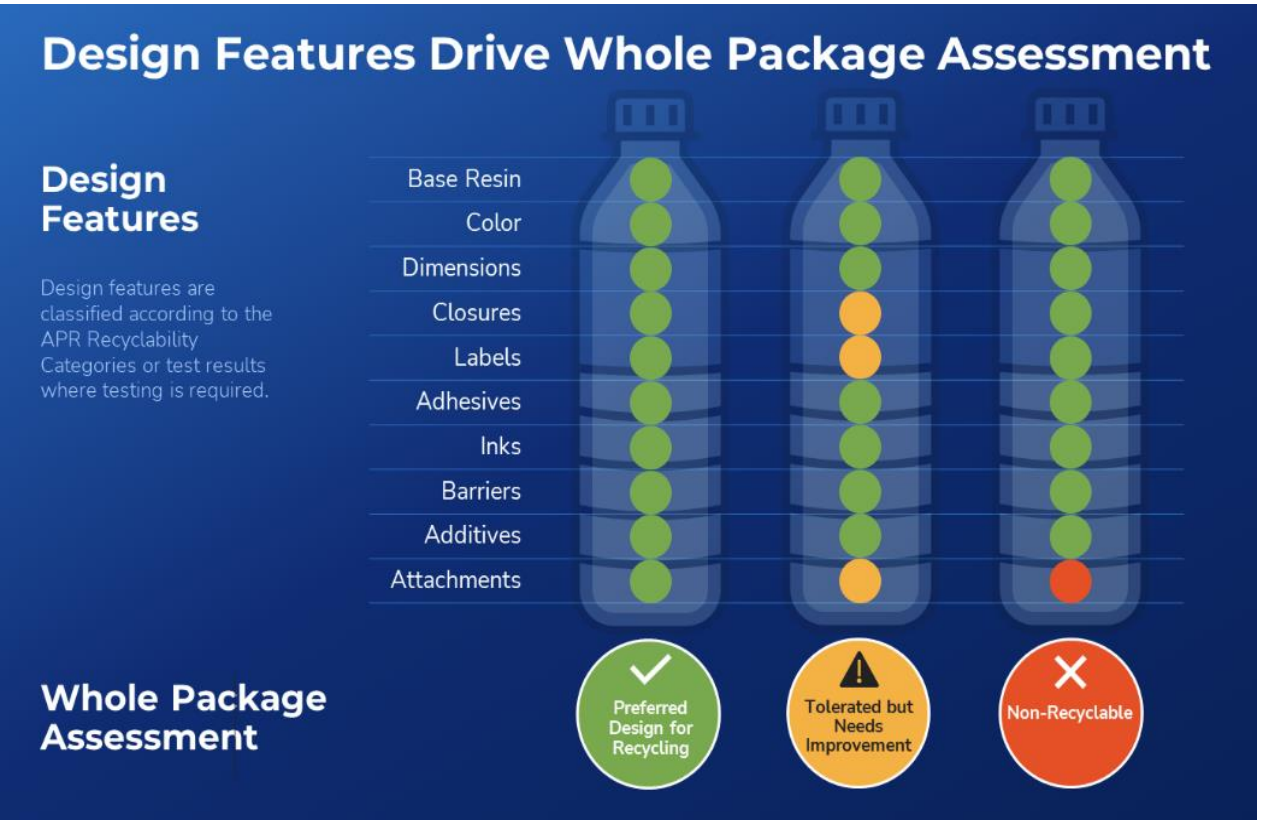
MULTIPLE PATHWAYS TO ENHANCE RECYCLABILITY IN PACKAGING

AGENDA

- Design for recyclability
- Enhancing recycled material properties or increasing PCR content
- Meeting carbon footprint targets
- Key takeaways
- Avient NPE highlights

DESIGN FOR RECYCLABILITY



Source: https://plasticsrecycling.org/recycling-categories
Association of Plastics Recyclers (APR)

- Incorporate materials that are easily recyclable and compatible with existing recycling infrastructure
  - Mono-materials
  - PP, PE, PET
- Consider design features that support and enhance sorting in existing processes
- Develop your product in alignment with Design for Recycling guidelines (EBPB, RecyClass, APR)
- Sorting challenges can include:
  - Dark colors
  - Secondary finishes
  - Labels, sleeves, or adhesives
  - Metal components

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PCR PROCESSING CHALLENGES

AT THE PROCESSOR

- Contaminated resin bales
- Reduced mechanical properties due to multiple heat histories
- Barriers / contaminates / adhesives causing discoloration and specks
- Rheology control / IV and melt flow variability

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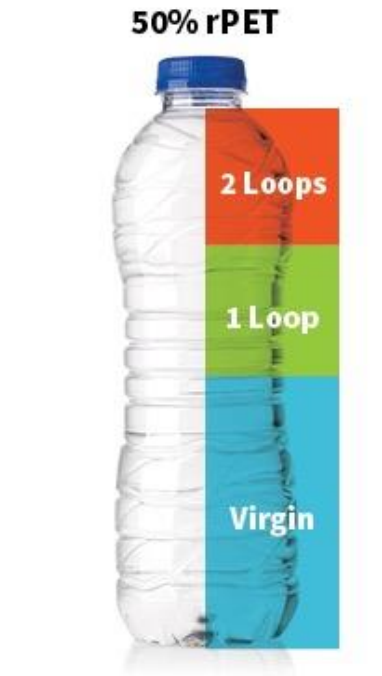
INCREASED PCR CONTENT

