TRINSEO

PLASTICS WITH **RECYCLED CONTENT** FOR CONSUMER ELECTRONICS

Tony Samurkas, PhD | Director Technical Service & Development NA and Global Technology Advisor |

December 6, 2018 at 12:00 to 1:00 pm EST

About Trinseo

STYRON

TRINSEO

TSE LISTED NYSE

6 . 2010

Carve-out from Dow Chemical

2 . 2014

Company changed name

6 . 2014

IPO at New York Stock Exchange

7 . 2017

Acquisition of API (Applicazioni Plastiche Industriali S.p.A.)

Product portfolio expanded to soft-touch TPEs and bioplastics

API A Trinseo company.

Going Forward, our innovation continues...

Corporate Facts

$4.4 Billion
in net sales (2017)

Major business divisions
Performance Materials
Basic Plastics and Feedstocks

16 Manufacturing sites

2200
Employees




Tony Samurkas

→ Samurkas is the Director of Technical Service & Development in North America and the Global Technology Advisor for Trinseo's Performance Plastics business

→ He has 30 years of experience in the plastics industry including with Dow Chemical, Dow's Essex Specialty Products Division, and Johnson & Johnson

→ Besides his technology-innovation role he leads a number of strategic global initiatives including the integration of API, S.p.A., Trinseo's soft polymers company, into the Trinseo organization

→ Located in Auburn Hills, Michigan, he works globally and holds both a Bachelor of Engineering and a PhD in Chemical Engineering from McGill University, Montreal, Canada

Trinseo Performance Plastics Business

Business & Products

- Support customers in industries ranging from automotive, medical devices, consumer electronics, lighting, and electrical
  - ➢ Focused on technology-based applications leveraging cross-industry experiences

Brands

- **Thermoplastics and Thermoplastic Elastomers (TPEs)**

→ CALIBRE™ Polycarbonate Resins
→ EMERGE™ Advanced Resins
→ MAGNUM™ ABS Resins
→ PULSE™ PC/ABS Resins
→ ENLITE™ Structural Polymers
→ APILON™ TPU
→ MEGOL TPS
→ APIGO™ TPO

End Uses



Trinseo and Consumer Electronics

→ Supporting the industry for **decades**

→ **Global manufacturing** to ensure supply reliability and product consistency

→ Focused on providing **high quality** resins and **quality management** systems to support customer **compliance with quality and regulatory standards**

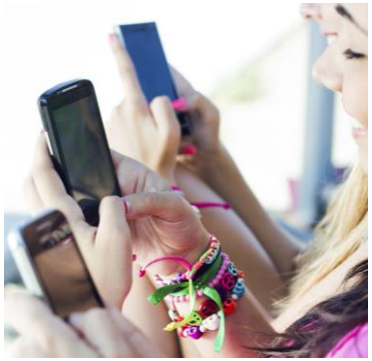
→ Dedicated to providing product **innovation** and **technical support**

- → Leveraging technologies across-industries
- → Wide range of innovative EMERGE™ FR and non-FR PC Compounds in wide range of colors
- → EMERGE™ FR and non-FR PC ECO line of high quality aesthetic, recycled content products
- → MAGNUM™ ABS resins for vivid colors

→ **TPEs** for accessories and overmolding

CE Industry has evolved

Traditional Perception



Convergence of CE with Other Sectors

Growing Emphasis on Sustainability

Agenda

- **Options for Sustainability**
- **Marketplace Trends**
- **Challenges with Post Consumer Recycled Resins**
  - → Cost
  - → PCR Feedstock Availability
  - → Material Performance Properties
  - → End Use Products – Targets for Recycled Material
- **Evolving to a PCR PC Solution**

Introduction –
The need for sustainability in plastics

TRINSEO™

Why the interest?

