Low Viscosity Polycaprolactone Polyols for Performance and Sustainability

Chuck Jones, PhD

Market Segment Manager – Coatings

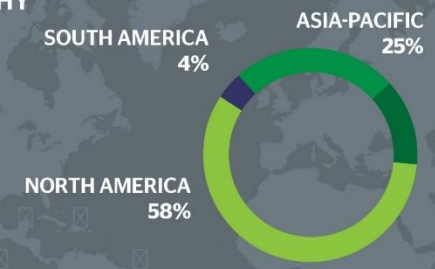
AGENDA

1. Introduction to Caprolactone Polyols
2. Legislative Landscape
3. Label-Free Triols for Clear Coats
4. Caprolactone Polyols Performance Showcase
5. Key Takeaways

1 | Introduction to Caprolactone Polyols

INGEVITY
AT A GLANCE

2024 NET SALES BY GEOGRAPHY



OUR BUSINESS IN 2024

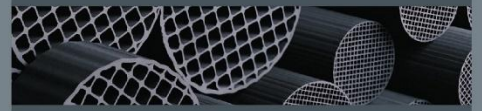
NET SALES	ADJ. EBITDA MARGIN [1]	DILUTED ADJUSTED EPS [1]	PERFORMANCE MATERIALS SALES	ADVANCED POLYMER TECHNOLOGIES SALES	PERFORMANCE CHEMICALS SALES
$1.4 BILLION	25.8%	$3.51	$609.6 MILLION	$188.6 MILLION	$608.2 MILLION

OUR COMPANY

EMPLOYEES GLOBALLY	MANUFACTURING SITES	LOCATIONS	TECHNICAL CENTERS	WE DO BUSINESS IN
~1,600	11	24	7	75 COUNTRIES

PERFORMANCE MATERIALS

Carbon Technologies



MARKETS
- Automotive
- Food and beverage purification
- Water Treatment

ADVANCED POLYMER TECHNOLOGIES

Caprolactone Technologies

MARKETS
- Automotive and transportation
- Bioplastics
- Consumer packaging
- Footwear and apparel
- Industrial equipment
- Medical and health

PERFORMANCE CHEMICALS

Industrial Specialties

MARKETS
- Adhesives
- Agricultural chemicals
- Industrial intermediates
- Lubricants
- Oilfield
- Rubber

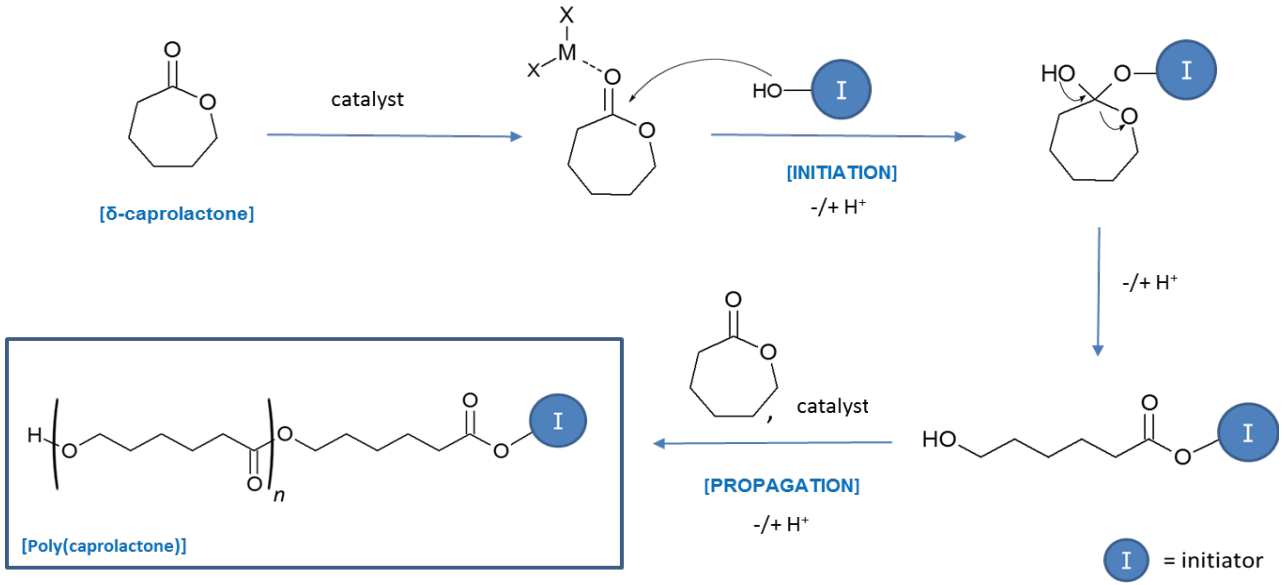
Road Technologies

MARKETS
- Pavement construction
- Pavement markings
- Pavement preservation
- Pavement reconstruction and recycling

1: See page 119 of our 2024 Annual Report and 10-K for definitions and reconciliations of these non-GAAP financial measures.