AT THE CONVERTER

- Slower throughput
- Higher scrap
- Poor mold release
- Inconsistent rheology
- Thermal instability
- Reduced mechanical properties
- Contamination
- Dimensional instability
- Incompatibility of multiple resins
- Odor



8 WAYS TO SUSTAINABILITY PRODUCTS

REDUCE

- Lightweighting
- Reduced Energy Use
- VOC Reduction

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- Recycle Solutions
- Bio-polymers

PRESERVE

- Eco-conscious
- Sustainable Infrastructure
- Human Health & Safety

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HOW WE ENABLE SUSTAINABILITY

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KEY CUSTOMER CHALLENGES:

- PCR availability and quality - Post-Consumer Recyclate availability in the current market is limited and recyclate quality is variable. This makes it difficult to incorporate PCR into a circular loop
- PCR color variability and sorting - Variability in PCR color makes it difficult to incorporate into applications where color targets are strict
- Product Carbon Footprint Targets - Companies are wanting to increase transparency in their sustainability claims, by using certified product carbon footprint data.

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Solutions to increase recycled content and minimize plastic waste

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PCR Availability and Quality

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Solutions to increase recycled content and minimize plastic waste

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EXPANDS PCR USAGE

Design for Recycling

CycleWorks™ Center for Mechanical Recycling

- Recycling trials and field testing
- Solutions evaluation and screening
- Customer collaboration

CycleWorks™ Innovation Center
Milan, Italy

Simulation capabilities

- Bottles
- Films
- Chips
- etc…

Grinding

Flakes

Washing

Washed & dried flakes

Extrusion

SSP

Conversion

Advanced Analysis

Recycled Granules

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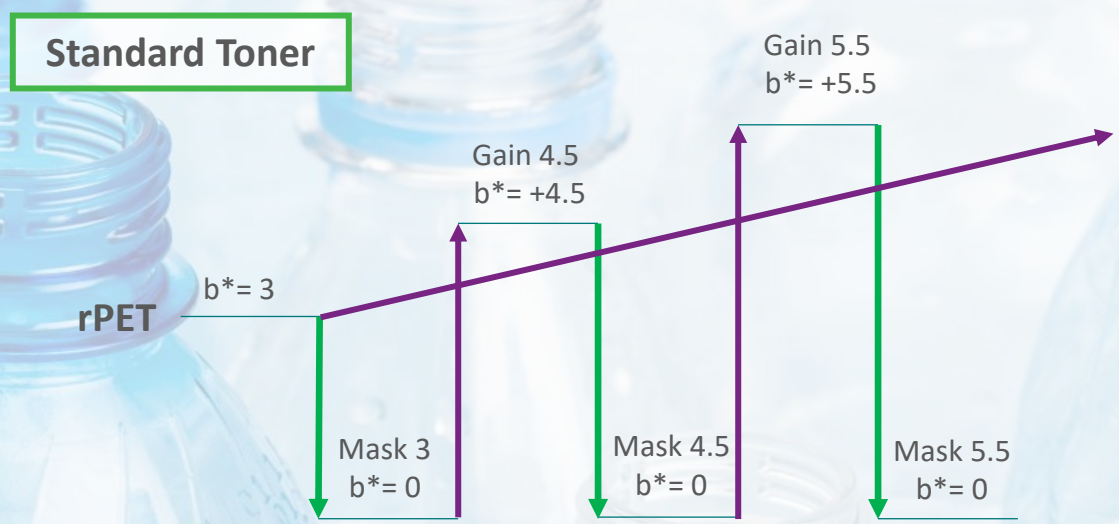
ENHANCES RECYCLING

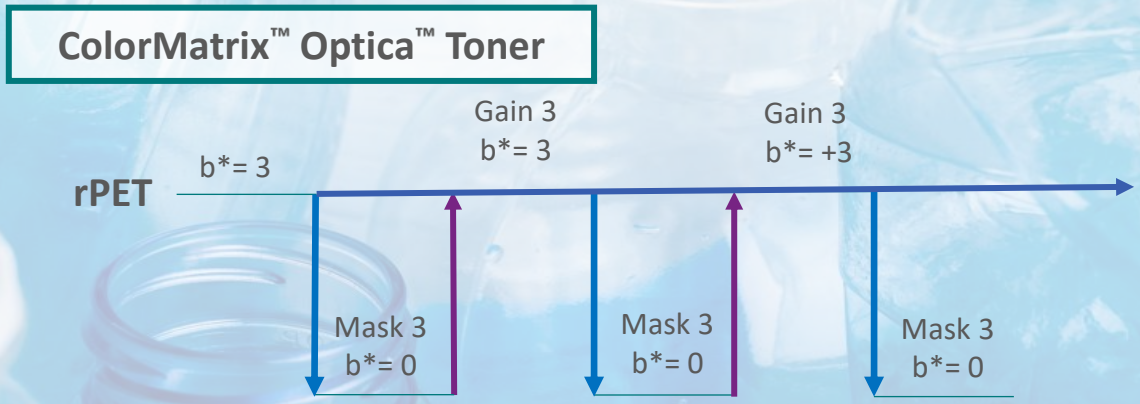
Increased Recycle Content
ColorMatrix™ Optica™
Process Aid and Toner for bottles containing recycled PET (rPET)