- **Protect scarce resources**

Reduce fossil fuel use

- **Divert potential waste from landfills**

Protect the environment

- **Greater public awareness**

Consumer interest

Options for Sustainable Plastics

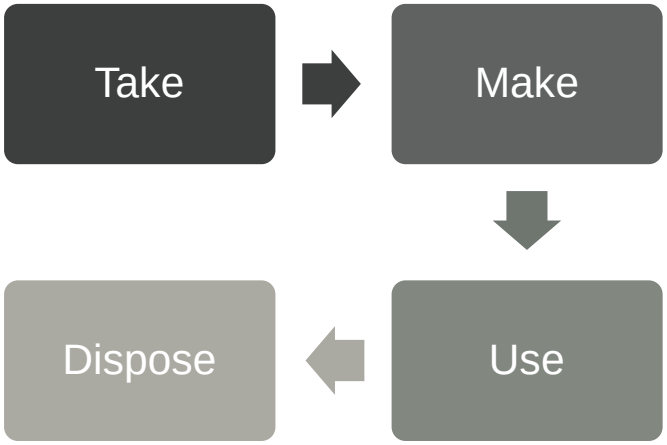
Bio-Based Plastics

Bio-degradable Plastics

PCR Content Containing Plastics

PCR: A Circular Economy Solution

Traditional Linear Approach



Circular Solution

Government Regulations

The California Rigid Plastic Packaging Container Law

May 27, 2016

The California Rigid Plastic Packaging Container (RPPC) Act of 1991 and its regulations are intended to facilitate the reuse and recycling of rigid plastic packaging containers, with provisions that are geared towards increasing the use of postconsumer recycled plastic and reducing the use of virgin material.[i] The implementing regulations for the law have been modified several times over the years with the last round of amendments being made in 2013. That lengthy rulemaking process resulted in an expanded definition for rigid plastic packaging containers that swept up an additional 350 million containers in its wake.[ii]

Expanded Definition

The RPPC regulations cover rigid plastic packaging containers having volumes that range from eight ounces to five gallons. These containers include uses for a wide range of products that include, among other items, cleaning products, adhesives, electronics, toys, and paints and coatings. Statutory exemptions do exist, however, for containers used to hold materials regulated by the U.S. Food and Drug Administration (*i.e.*, food, drugs, cosmetics, baby formula, and medical devices); pesticides regulated by the U.S. Environmental Protection Agency; and hazardous substances subject to regulation by the U.S. Department of Transportation.

If a given packaging article meets the definition of an RPPC and is not exempt from regulation, then the manufacturer of the product held in the package is responsible for complying with the regulations by, for example, incorporating at least 25% post-consumer recycled plastic or source-reducing the container by 10%.[iii]

The January 2013 amendment to the regulations expanded the definition of RPPC by including in it the following additional packaging.

- Rigid packaging made entirely of plastic, with the exception of caps, lids, labels, and additives, as well as handles, hinges, and other incidental packaging elements made of non-plastic material. Previously, containers with handles, hinges, and the like that were made of non-plastic materials were not included within the scope of the definition;
- Rigid packaging that is designed to be folded or collapsed. Previously, only containers that were made to maintain their shape while holding a product were covered;
- Rigid packaging capable of "at least one closure (including but not limited to closure occurring during the production or manufacturing process)." Previously, the packaging had to be capable of multiple closures and come complete with an attached or unattached lid or cap.

Hence, containers such as buckets, pails, tubs, tubes, jugs, clamshells, and plastic folding cartons are all covered by the

The New York Times

European Parliament Approves Ban on Single-Use Plastics

Volunteers cleared trash from the banks of the River Thames during the annual Big Bottle Count in London last month. Matt Dunham/Associated Press

By Ceylan Yeginsu

Oct. 25, 2018

LONDON — The European Parliament has overwhelmingly approved a ban on single-use plastics such as straws, plates, cutlery and cotton-swab sticks in Europe by 2021, joining a global shift as environmentalists emphasize the urgency of halting the use of materials that are detrimental to the planet.

Under the proposal, approved on a vote of 571 to 53 on Wednesday, 10 single-use plastics that most often end up in the ocean will be prohibited in the European Union, as well as oxo-degradable plastics, such as bags or fast-food container packaging.

Corporate Initiatives

- → HP used 40 million pounds of recycled plastics in its products last year
- → In 2017 it launched its first photo printers made with recycled e-plastics and
- → models of monitors and PCs with PCR plastics
- → In 2017 it introduced ink cartridges made from plastic recovered from Haiti where it's considered at risk of becoming ocean litter

SONY

- → Target to reduce virgin plastic used per product by 10% from 2013 to 2020
- → The company has been working to incorporate recycled plastics into products while reducing the size
- → In 2017 virgin plastic used per product was down 2.3% from fiscal 2013
- → Expanded use of recycled plastic in TVs, video players, camcorders

- → 2020 goal is to use 100 million pounds of recycled material in its products
- → In 2018, it has used more that 20 million pounds of recycled plastics for a total of 73 million pounds since 2013
- → Recycled plastic comes from a number of sources including recovered PET, the company's closed-loop e-plastics program, carbon fiber recycling and its "ocean bound plastics" project

- → By 2020 it aims to ensure that 15 percent of its total revenue comes from circular initiatives – part of which will be through specifying that more of its products contain at least 30 percent recycled plastics

- → On November 8 announced that the bottom cover and connector wall in the Mac mini are made from 60% recycled plastics
- → Vent and speakers in the new MacBook Air contain 35% and 45% recycled plastic respectively
- → Announced use of PCR plastics in mobile device speaker housings
- → The goal is to eventually use only recycled or renewable materials in its products and source them responsibly

TRINSEO™

“It’s USED plastic, why isn’t it cheaper?”