ingevity

Polycaprolactone Polyols

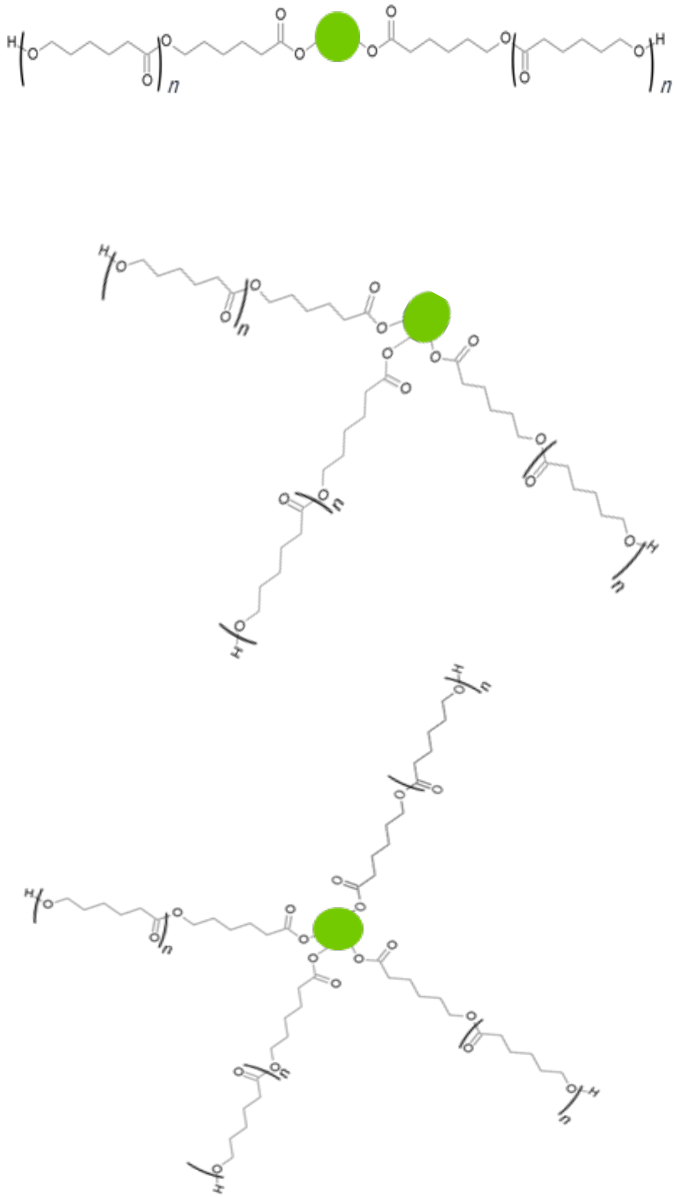


- PCL polyols are made *via* ring opening polymerisation
- No by-products
- Acid value and water content can be kept very low
- Controlled polymerization means that all hydroxyls are primary
- Very narrow polydispersity which makes for better batch-to-batch consistency

ingevity

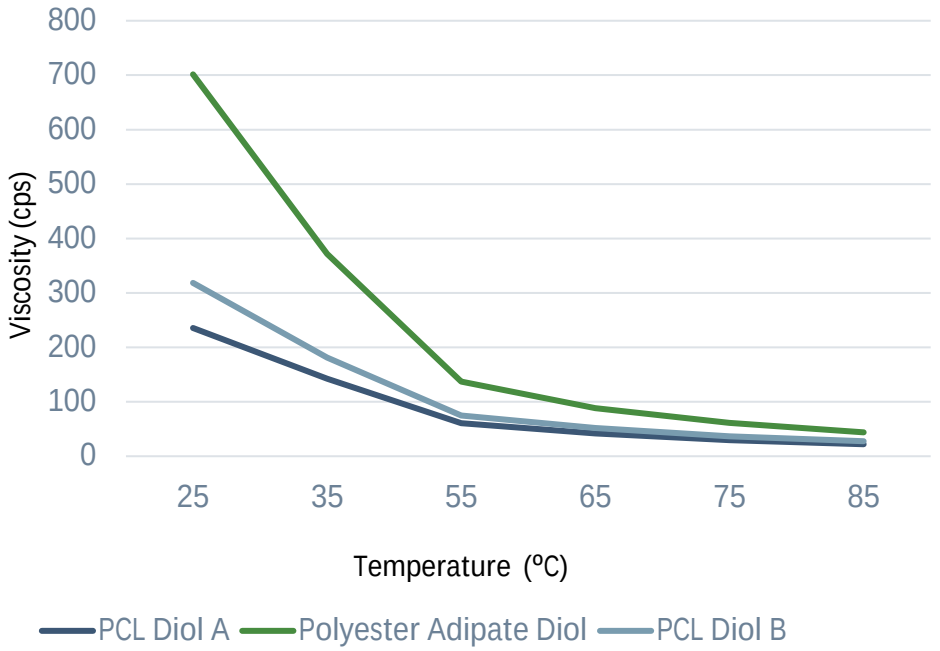
PCL Polyol Properties

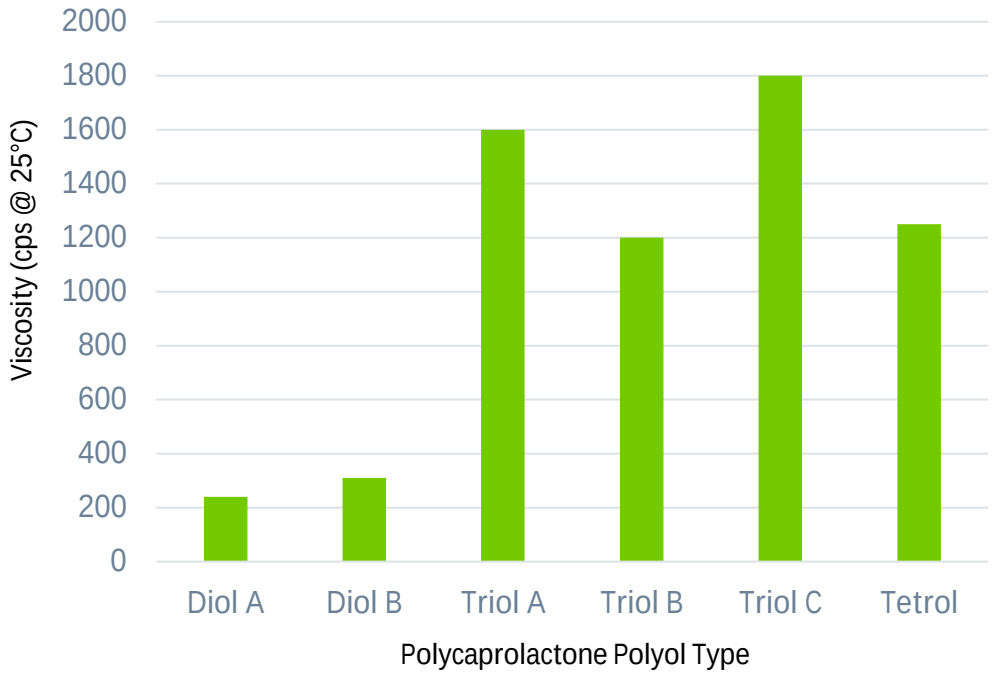
Polyol	MW (g/mol)	Functionality	OH Value (mg KOH/g)	Solid Content (%)	Viscosity (mPa·s @ 25°C)
PCL Diol A	400	2.0	280	100	240
PCL Diol B	500	2.0	204	100	310
PCL Triol A	300	3.0	550	100	1600
PCL Triol B	500	3.0	310	100	1200
PCL Triol C	900	3.0	182	100	1250
PCL Tetrol	1000	4.0	225	100	1800



ingevity

PCL Processing Benefits





Low viscosity enables less (or zero) solvents, resulting in lower VOC levels

ingevity

2 | Legislative Landscape

Legislative buzzwords in 2025

Carcinogenic

TiO2

REACH

NMP

PFAS

Cumene

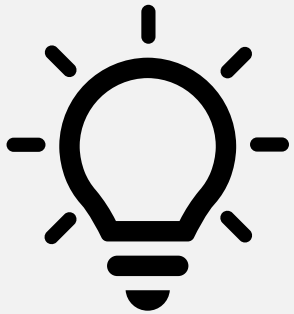
Low VOC

TMP

How can we address these challenges?

