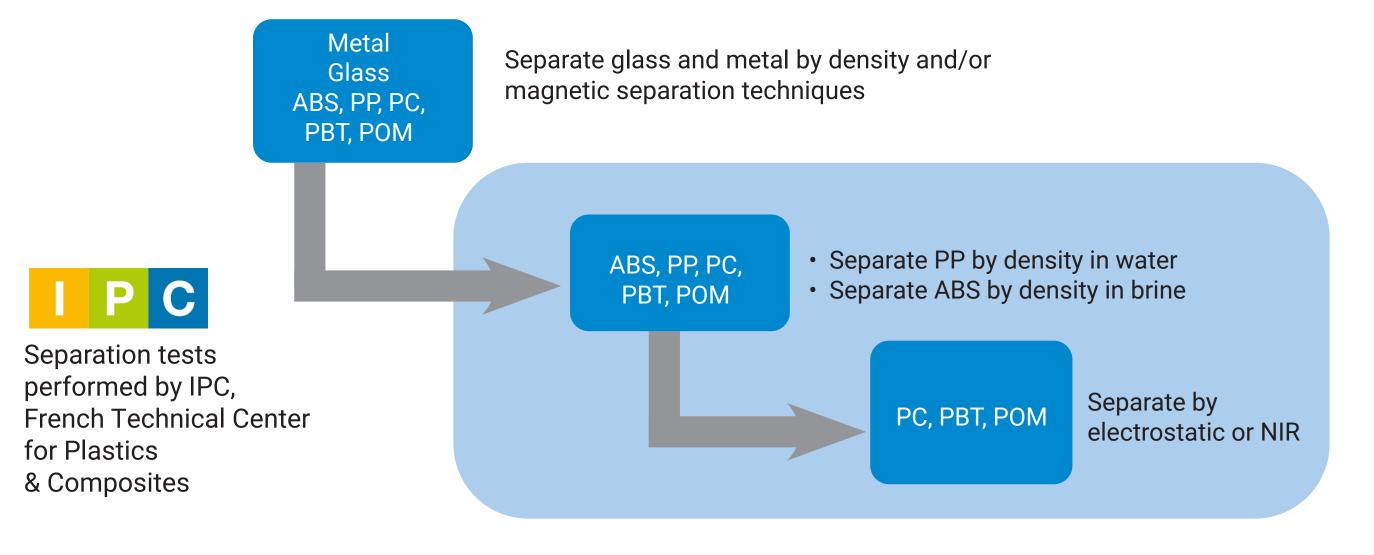
Degradation due to external factors (i.e., cleaning reagents)

Contamination from other material types (ex. metals, glass, polymers) Typical injector pen may be comprised of:

- Metal
- Glass
- PPABS
- PC
- POM
- PBT



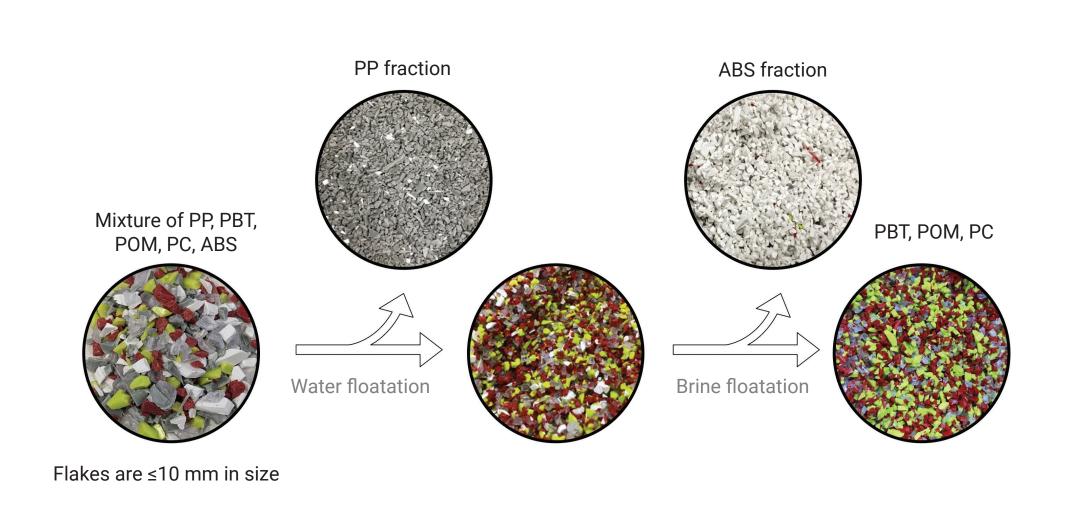
Separating different material types requires multiple steps