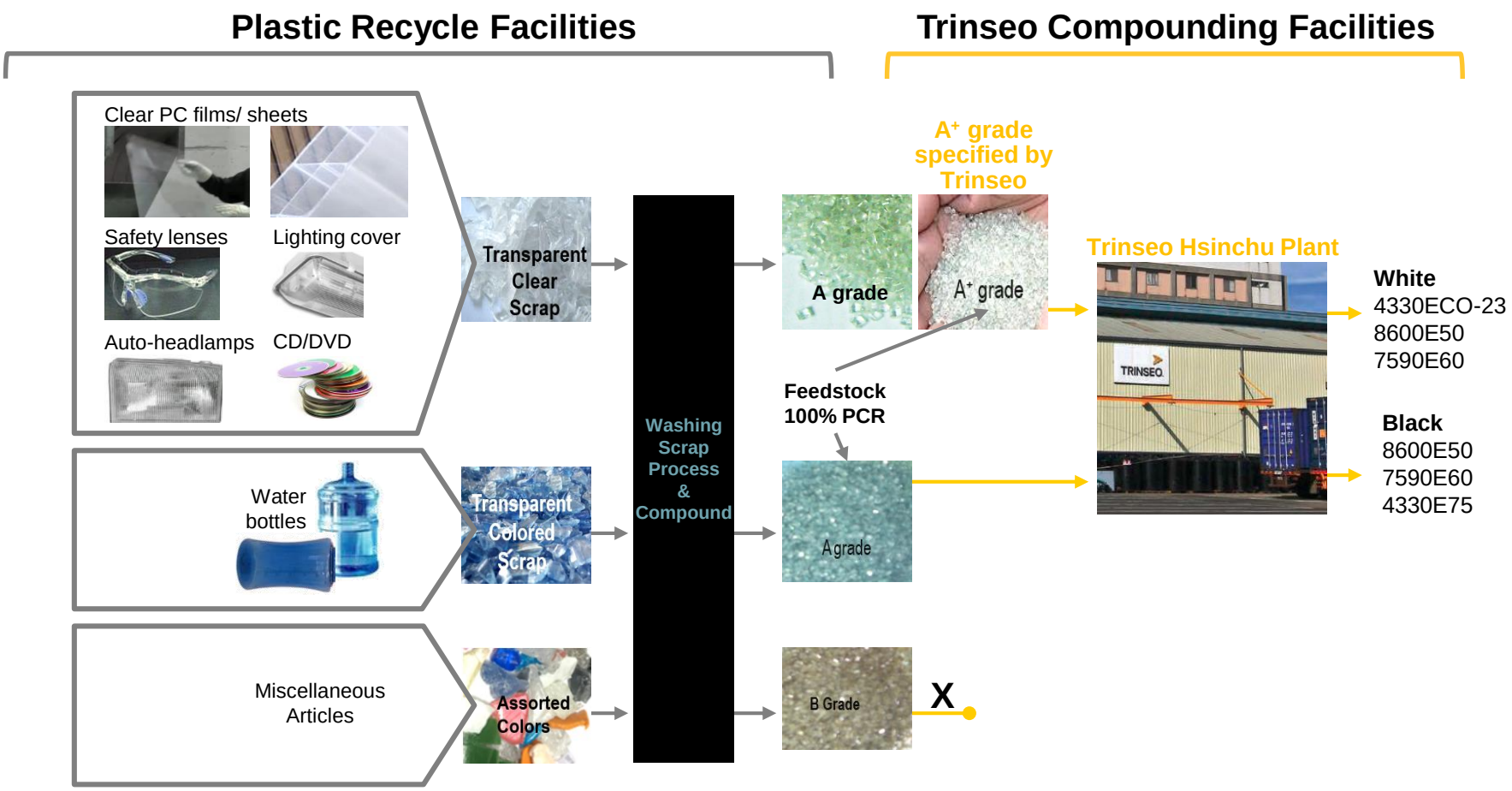
Not if you want exceptional performance and aesthetics…

Challenges of adding PCR content

Cost comparison

Consideration	Virgin PC based materials	With PCR content
Raw Material	• Monomer production • Polymerization • Quality Control	• Part collection • Selection • Regrinding • Quality Control
Availability and shipment	• Standardized	• More complex and specific
Formulation	• Baseline formulation from well identified raw materials	• Potentially more complex formulation to compensate for feedstock quality variations
Material loss and scrap rate	• Standard	• Increased scrap rate
Compounding	• Standard high throughput	• Potentially lower throughput. More online quality monitoring
Quality Control	• Standard	• Higher frequency
Supply Chain	• Standard	• Standard
General overhead, other fixed costs and margin	• Standard	• Additional steps from procurement to development to production to molding