Collaboration
with formulators

+



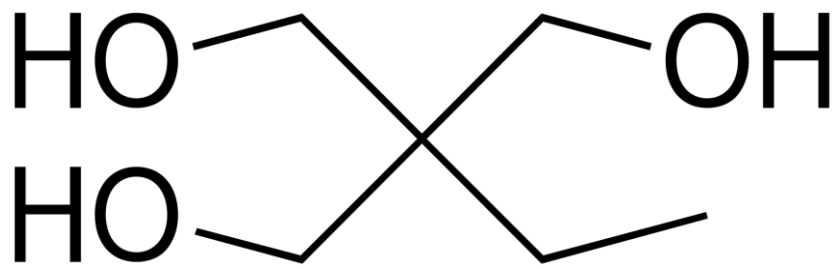
Innovation &
Differentiation

ingevity

Raw Material of Concern

TMP	
PCL Triol A	10 – 15%
PCL Triol B	< 3%
PCL Triol C	< 1%

Trimethylolpropane (TMP)



Section 2. Hazards identification

Classification of the substance or mixture : REPRODUCTIVE TOXICITY - Category 2

GHS label elements

Hazard pictograms :

Signal word : Warning

Hazard statements : Suspected of damaging fertility or the unborn child.

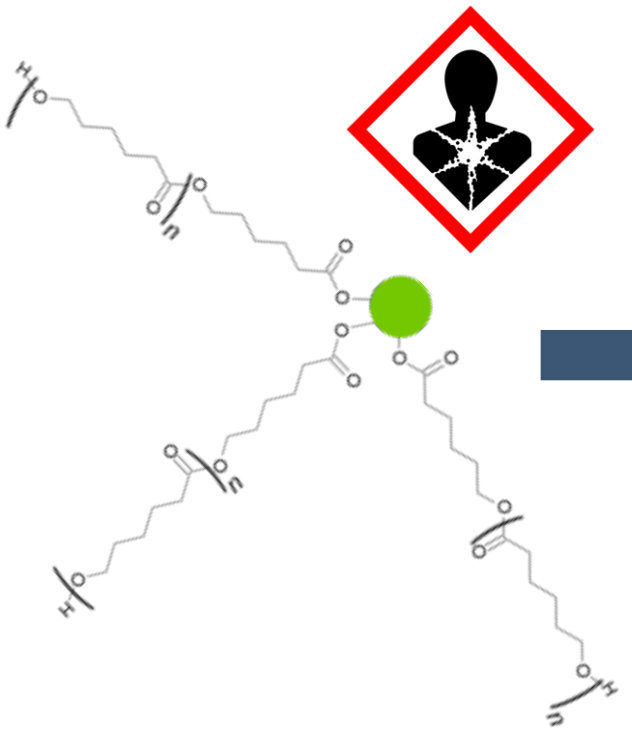
Sensitive End-Use Applications

Automotive

Wood Coatings

ingevity

New Polycaprolactone Triols



Innovation

Differentiation

Low Viscosity

Partly Bio-Based

TMP-free

PCL X-300

PCL X-500

Reduces formulation VOC

Linear Curing Profile

Improved Abrasion Resistance

Improved Flexibility

Bio Content (22% and 12%)*

% Biobased Carbon Content (C14) ASTM D6866-24 Method B (AMS) TOC

3 | PCL Triols for Clear Coats

PCL Triols for 2K Clear Coats

Novel PCL Triols provide fine tuning properties for clear coats suitable for a variety of applications & specifications.

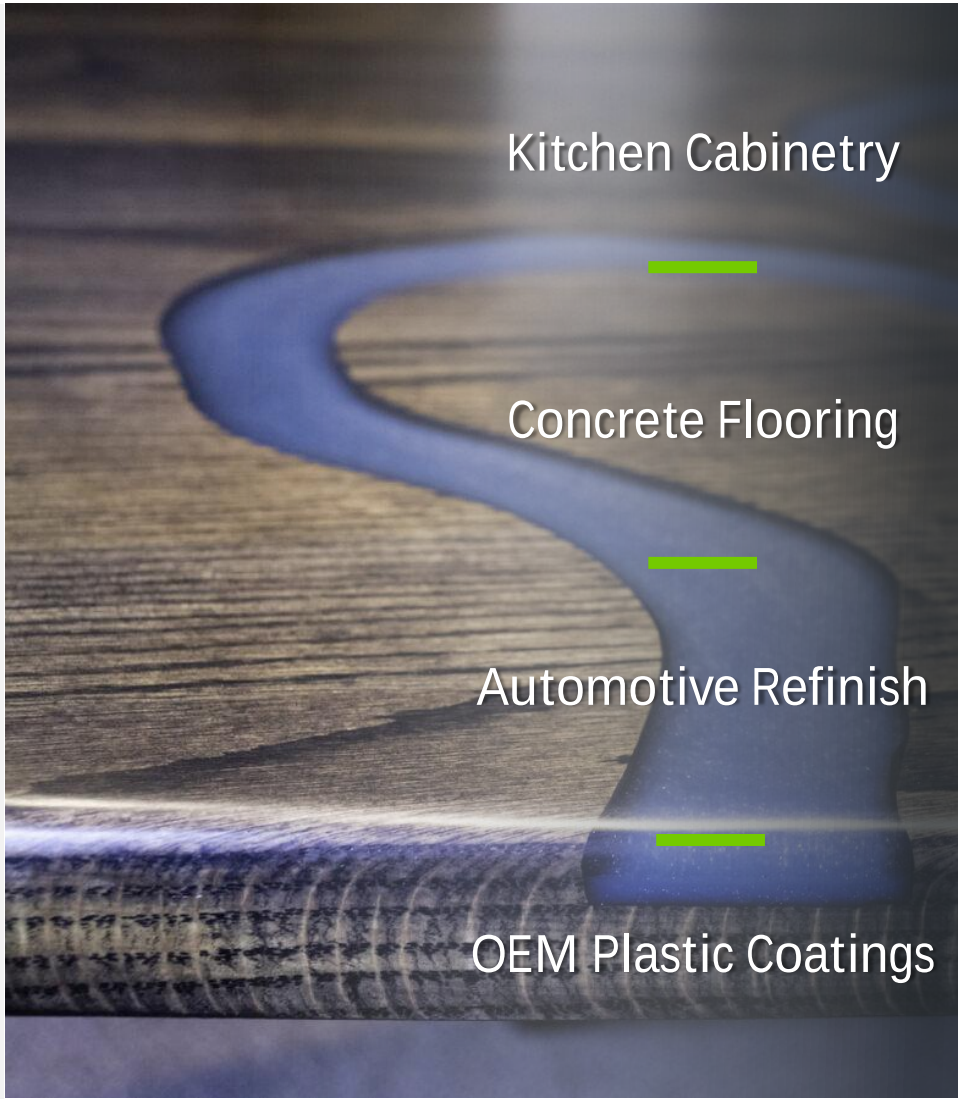
Physical Property Highlights

- Liquid at room temperature
- 100% Solids, VOC-Free
- Hazard label free

- Improved flexibility for low-temperature performance
- Improved abrasion resistance for topcoats
- Resistance to cleaning agents
- Reduced solvent content

