New Covestro medical polycarbonate pushes the boundaries of heat resistance

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An introduction of our presenters...

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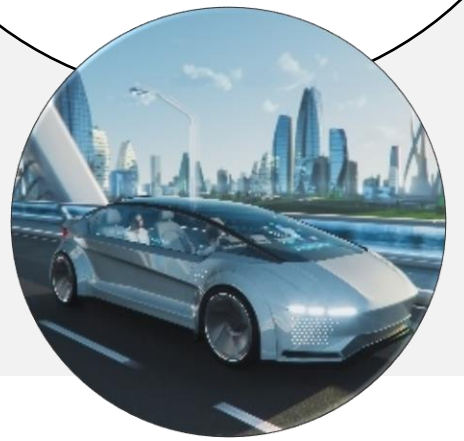
Covestro – global plastics manufacturer

Strong and global

- €14.4 bn in sales
- 17,500 employees[1]
- 48 production sites

Game-changing and beneficial

- Polymer materials of superior quality
- Across numerous industry sectors
- Keeping an eye on global challenges



Innovative and sustainable

- 1,350 employees in research and development
- 80 years of ideas and inventions
- Pioneer of the circular economy

[1]calculated as full-time equivalent (FTE)

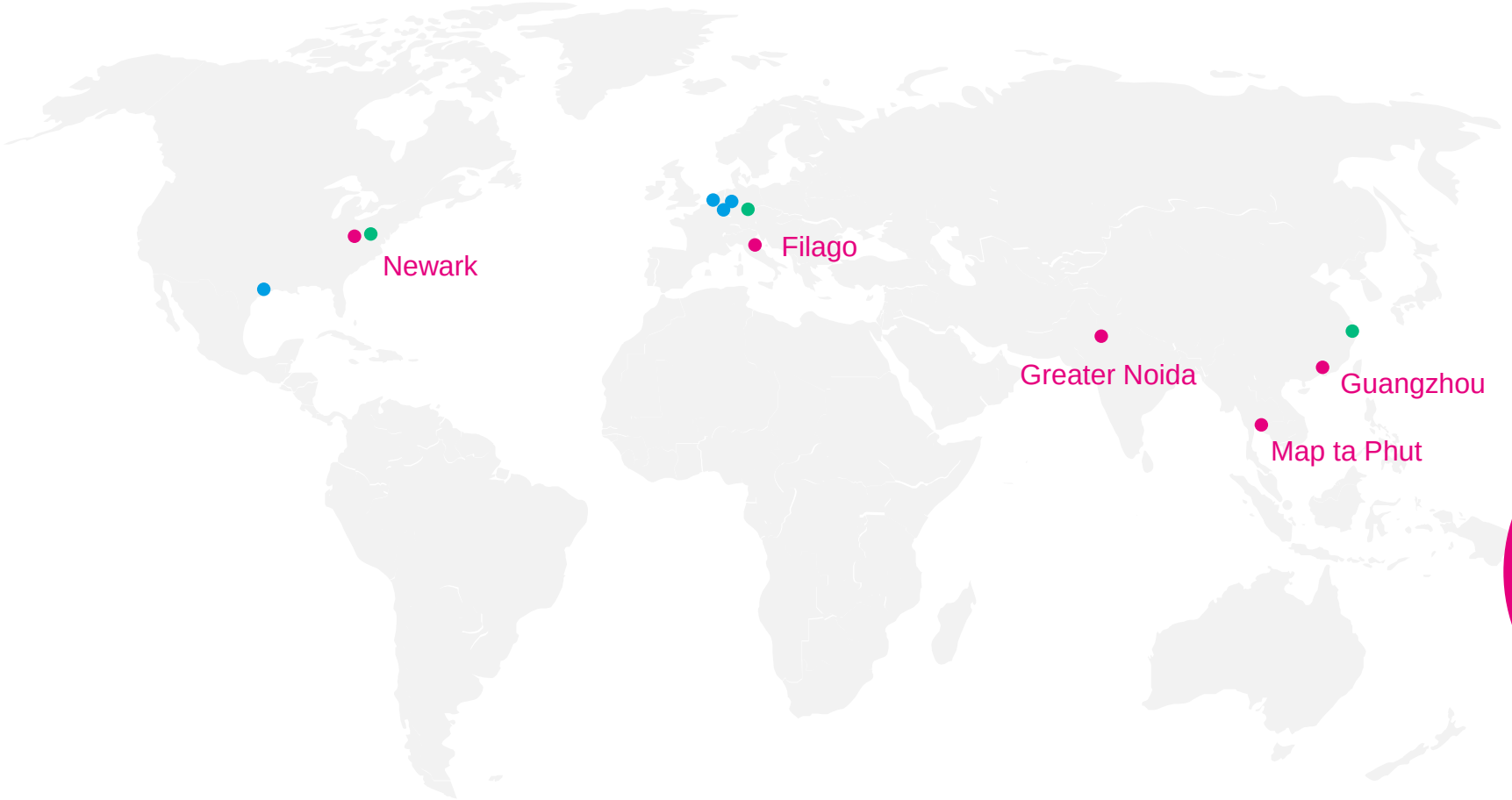
You’ll find us around the world … and just around the corner