Scrap sources for PCR PC Feedstock



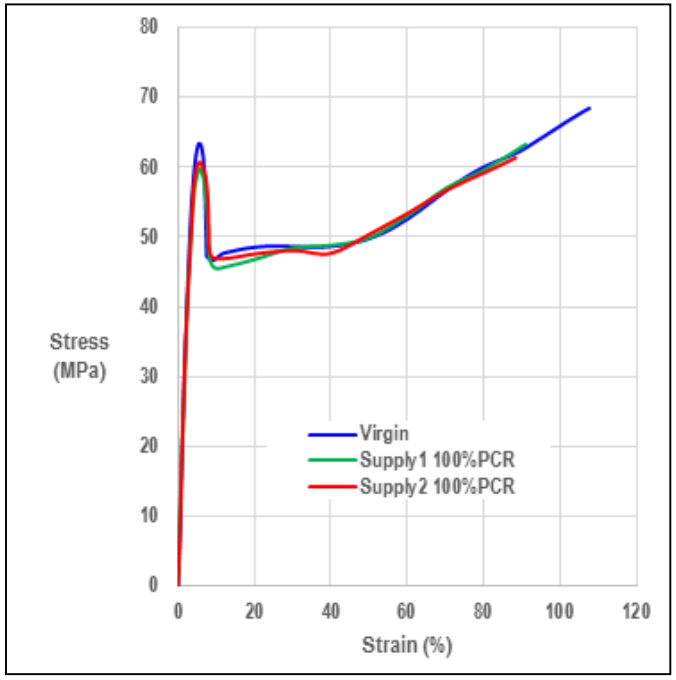
Regulatory and performance concerns about PCR feedstock

Check List		PCR PC Grades			Notes
		A+	Tinted A	B	
Regulatory Compliance	RoHS & Reach	√	√	√	External lab measurement
	SVHC	√	√	Uncertain	Substances of very high concern
	RPPC California PCR > 25%	√	√	√	Governmental regulations
	EPEAT PCR > 25%	√	√	√	
Material Attributes	White & Light	√	X	X	White
	Black	√	√	√	Black