Triol Properties

Product	Functionality	Molecular Weight (g/mol)	Viscosity (23°C, mPa•s)	Key Performance Improvements
PCL X-300	3.0	300	610	Scratch resistance and durability
PCL X-500	3.0	500	860	Flexibility and impact resistance



ingevity

4 | Performance Showcase

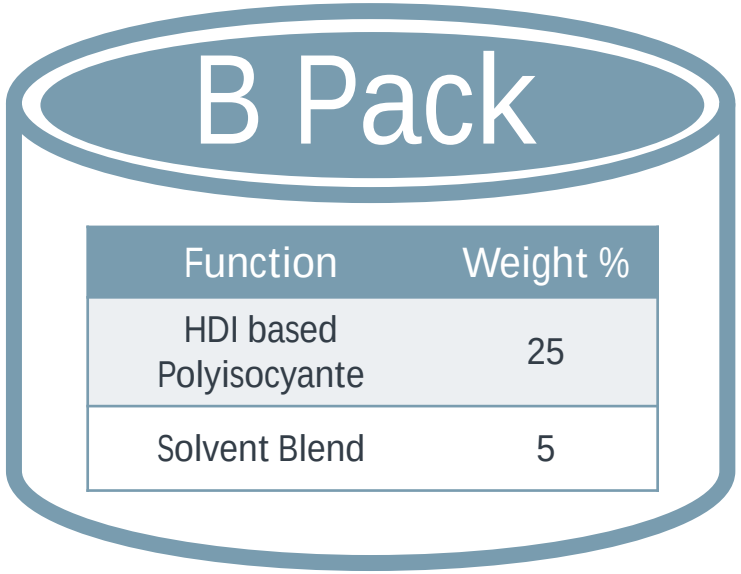
Guide Formulation

Acrylic polyol as main binder – Solvent borne formulation – Clear 2K PU topcoat

Raw Material	Weight %
Solvent-borne acrylic polyol	54
Polycaprolactone (PCL) polyol	6
Defoamer	0.75
Wetting agent	0.25
Catalyst	1
Solvent Blend	8