- Enables increased use of rPET
- Provides superior aesthetics
- Reduced yellowing during later recycling in comparison to conventional toners
- Incorporated process aid lowers energy use during bottle blowing – less CO_2 Emissions

The Challenge



How Optica supports circularity



OPTICA™ - BENEFITS FOR THE CONVERTER

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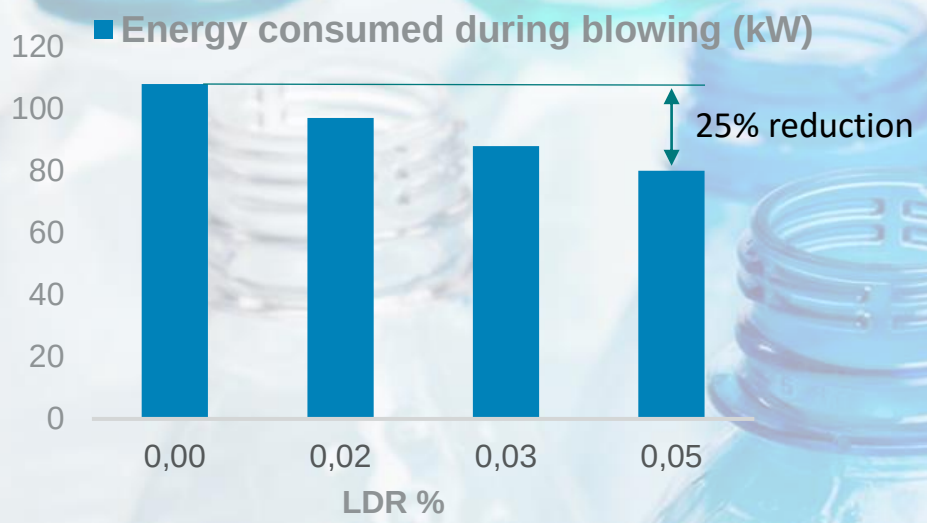
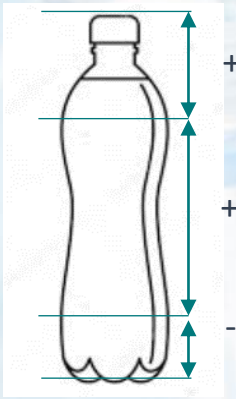


Reduced energy consumption

Polymer Weight Distribution

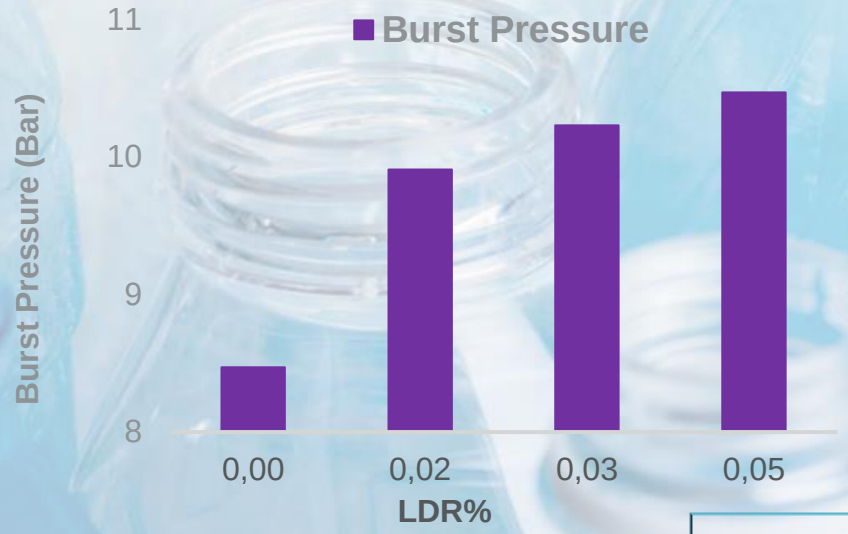


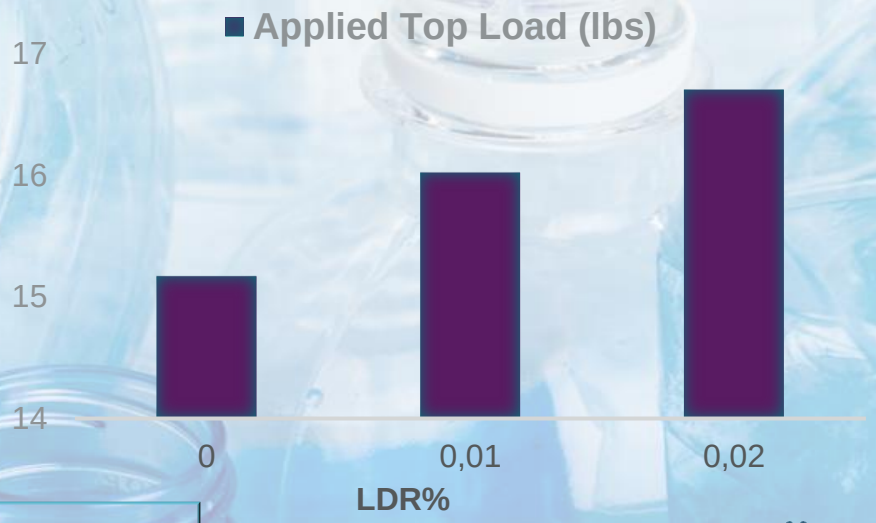
+2% in neck weight

+3% in body weight

-12% in base weight

Re-optimisation in bottle blowing





Improved mechanical strength

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PCR Color Variability and Sorting