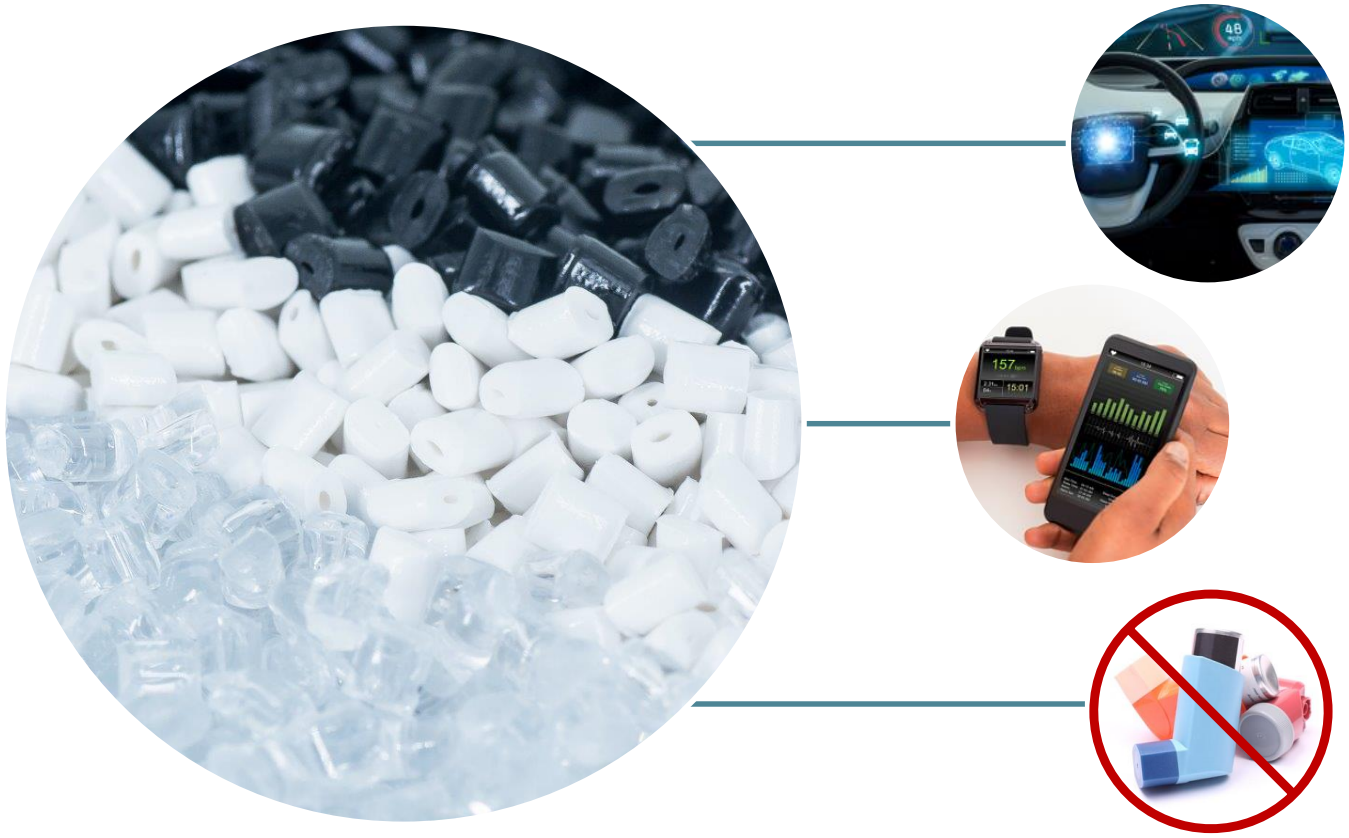
PCR PC Feedstock Comparison

PCR PC vs. Virgin PC
→ Mechanical properties
→ MFR
→ Optical properties

	Virgin	PCR Supply 1	PCR Supply 2
MFR (g/10min)	15	15	15
TAT (%)	87	85.5	85.5
TB (MPa)	68	63.5	61.0
TY (MPa)	64.3	61.3	60.1
TM (GPa)	2.19	2.21	2.26
TE (%)	95.4%	87.6%	93.0%



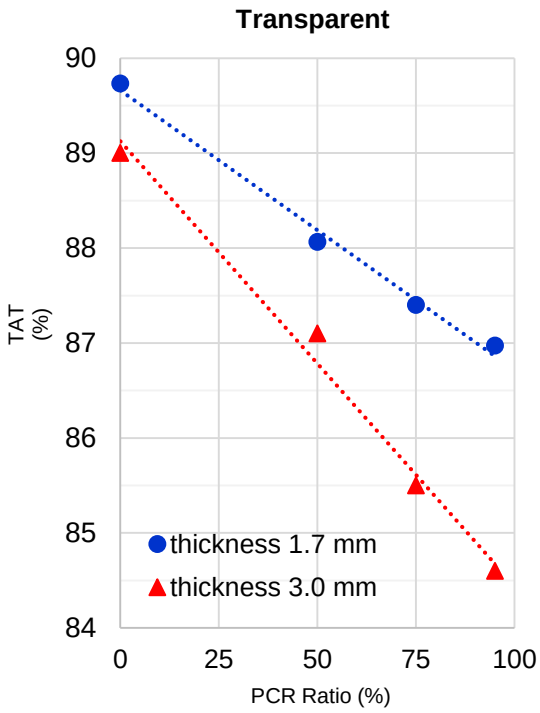
Candidate Applications for PCR Usage?