4-to-1 Kit system

Weight solids : 70%
Isocyanate index: 1.05

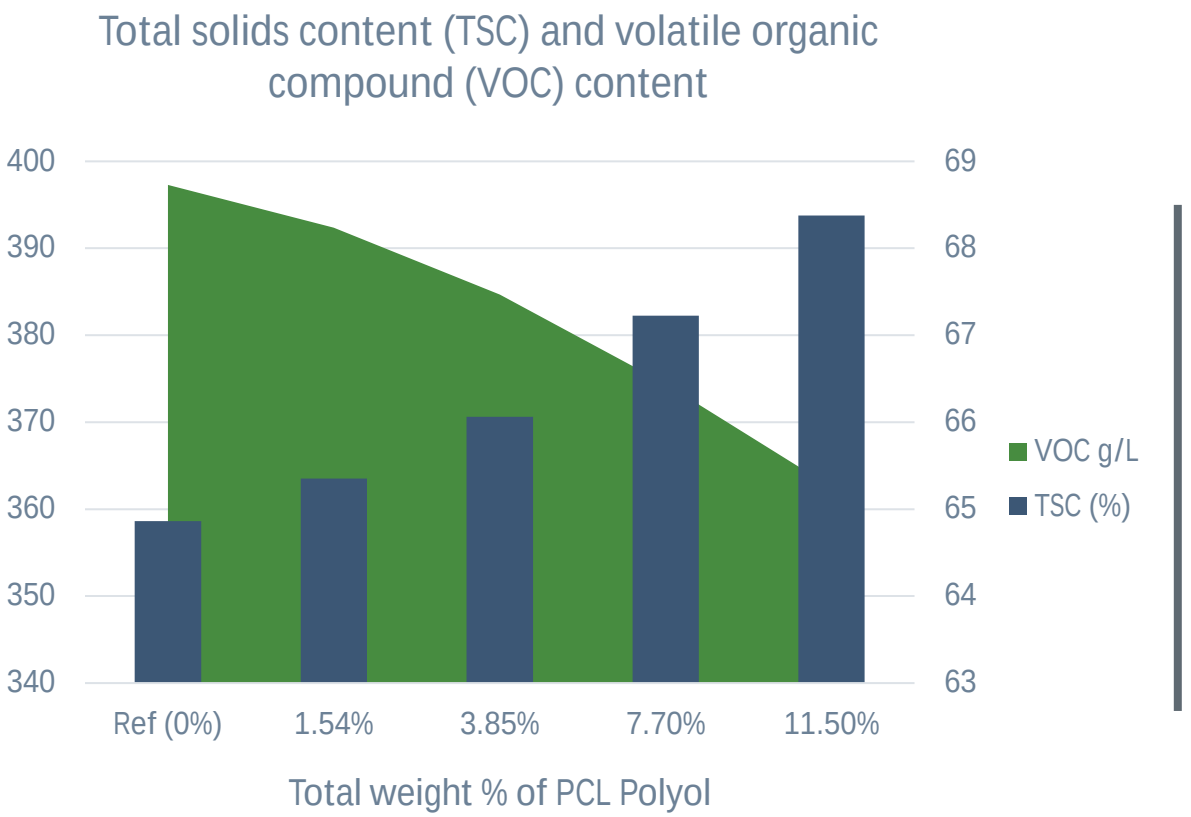


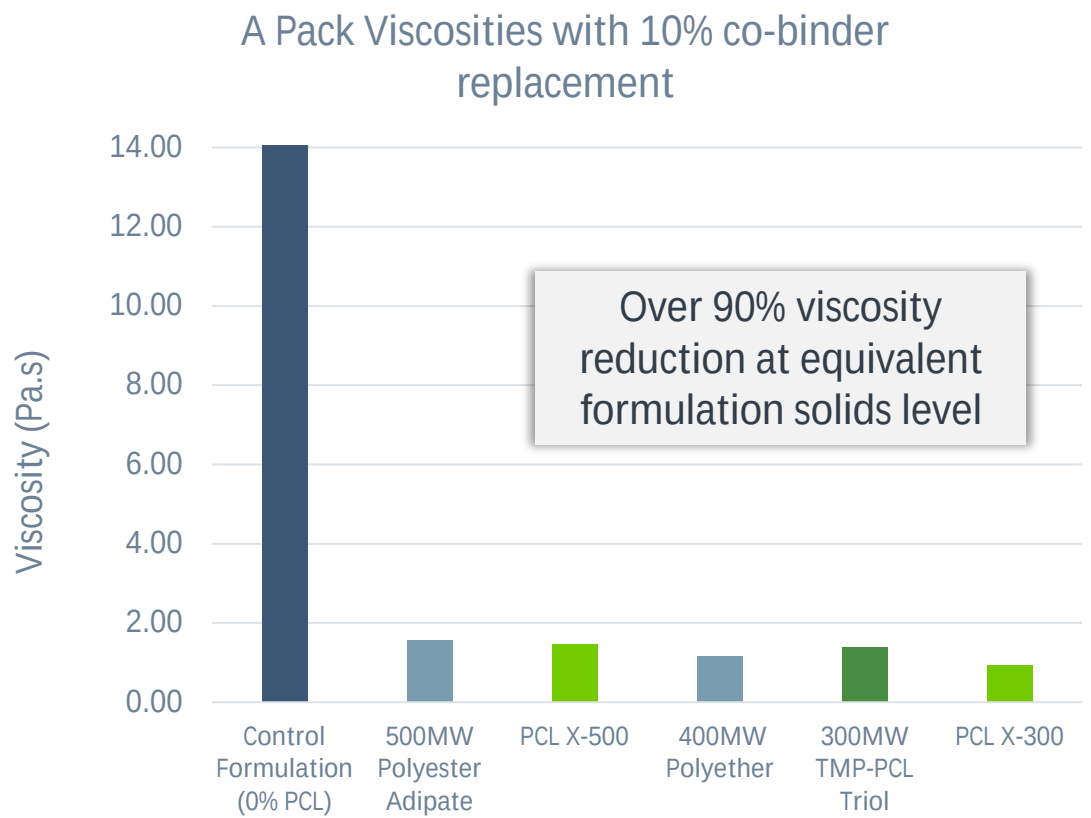
Function	Weight %
HDI based Polyisocyante	25
Solvent Blend	5

**NOTE: NCO content varied to maintain isocyanate index of 1.05*

ingevity

VOC reduction with improved processability





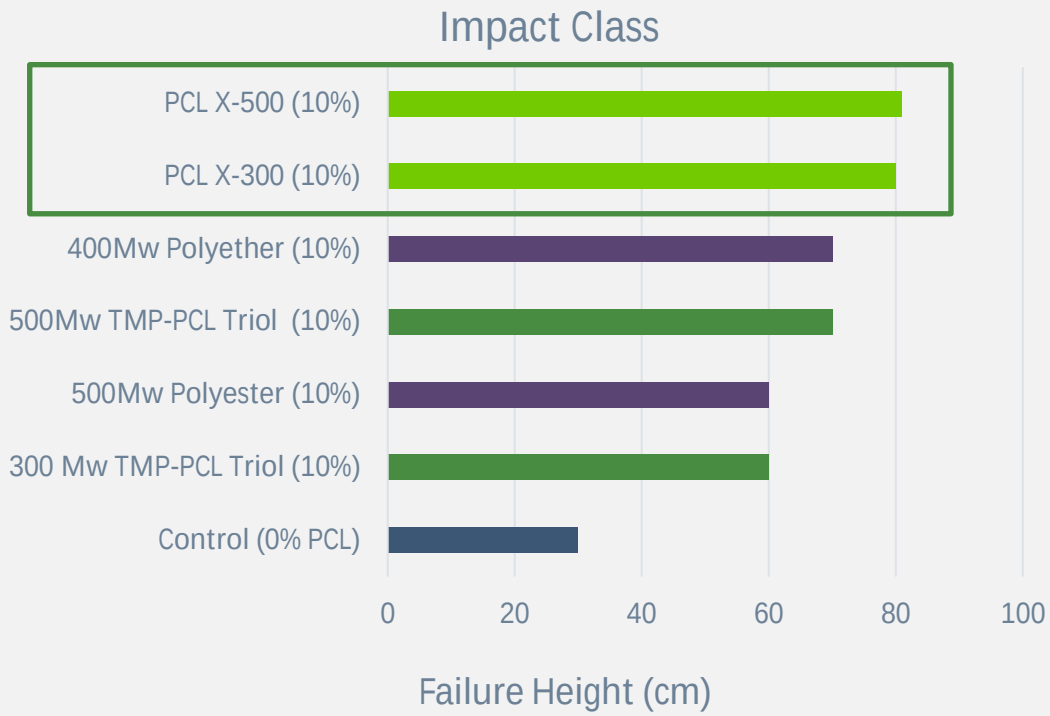
Low viscosity enables less (or zero) solvents, resulting in lower VOC levels

ingevity

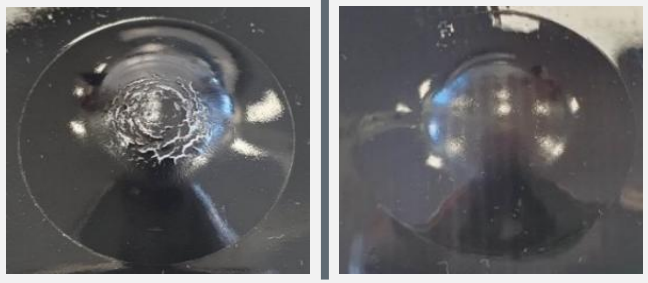
High flexibility and impact resistance

Impact Test Performance (ISO 6272-1 Classification Test)

- Films were prepared at 70-75 µm DFT specification.
- Substrate: Aluminium panels 0.64 mm thick, alloy 3003 H14.
- Tests performed at 23°C & 50% RH



Without PCL | With PCL



- Superior impact & flexibility compared to other resin technologies used as co-binders.

Improved leading-edge performance

Improved low-temp performance

ISO 6860
Mandrel Bend Test

PCL X-500
(10%)