3
innovation hubs

9
Production sites

We take pride in the **global consistency**, **quality** and **reliable supply** of our healthcare polycarbonate materials

A worldwide connected network of color development centers



3
innovation hubs

9
Production sites

5
color & design centers

Color developed in one location can be available in any with consistency

Leading polycarbonate supplier to the Healthcare industry

For 50 years, Healthcare OEMs have relied on our materials and industry expertise:

- Consistency, quality and long-term reliable supply
- Global product availability from sites following GMP
- Innovative materials meeting rigorous Healthcare requirements
- Excellent technical and regulatory service

Covestro medical grades and regulatory compliance

- Biocompatible per ISO 10993-1 and USP Class VI for contact of 30 days or less
- Product stewardship
- Supplier notification of change
- FDA Device (MAF) and Drug Master File (DMF) can be set up upon customer request
- Manufactured at ISO 9001 certified sites that follow GMP standards

Comparing properties of medical engineering resins

Thermoplastic	Modulus (MPa)	Strain at break (%)	HDT, °C (1.8 MPa)
Polysulfone	2340	>90	207
Apec® high heat polycarbonate	2400	>50	148-173
Makrolon® polycarbonate	2400	>90	124
Nylon	3300	5	105
Acrylic	3200	3.5	98
Acrylonitrile butadiene styrene	2500	>15	86
Polyester	1550	210	85