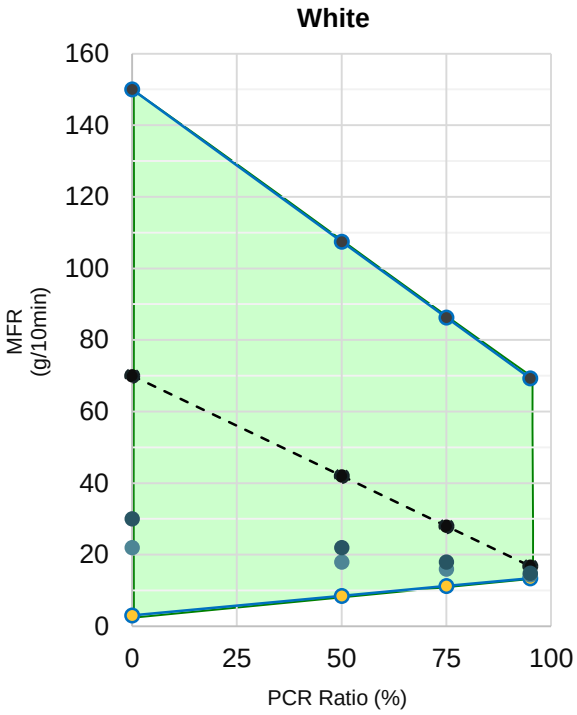


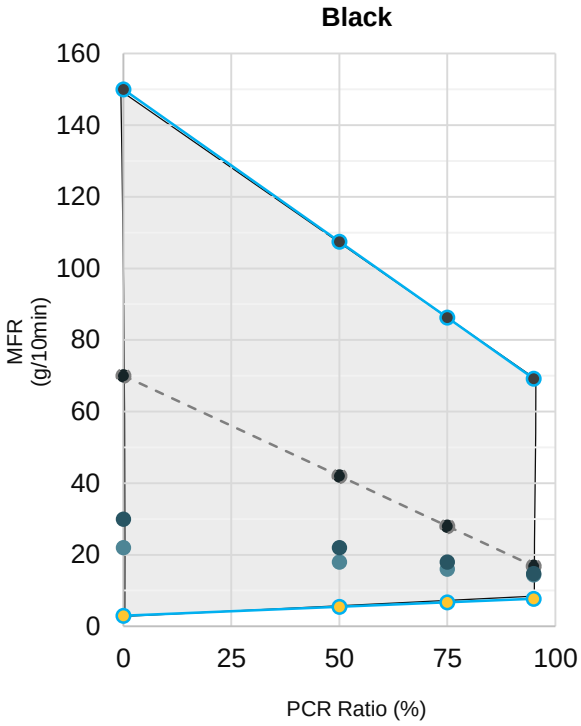
Trinseo EMERGE ECO portfolio

TRINSEO

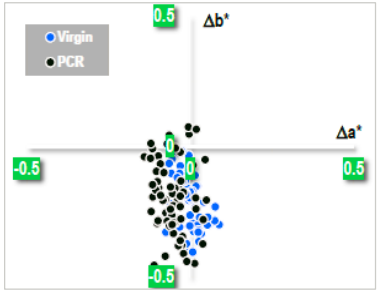
Examples of PCR PC content performance boundaries







FR & RTI Rated PC Compounds with High PCR Content



EMERGE™ 8600E50
EMERGE™ 4330E75

→ To reduce carbon footprint, Trinseo developed a series of PC resins containing PCR in a bright white color that perform similarly to the virgin resins, using advanced formulation and manufacturing technologies.

Attributes: High performance FR and excellent aesthetics

→ Ultra clean to achieve excellent aesthetics
→ Carbon footprint reduction >50%
→ UL V1@1.0 and V0@1.5mm with 125℃ RTI
→ PCR content certified according to UL ECVP 2809

EMERGE PC 8600EZZ(a)

Polycarbonate (PC), 0-50% Post Consumer Recycle (PCR) "EMERGE", furnished as pellets

Color	Min. Thk (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str
ALL	0.55	V-2	-	-	80	80	80
	1.0	V-1	3	0	125	125	125
	1.5	V-0	3	0	125	125	125
	2.5	V-0	3	0	125	125	125
	3.0	V-0	2	0	125	125	125

Comparative Tracking Index (CTI): 3
Dielectric Strength (kV/mm): 22
High-Voltage Arc Tracking Rate (HVTR): -
Dimensional Stability (%): -

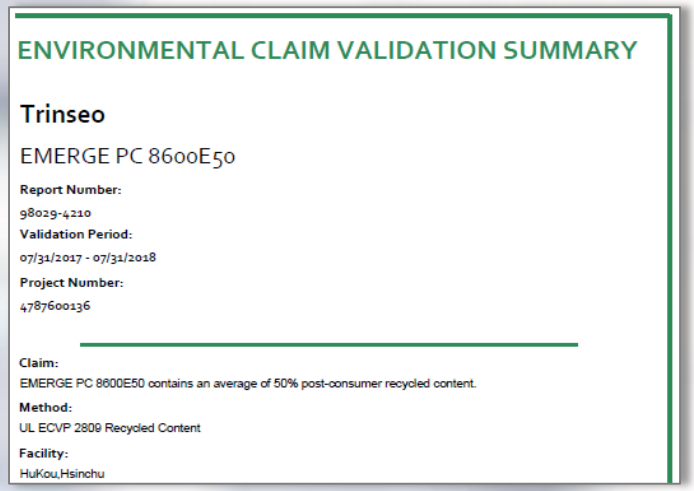
Inclined Plane Tracking (IPT) kV: -
Volume Resistivity (10^X ohm-cm): 17
High Volt, Low Current Arc Resis (D495): 7

(a) - Melt flow range of 3 to 22 g/10 min. inclusive.
NOTE - Material designations may be followed by numbers and/or letters representing color and/or granulation and/or lubrication.
ZZ - Denoted by two digits (00-50) to represent the percentage of recycle content by weight

