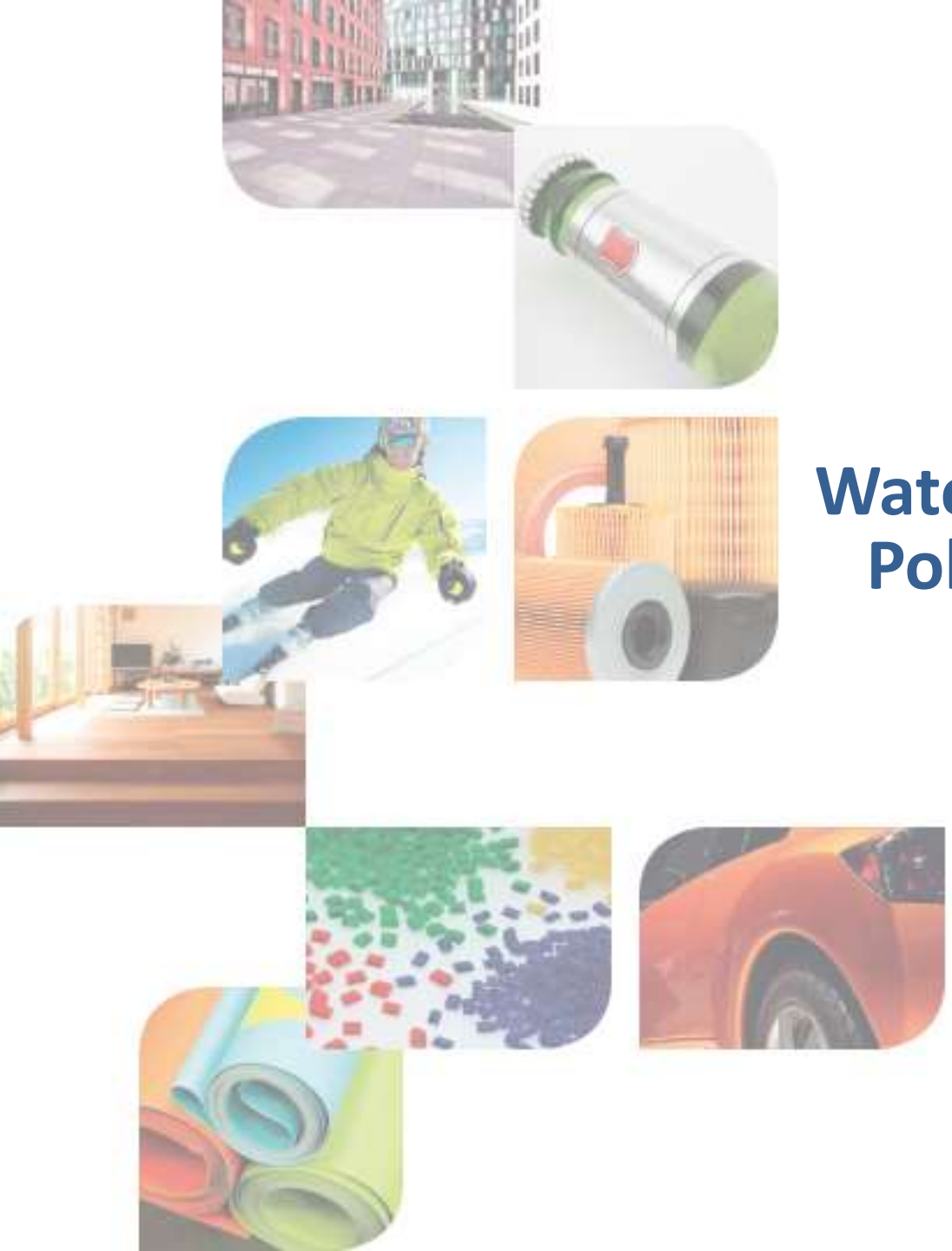


Water Borne Self-Matting Polyamide Technology

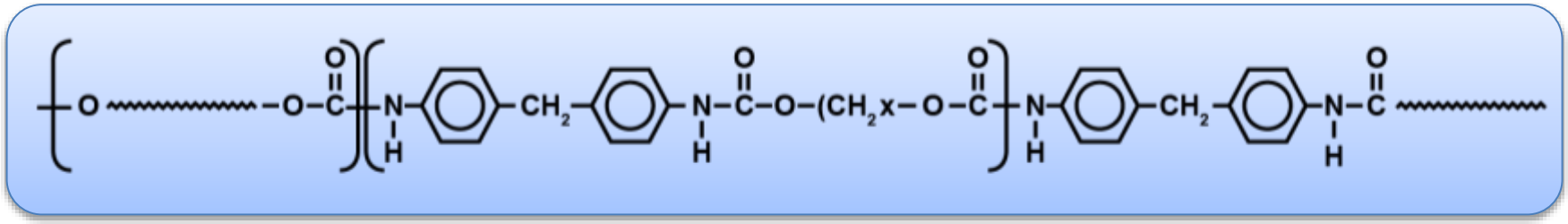
Eric Broz

Coatings Trends & Technologies Conference

September 10, 2019

WHAT WE ADD MAKES THE DIFFERENCE.™

TYPICAL POLYURETHANE



HO- -OH + OCN- -NCO + HO- -OH + **Diluent**

Polyol (Soft segment)	Poly-Isocyanate (Hard segment)	Acid (Water dispersing)	Process Aid (Viscosity control)