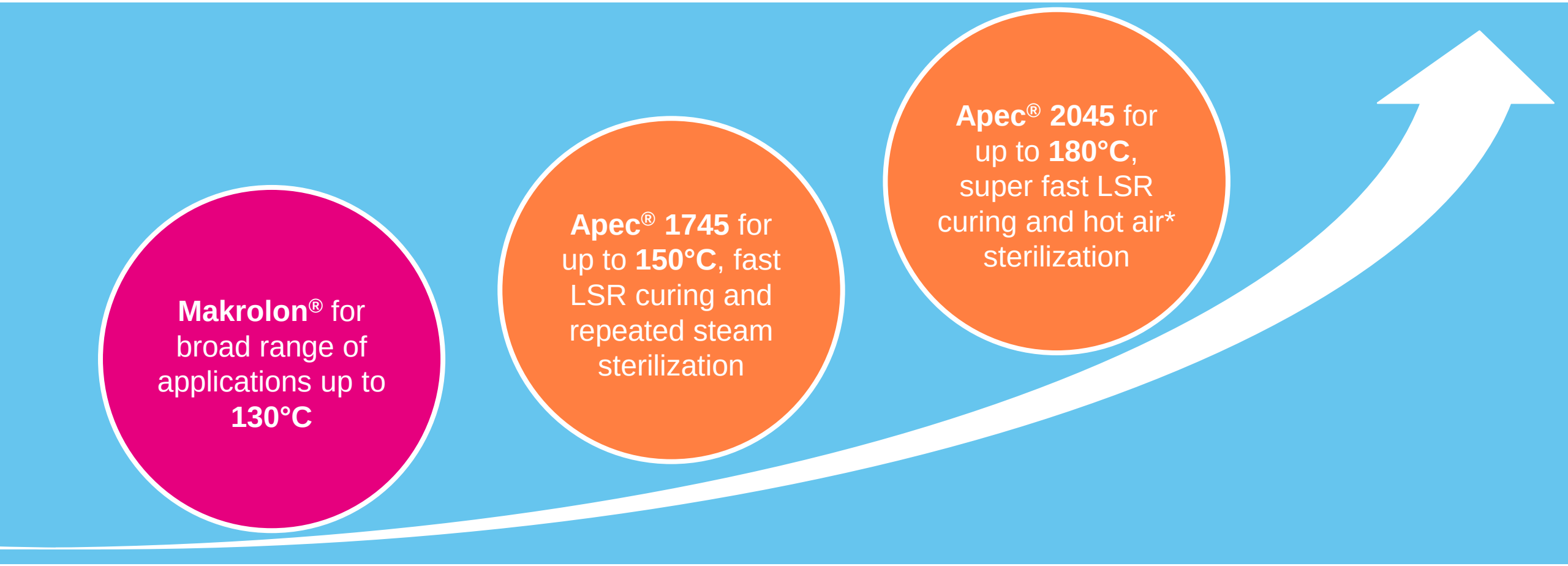
Makrolon® and Apec® polycarbonate offer the **best versatility** in terms of **cost** and **performance**

Comparing sterilization compatibility of engineering resins

Thermoplastic	Autoclave	Ethylene oxide	Radiation
Polysulfone	✓	✓	✓
Apec® high heat polycarbonate	✓	✓	✓
Makrolon® polycarbonate	varies	✓	✓
Nylon	varies	✓	✓
Acrylic	✘	✓	✓
Acrylonitrile butadiene styrene	varies	✓	varies
Polyester	✘	✓	✓

Makrolon® and Apec® polycarbonate are compatible with common sterilization techniques

Heat resistance of Covestro medical polycarbonates



*We recommend to test feasibility of hot air sterilization for your application

Comparison of physical properties

Property	Makrolon® 2458	Apec® 1745	Apec® 2045
Luminous Transmittance, 1mm	89	88	90
Melt Volume Rate	19[1]	17[2]	8[2]
Flexural Modulus	2350	2400	2450
Vicat Softening Temperature	146	170	203
Charpy Impact Strength (-30°C)	NB	NB	NB