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Solutions to increase recycled content and minimize plastic waste

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SUPPORT

PCR RESIN COLORATION

PCR Color Prediction Service

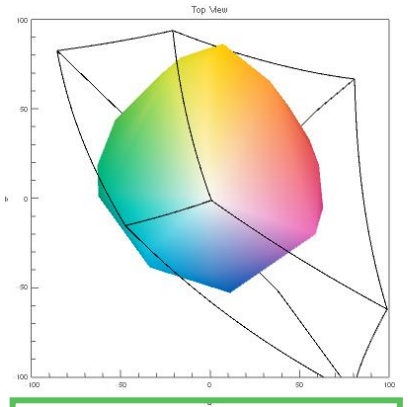
- Enables use of lower-quality PCR
- Predicts achievable colors
- Increases PCR utilization rates
- Helps brands to achieve PCR usage goals

The Challenge

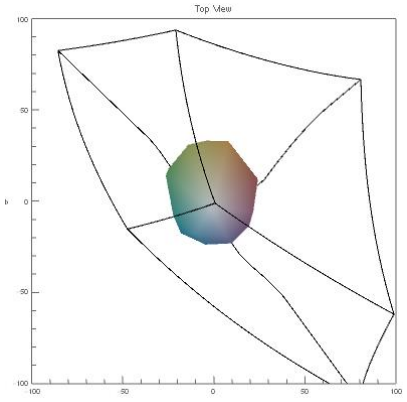
Inconsistent quality streams pose a challenge to converters, and brands to have consistent product quality

PCR resin quality varies from virgin to recycled or from recycled to recycled, creating color deviation on existing products

PCR resin undertone and opacity restricts color options asking for compromises sometimes too late, given the pre-agreed product launch deadline



Gamut Virgin Resin



Gamut PCR Resin

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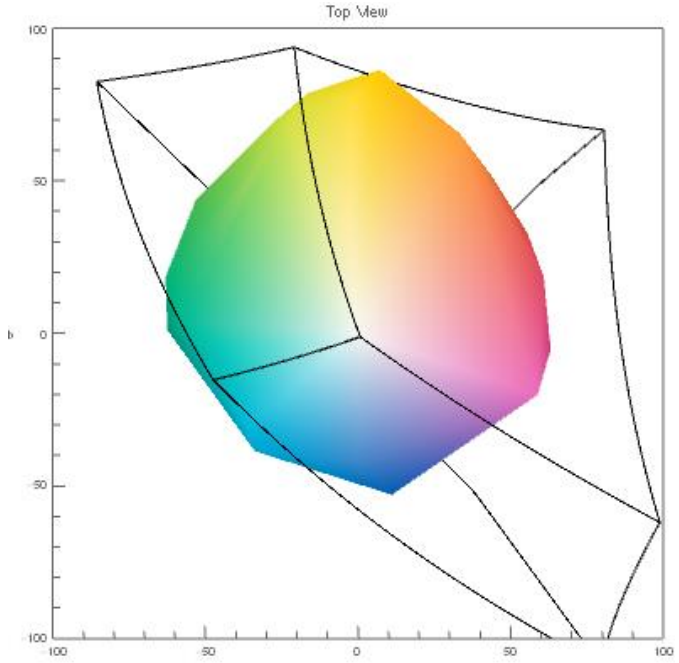
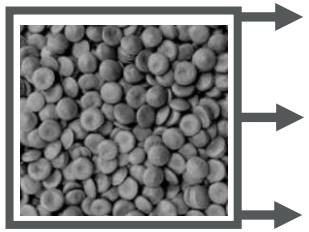
UNDERSTANDING RESIN GAMUT

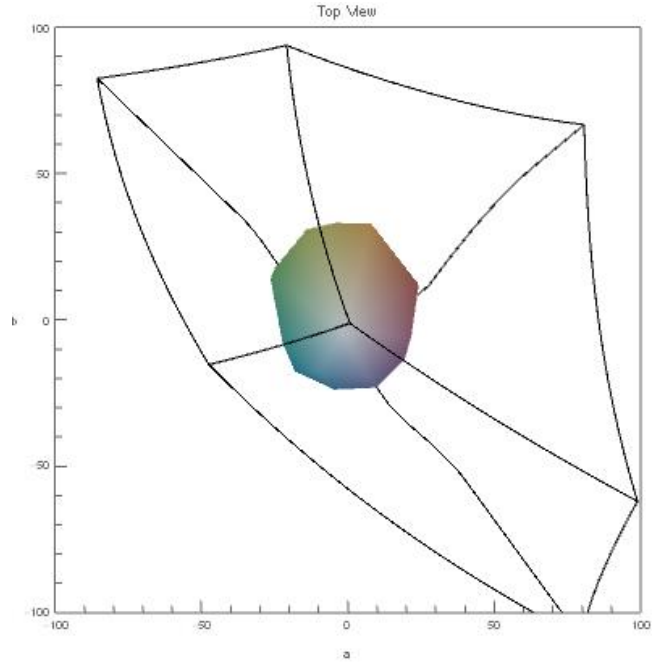
IS MY COLOR DOABLE?