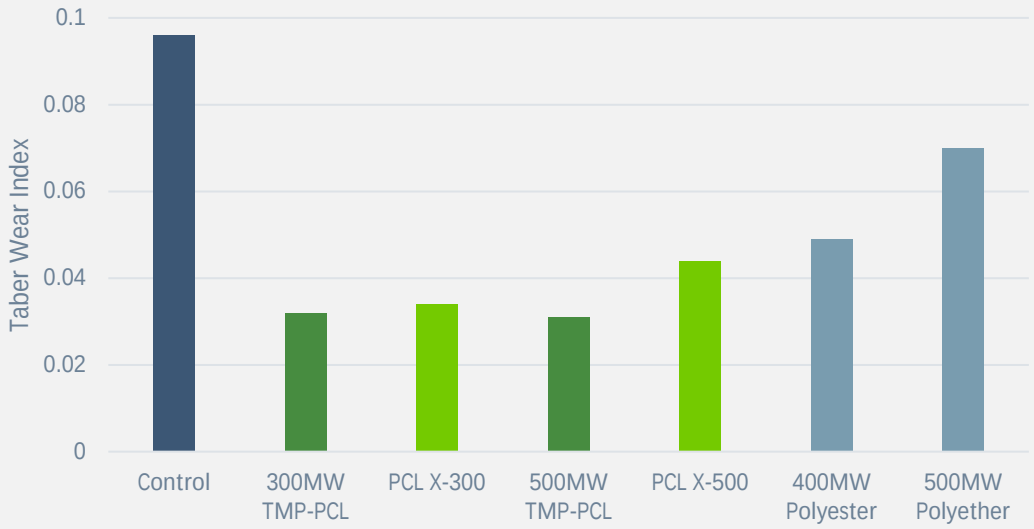
Control

ingevity

Superior Abrasion and Scratch Resistance

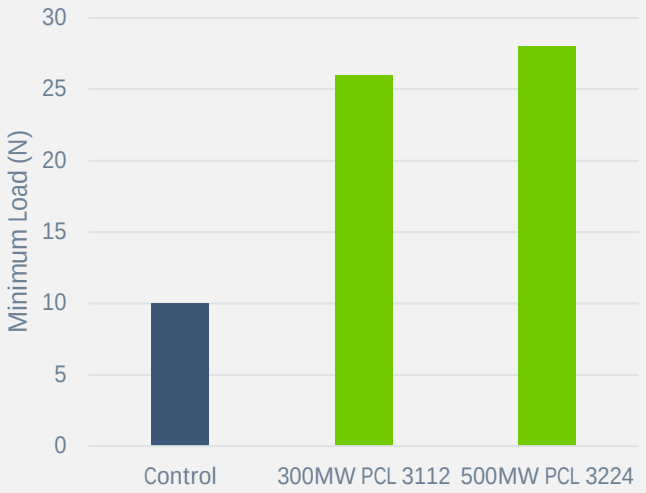
Taber Abrasion (ASTM D4060 – Taber Wear Index)

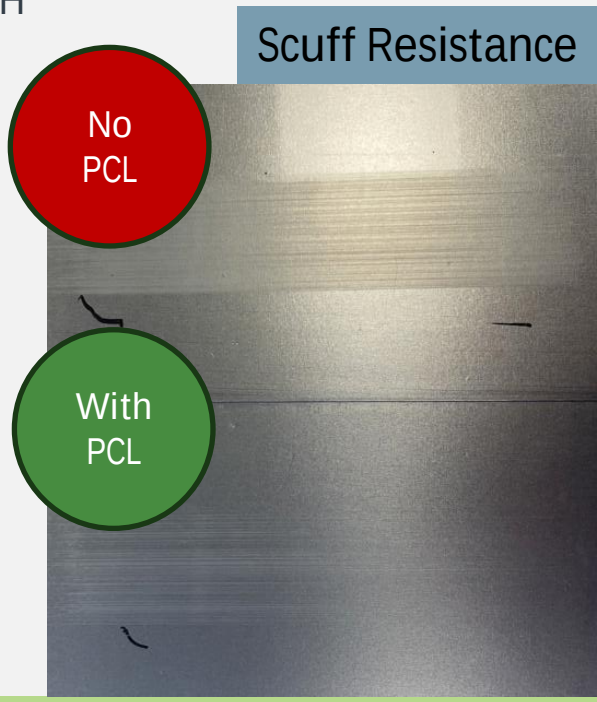
- Films were prepared at 70-75 µm DFT specification.
- 1kg weight on each arm, CS-17 Wheel
- Tests performed at 23°C & 50% RH



Resistance to Scratching & Indentation (ISO 1518-1)

- Films were prepared at 70-75 µm DFT specification.
- Weight varied on stylus/needle until failure
- Tests performed at 23°C & 50% RH





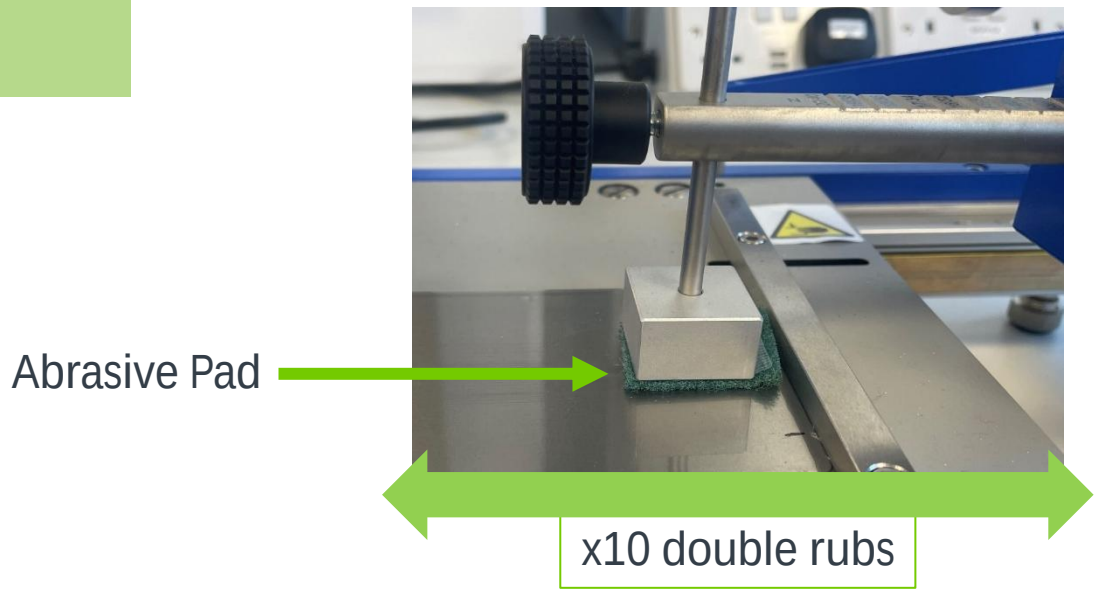
Coatings modified with PCL polyols show improved abrasion performance.