1. 300°C/1.2kg; 2. 330°C/2.16kg
NB – No Break

Transparent, tough materials for medical devices requiring high heat resistance

Apec® high-heat polycarbonate

Apec® 1745
Apec® 2045

Glass-like transparency

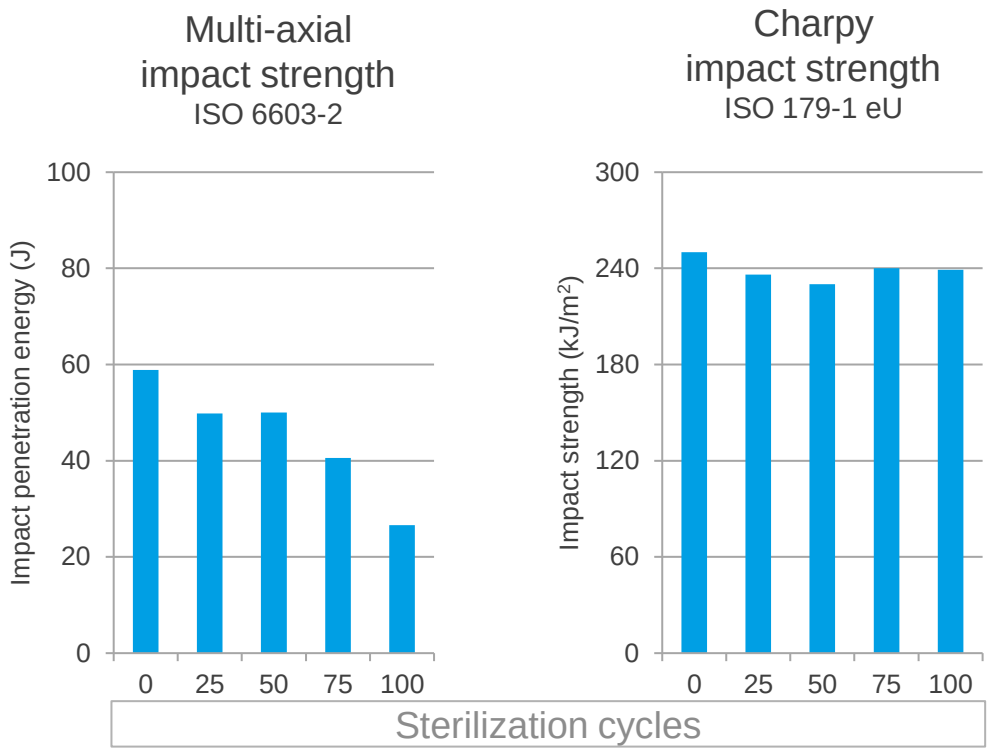
Sterilizable with steam, ETO or hot air*

Designed for steam sterilization and accelerating LSR curing

Durable and impact resistant

*For Apec® 2045 only, maximum recommended temperature: 180°C, we recommend to test feasibility of hot air sterilization for your application

Suitability of Apec® 1745 polycarbonate for steam sterilization

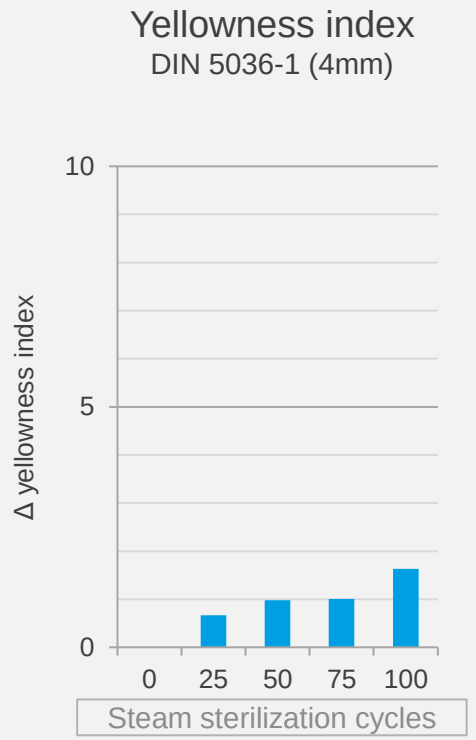


Durable material with excellent **ductility retention up to 100 cycles**

Each cycle was minimum 15 minutes, 136°C, 3 Bar

Outstanding optical properties and color retention

Apec® 1745 can withstand 134°C steam sterilization



Each cycle was minimum 15 minutes, 136°C, 3 Bar

Apec® 2045 polycarbonate features

- HDT-B of 192°C
- Sterilization by irradiation, autoclave and hot air*
- High modulus, excellent toughness
- High clarity and glass-like transparency
- Highest heat resistance that can more than double productivity in liquid silicone rubber (LSR) overmolding

*Maximum recommended temperature: 180°C, we recommend to test feasibility of hot air sterilization for your application