- Colour of virgin HDPE pellets
- Wide color gamut
- Wide color option possibilities





- Colour of jazz/grey rHDPE pellets
- Narrow color gamut vs HDPE
- Fewer color option possibilities



Avient can provide customer guidance on maximum recycle content possible and color concentration required to achieve desired color

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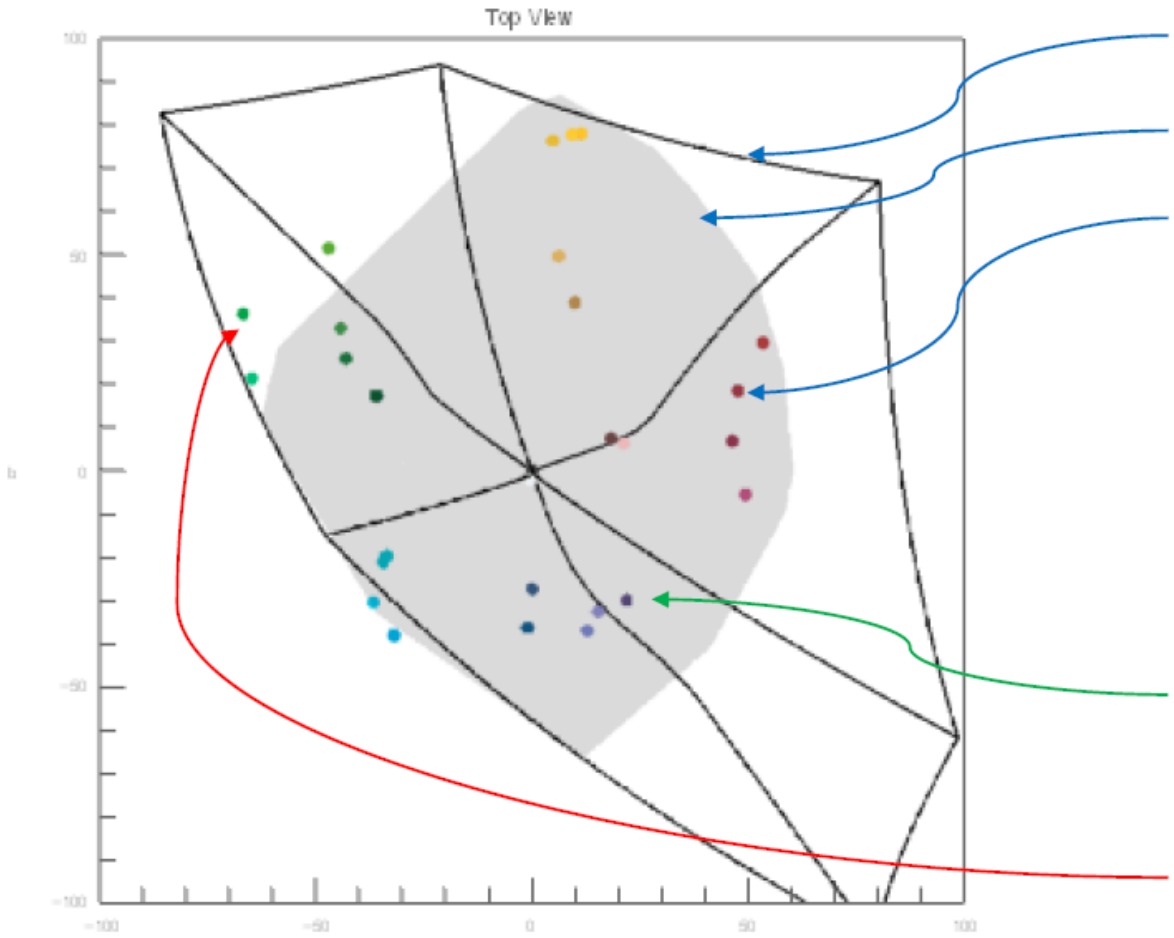
COLOR GAMUT AND RESIN GAMUT

KEY STEP TO UNDERSTAND IF A COLOR IS DOABLE



- Gamut of an sRGB color display (black wireframe)
- Gamut of the resin (grey area)
- Single color/product (colored dots)
- Colored dots inside the gamut are doable
- Colored dots outside the gamut are not doable