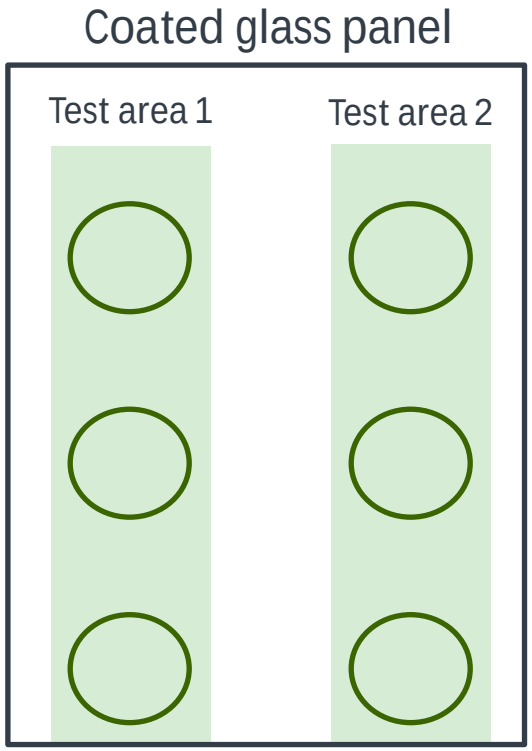
ingevity

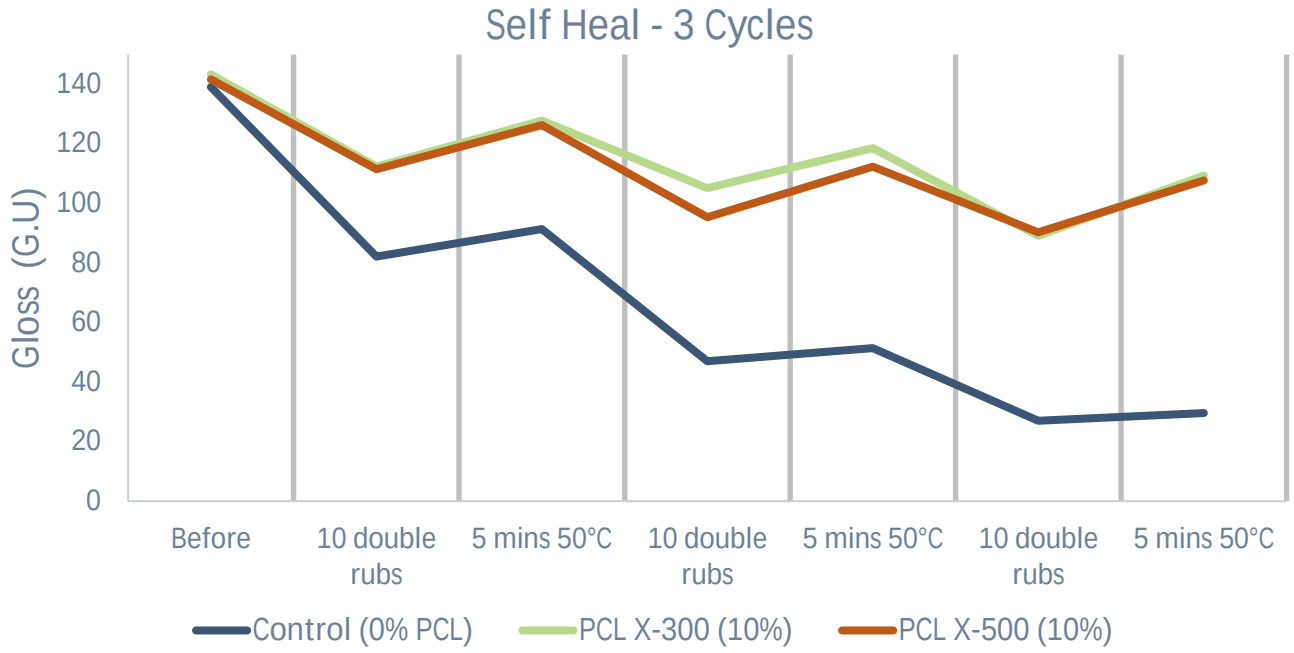
Self-Healing

Scuff test followed by heat exposure

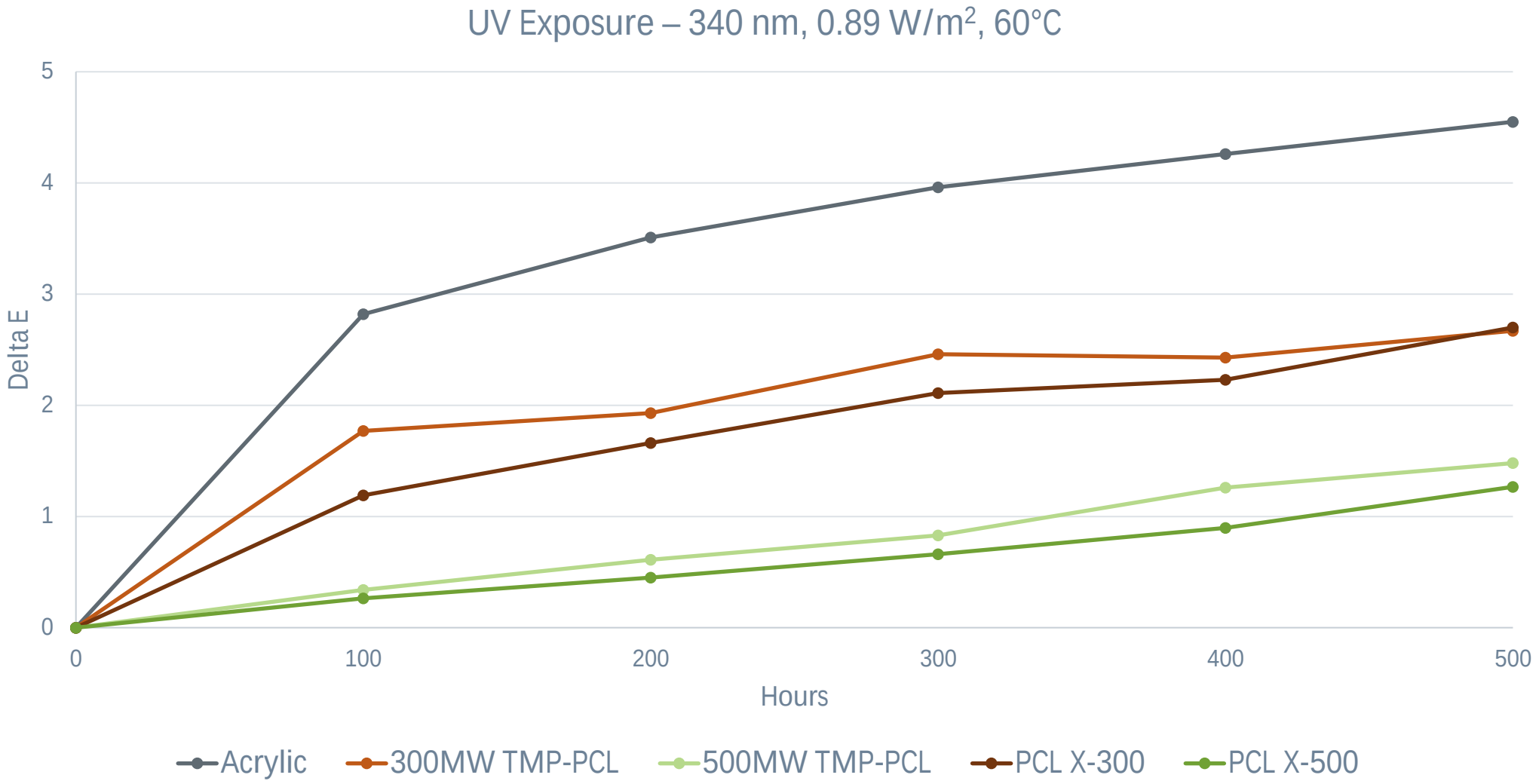
- Films were prepared at 70-75 µm DFT specification.
- Substrate: Glass plate of standard hardness.
- Tests performed at 23°C & 50% RH