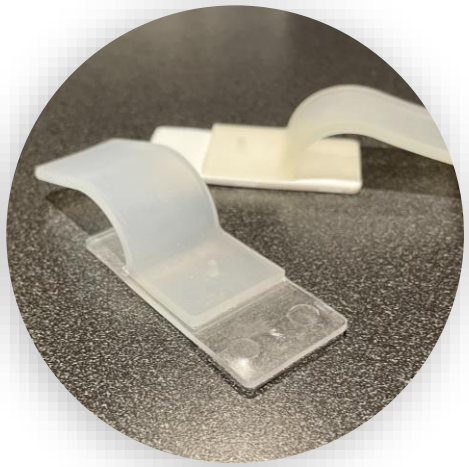
Liquid silicone rubber (LSR) overmolding overview

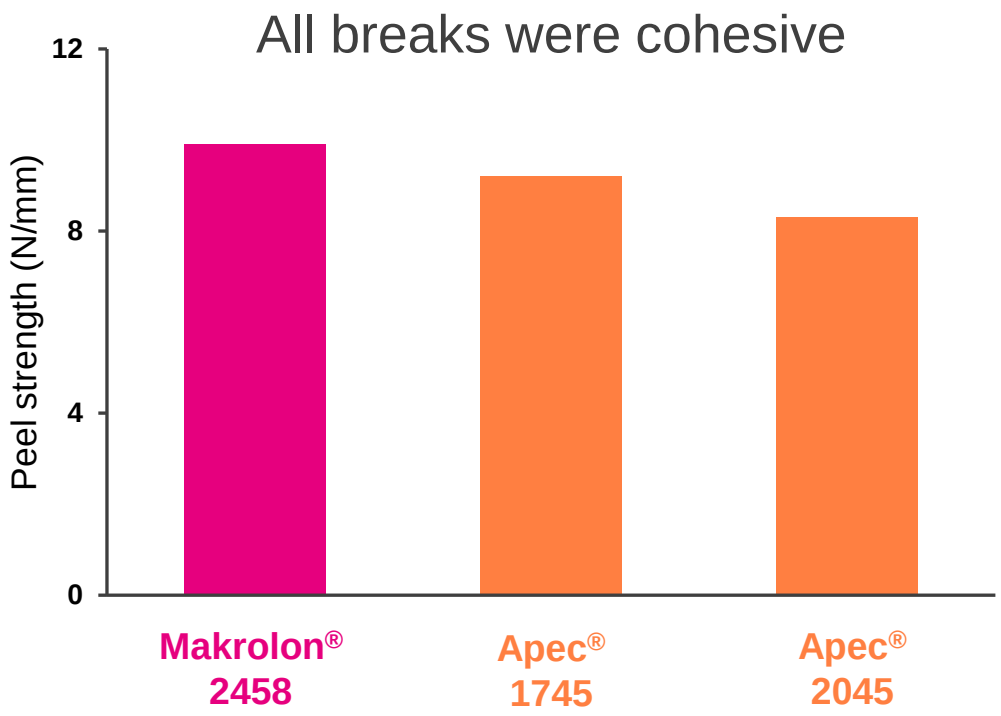
LSR overmolding

Used for airtight seals, soft surfaces and water resistance

Cures at high temperatures

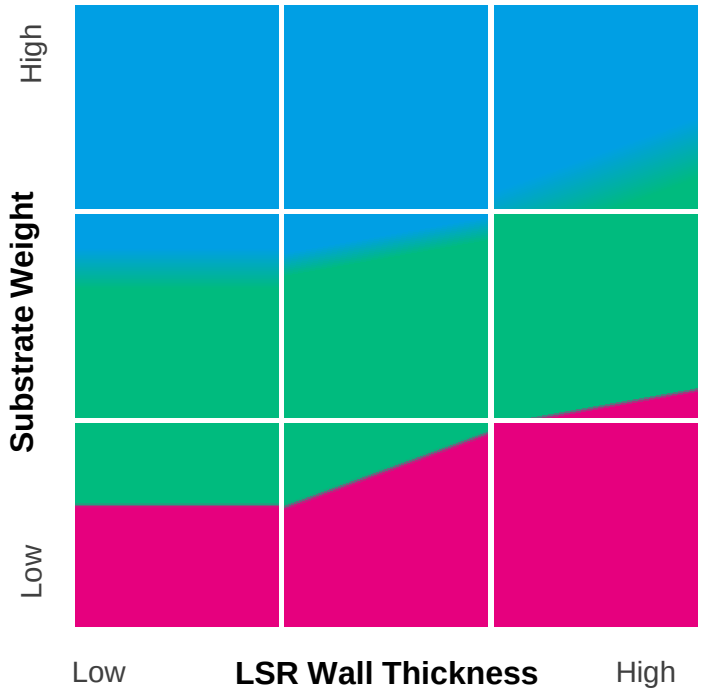