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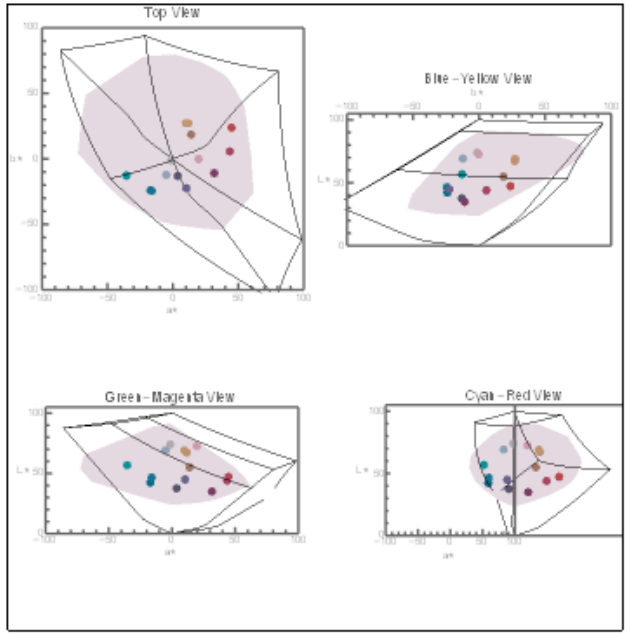
ASSESS COLOR FEASIBILITY - EXAMPLE

VERSUS PCR RESIN GAMUT

r-PET 1 - size of gamut: 393’628

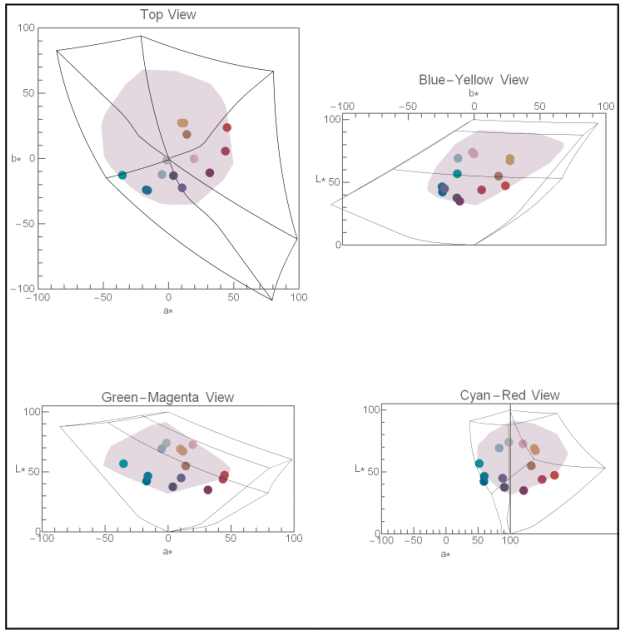


OK FE31820052@
OK FE54820080@
OK FE53820079@
OK FE24820028@
OK FE31820053@
OK FE51820081@
OK FEG3820010@0
OK FEG3820009@0
OK FE84820051@0
OK FE43820024@1
OK FE53820083@
OK FE72820011@
OK FE54820086@
OK FE34820055@

COLORS ARE INSIDE THE GAMUT OF THE RESIN

→ ALL THE COLORS CAN BE MATCH IN r-PET 1

r-PET 3 - size of gamut: 210’942



NOK FE31820052@ 0.5% .457 mm Distance=1.88057
OK FE54820080@ 0.5% .508 mm
OK FE53820079@ 0.5% .457 mm
NOK FE24820028@ 0.5% .482 mm Distance=0.766121
OK FE31820053@ 0.5% .61 mm
NOK FE51820081@ 0.7% .660 mm Distance=1.15118
OK FEG3820010@0.7% .48 mm
OK FEG3820009@0.7% .48 mm
OK FE84820051@0.6% .51 mm
OK FE43820024@1.4% .53 mm
OK FE53820083@ 0.6% .58 mm
OK FE72820011@ 1.0% .46 mm
NOK FE54820086@ 1.2% .52 mm Distance=4.9297
NOK FE34820055@ 0.9% .50 mm Distance=6.67859

SOME COLORS ARE OUTSIDE / TO THE EDGE OF THE GAMUT

→ THE COLORS CAN NOT BE MATCHED IN 100% r-PET 3

→ COMPROMISE NEEDED (i.e decrease pcr content, adjust the target...)

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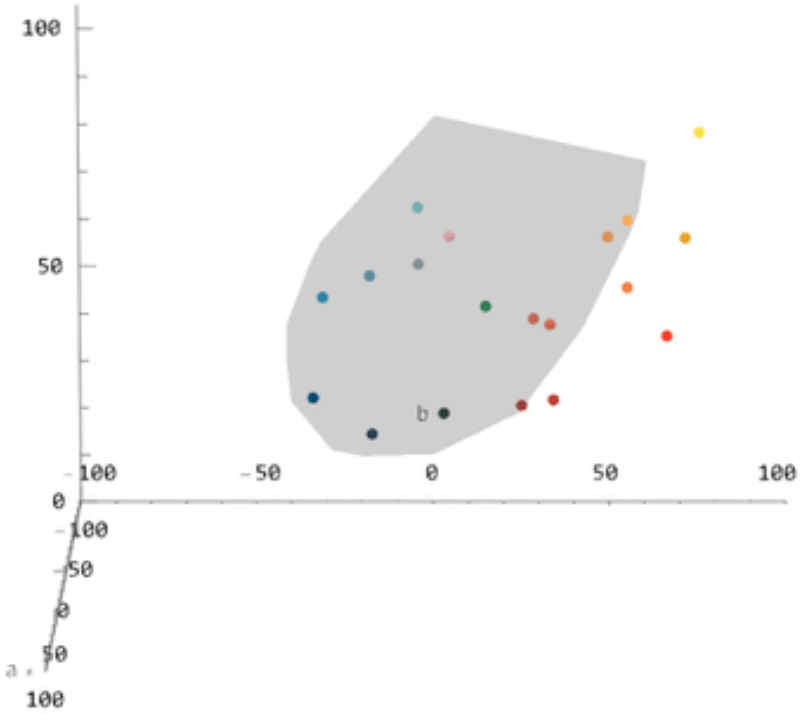