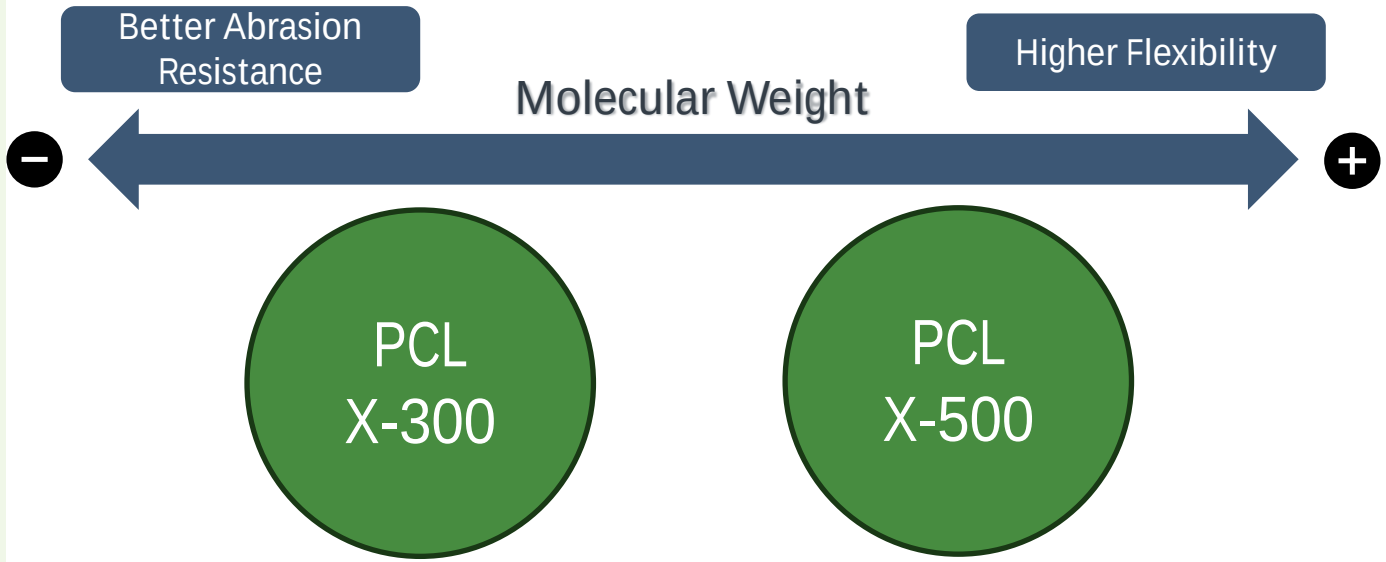
Improved Weathering Resistance



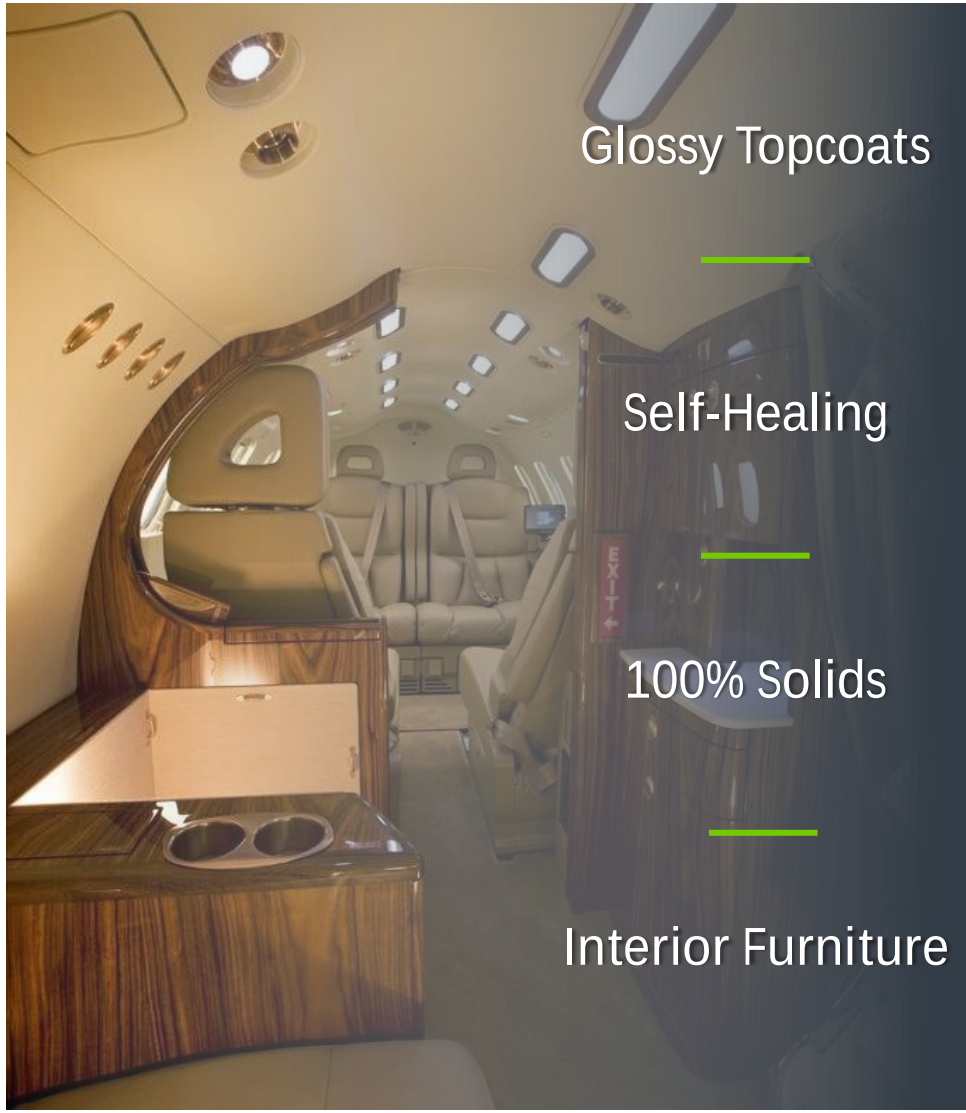
ingevity

5 | Key Takeaways

Conclusion



- Higher functionality for a more durable finish
- Superior abrasion performance and flexibility.
- Enhanced crosslinking density for top-coat applications.
- Preferred for SB 2K PU systems, clear and pigmented.
- Molecular weight modulation for tailored properties.



Chuck Jones, PhD
Market Segment Manager - Coatings

chuck.jones@ingevity.com
(215) 499-2356