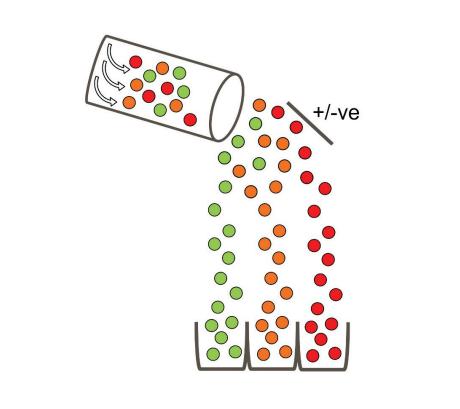


Circular end-of-life consideration: Effective separation requires fewer materials

Appreciable separation by density utilizing floatation



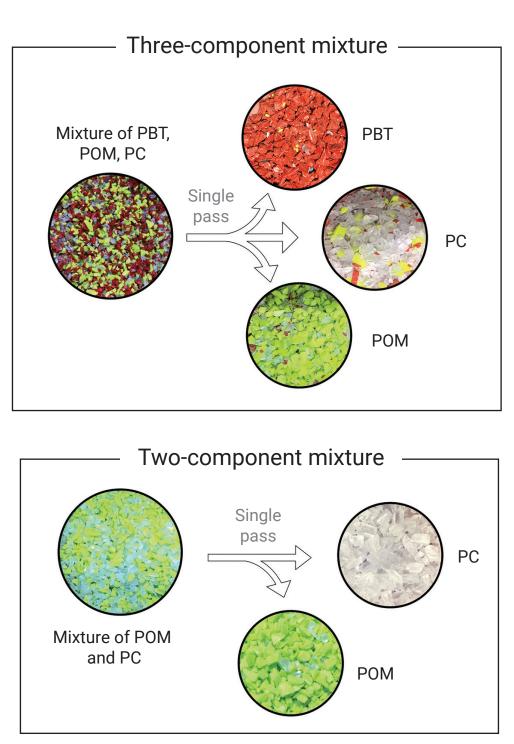
Effective separation by electrostatic



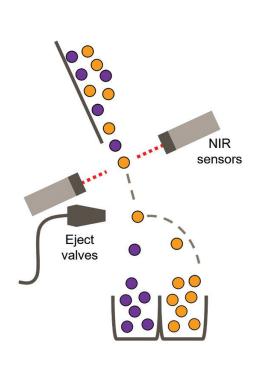
Electrostatic separation utilizes:

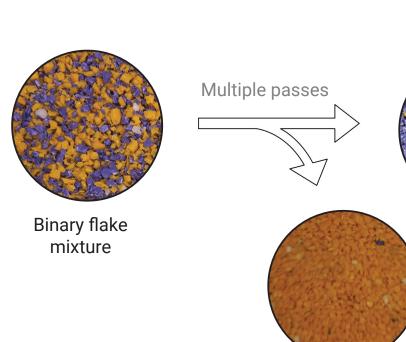
- Friction between particles to generate surface charge
- Surface charge to differentiate material types

Electrostatic separation is more effective when separating fewer types of materials, leading to high purity levels.



Effective separation by color or material type





NIR utilized to differentiate by color achieves:

- Purity levels >93%
- Increased purity with fewer materials

Consideration of the entire life cycle:

Yellow fraction

From product conception, and manufacturing to end-of-life



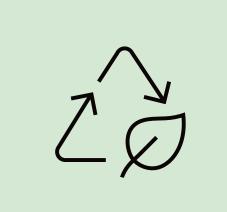
Utilize low GWP materials during the specification phase



Optimize to use less material per device and fewer parts by combining functions



Accurately model the manufacturing process when using low GWP materials



Fewer and easier to separate materials yield high quality recycled content