Adhesion testing to Liquid Silicone Rubber (LSR)





Makrolon® and Apec® polycarbonate have **excellent bonding**

Let us assist with simulating material performance



Most cost-effective substrate

Makrolon® Apec® 1745, 2045 Apec® 2045

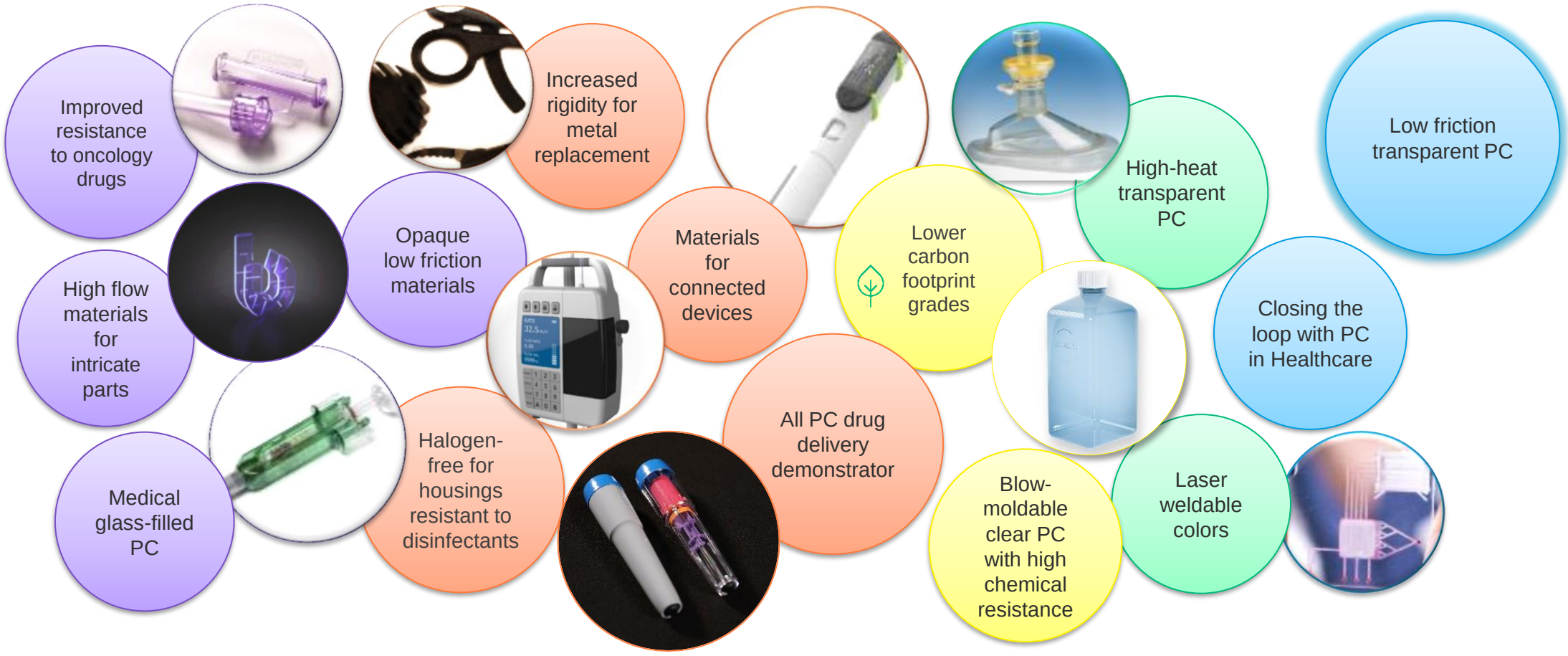
Based on 100$/hr injection machine cost scenario