Trinseo PCR PC Containing Product Portfolio

	Glass		Non-Flame Retardant			Flame Retardant V0			Notes
			Virgin	PCR		Virgin	PCR		
Transparent	0%	301-22	4310-20	4310E75-20	75%				
	0%	201-15	4310-15	4310E75-15	75%				NIR transparent black
	0%	201-10	4310-10			8410-10	8410ECO-10	50%	V0 @ 1.8
	0%	303-10	4330-10	4330E60-10	60%				
	0%	303-22	4330-22	4330E75-20	75%				
Opaque	0%		4330-10			8600-10	8600E50-10	50%	V0 @ 1.5
	0%		4330-10	4330E75-10	75%	8160-10	8160ECO-10	50%	V0 @ 1.0
	0%		4330-15				8600E50-15	50%	V0 @ 1.5
	0%		4330-22	4330ECO	50%	8600-20	8600E50-20	50%	V0 @ 1.5
	0%		4350-22	4330E75-20	75%				
	0%						LDS/PC 8900ECO	40%	V0 @ 0.5; LPKF certified
	0%					8900	8900ECO	40%	V0 @ 0.5
PC/ABS	0%			7160ECO	30%				ABS Rich HB 5.5 MFR
	0%		7350	7350ECO	50%				HB 4.3 MFR
	0%					7560	7560ECO	60%	20 MFR V0 @ 1.5
	0%					7590	7590E60	60%	15 MFR V0 @ 1.5; 55%PCR for AW
	0%					7590	7590ECO	30%	15 MFR V0 @ 1.5; 35%PCR for AB
	0%						7800	40%	13 MFR V0 @ 1.2
	0%						7880ECO	50%	10 MFR V0 @ 1.0
	0%					7580	7580ECO	50%	V0 @ 1.5 high HDT 86C
High HDT	10%		4201	4201ECO		8701	8701E50	50%	V0 @ 1.5
	20%		4202	4202ECO	70%	8702	8702ECO	70%	20 MFR V0 @ 1.5
	30%		4203	4203ECO	60%	8703	8703ECO	60%	
	40%		4204	4204ECO		8704			
High Flow	20%					4902	4902ECO		22 MFR V0 @ 1.6
	30%			4313ECO		4903	4903ECO	40%	15 MFR V0 @ 1.0
	40%		4314	4314ECO	30%				

PCR PC Containing Product Certifications



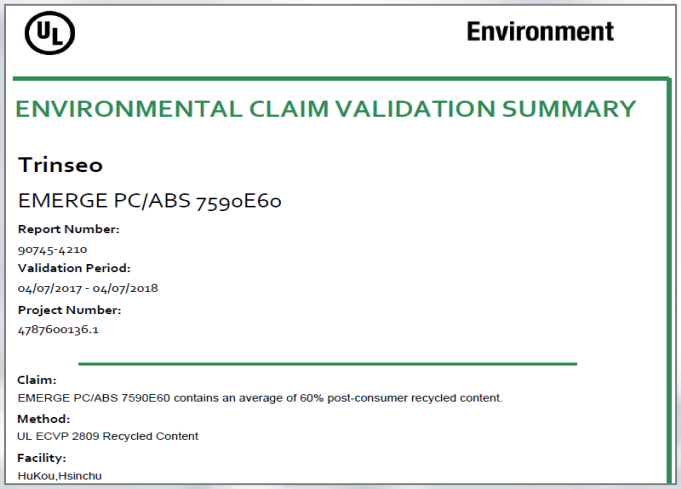
ENVIRONMENTAL CLAIM VALIDATION SUMMARY

Trinseo

EMERGE PC 8600E50

Report Number:
98029-4210
Validation Period:
07/31/2017 - 07/31/2018
Project Number:
4787600136

Claim:
EMERGE PC 8600E50 contains an average of 50% post-consumer recycled content.
Method:
UL ECVP 2809 Recycled Content
Facility:
HuKou,Hsinchu



Environment

ENVIRONMENTAL CLAIM VALIDATION SUMMARY

Trinseo

EMERGE PC/ABS 7590E60

Report Number:
90745-4210
Validation Period:
04/07/2017 - 04/07/2018
Project Number:
4787600136.1

Claim:
EMERGE PC/ABS 7590E60 contains an average of 60% post-consumer recycled content.
Method:
UL ECVP 2809 Recycled Content
Facility:
HuKou,Hsinchu