Packaging, Consumer, Automotive

How the Color Prediction Service supports transition to high level of PCR

- Help frame the available color space based on the PCR characteristics including opacity and undertone
- Allow quick and reliable assessment prior lab trials of color possibilities or limitations in targeted PCR
- Speed up color development process by cutting lab iterations based on the data generated by the color prediction tool
- Polyolefins, PET, Styrenics

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Meeting Product Carbon Footprint Targets

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Solutions to increase recycled content and minimize plastic waste

PRODUCT CARBON FOOTPRINT (PCF) CALCULATOR

- Avient's PCF calculator can calculate the carbon footprint of products from "Cradle to Gate"
- The calculator is certified by TÜV Rheinland and aligns with the ISO 14067:2018 standard for quantifying and reporting the carbon footprint of a product

TÜVRheinland®
CERTIFIED

Product Carbon Footprint
Certified Calculation Method

www.tuv.com
ID 0000084994

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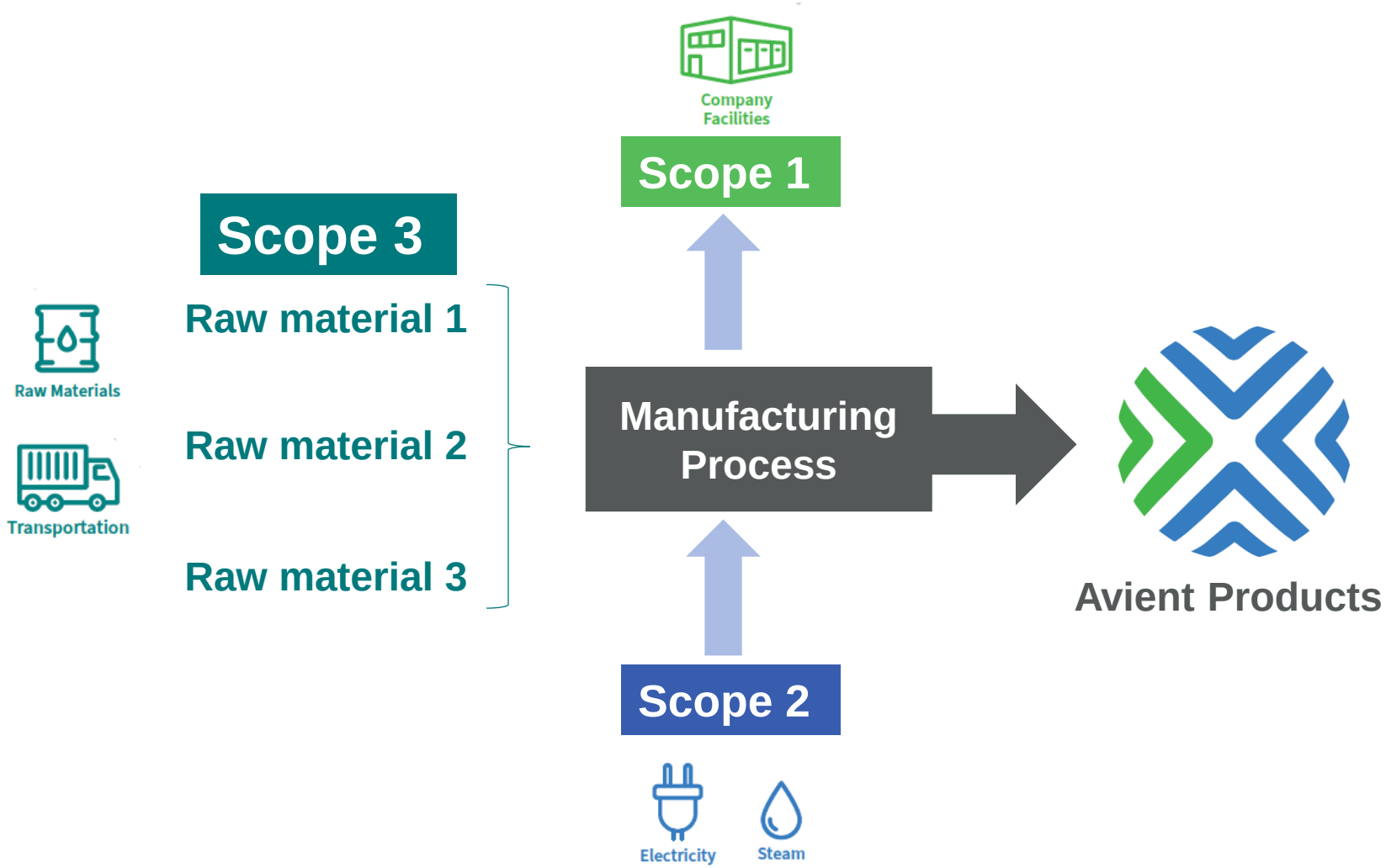
AVIENT'S PCF CALCULATOR