- Cost savings calculated from substrate weight and LSR cure time
- Apec® helps accelerate curing → improved productivity

Combine design inspiration with Apec®

Healthcare innovation

We understand needs and can develop solutions

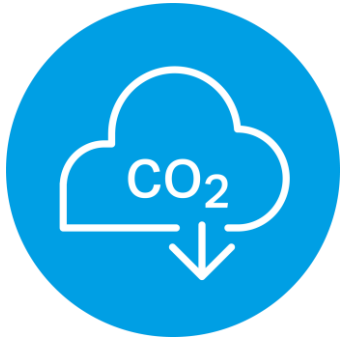


Makrolon® and Apec® polycarbonate can …

[3]A lower carbon footprint can be achieved if, in the future, it is decided to introduce raw materials that contain bio-circular content into the manufacturing process for Apec® polycarbonate.

REach your sustainability goals with drop-in solutions

Apec® RE



REduce the product carbon footprint

Preserve resources
up to 25% less fossil resources required, with e.g. 67% attributed bio-circular sustainable share [4,5*]

Drop-in solution
Zero implementation effort

* Specific product savings differ according product properties. Shown values represent selected Apec® RE grades.
[4] LCA calculation acc. to ISO 14040/14044 critical review by TÜV Rheinland, LCA with preliminary value chain data, cradle to gate, biogenic carbon included, impact assessment acc. to CML 2001 - Aug.2016, replacing key raw materials with mass balanced bio-circular ones according to ISCC PLUS. Bio-circular attributed via mass balance according to ISCC PLUS.
5 Based on ADP fossil category at LCA calculation considering raw materials and energies as described in 4.

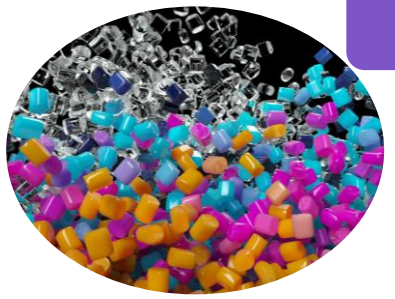
Closed-loop recycling concept

Pellets

Injection molding

Regrind

End use



Complex sorting

Today

ABS
POM
PP
PC
PA

× INCOMPATIBLE PLASTICS

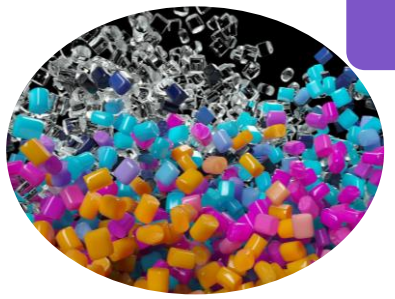
Closed-loop recycling concept

Pellets

Injection molding

End use

Regrind



Future

PC
PC+ABS
LF-PC
GF-PC
Apec®

✓ COMPATIBLE PLASTICS

Additional resources

New Healthcare Reference Guide

- Download here for:
  - ❑ Product overview
  - ❑ Case studies
  - ❑ Sterilization methods
  - ❑ Regulatory information
  - ❑ White papers

Or log into https://solutions.covestro.com for

- Product datasheets, safety datasheets (SDS), technical literature, design guides and more…

Thank you!

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