ECVP 2809

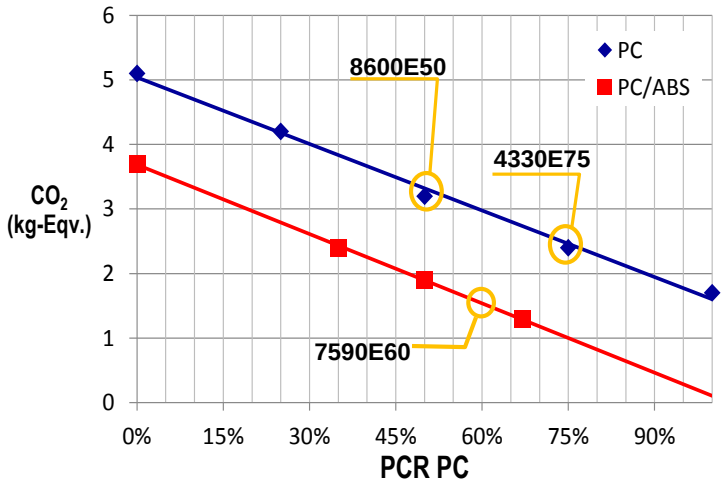
Introduction

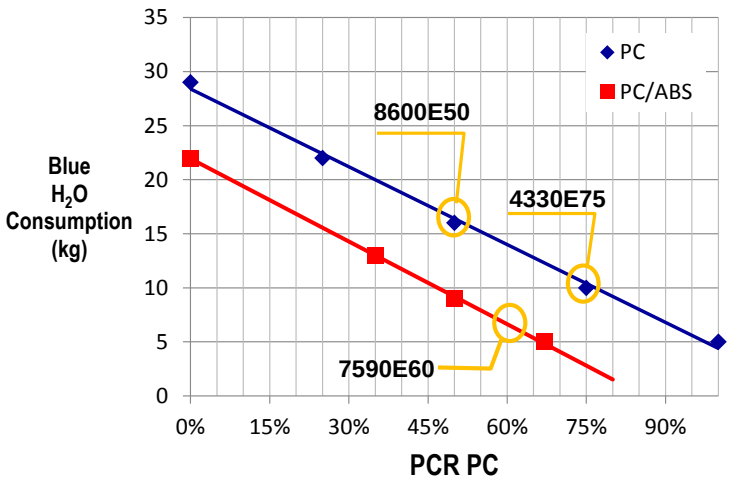
1. General
2. Scope
3. Units of Measurement
4. Undated References
5. Glossary

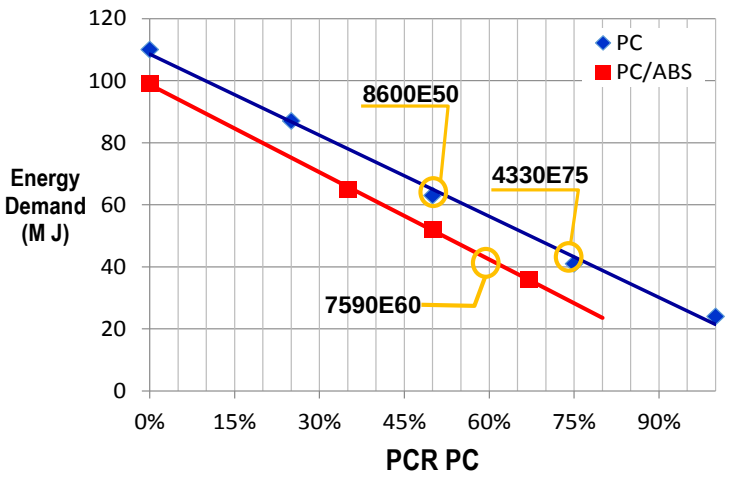
Compliance, Evaluation and Assessment Criteria

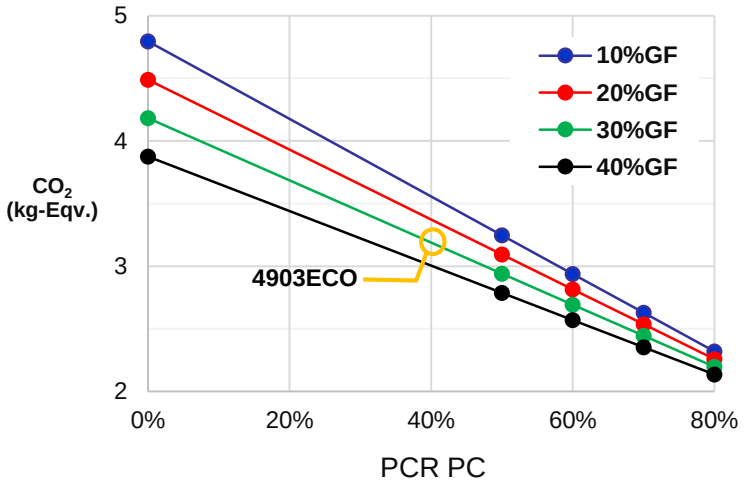
6. Documentation
7. Supply Chain Management of Materials
8. Calculations
9. Procedure
10. Example Claims
11. Information Required
12. Examples

LCA: Cradle-to-Gate, /kg of PC compound









Summary of what we've learned

- → Understand the technical demands and regulatory constraints of the application.
- → Essential to have a reputable PCR supplier and identify the necessary quality of PCR for the application.
- → Research and verify supplier reliability so that you can certify for your customer the PCR compounds quality and regulatory compliance.
- → Product innovation and improved manufacturing controls needed if "virgin like" properties required
- → Sustainability goals can be met by evaluating the complete application for opportunities to use PCR.

TRINSEO™

Thank You

A copy of this webinar will be sent to you and is available online.

Contact:

Jane Settle jpsettle@trinseo.com

AJ Durso ajdurso@trinseo.com