CALCULATION PROCESS



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KEY TAKEAWAYS

FOR EVERY CHALLENGE…

- ✓ PCR availability and quality
- ✓ PCR color variability and sorting
- ✓ Product carbon footprint targets

…THERE IS AN AVIENT SOLUTION

With performance-enhancing additives and solutions

With the Color Prediction Service and in-house expertise

With the product carbon footprint (PCF) calculator

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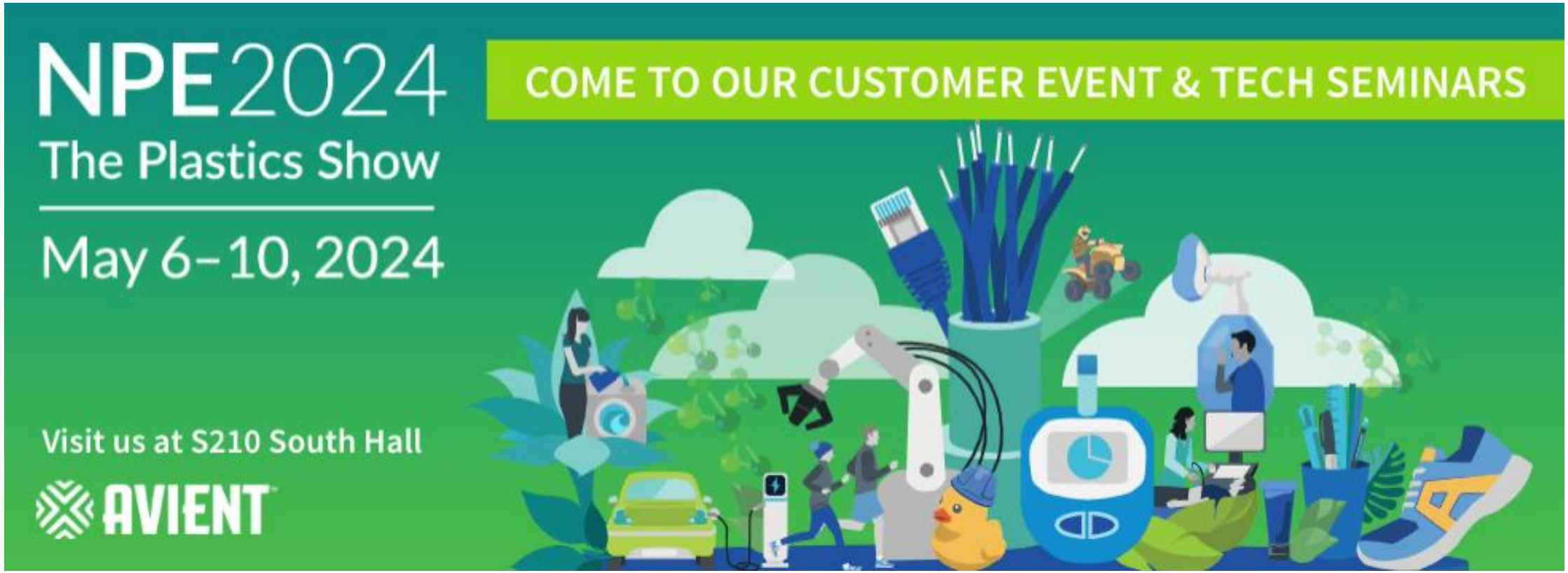
AVIENT AT NPE 2024



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NPE 2024
AVIENT TECHNICAL SYMPOSIUM

TUESDAY, MAY 7	
10:00	Weight Reduction Strategies for Improved Sustainability
11:00	How to Replace Metal with Long Fiber Technologies
1:00	Optimizing Product Appeal Through Color and Design
2:00	Multiple Pathways to Enhance Recyclability in Packaging
3:00	PFAS Alternatives: 2024 and Beyond

WEDNESDAY, MAY 8	
10:00	Structural Thermoplastic Composites 101
11:00	Making Composites Circular: Challenges and Opportunities
1:00	PFAS Alternatives: 2024 and Beyond
2:00	Product Carbon Footprint Decoded
3:00	Multiple Pathways to Enhance Recyclability in Packaging

THURSDAY, MAY 9	
10:00	Product Carbon Footprint Decoded
11:00	Exploring Sustainable Alternatives to Traditional Polyamides
1:00	Navigating the Pros and Cons of Sustainable TPEs
2:00	Advantages of TPEs with Antimicrobial Technology
3:00	The Latest Advancements in Non-Halogenated FR Solutions

Attendance is Complimentary - Space is Limited.

Register Now!

All seminars are held in Avient's meeting space South Hall, Level 2, Room S210.

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THANK YOU

ANY QUESTIONS?