Polyamide Technology

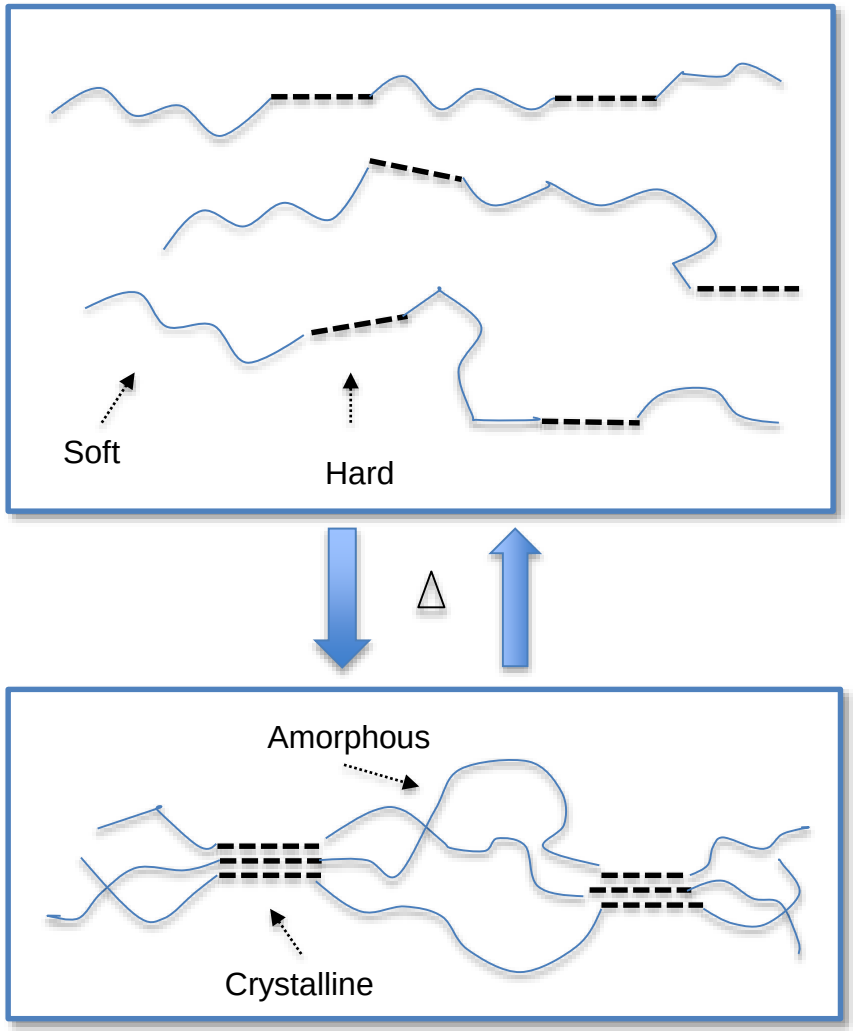
SEGMENTED POLYMERS – THERMOPLASTIC ELASTOMERS

Segments of **soft blocks** and **hard blocks**

Physical and mechanical properties dependent of segment properties and intermolecular interactions

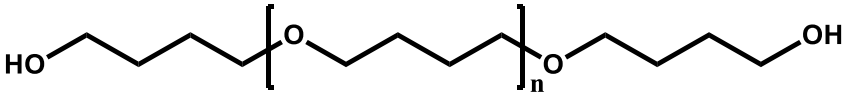
Common soft segments in PUD are made of **polyester, polyether, or polycarbonate polyols**

Chemical and physical properties strongly influenced by soft segment

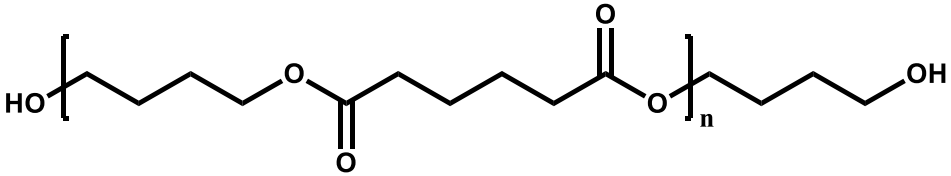


DIFFERENT TYPES OF POLYOLS – SOFT SEGMENTS IN PUD

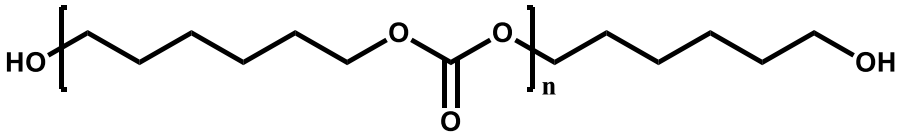
Polyether polyol
Good hydrolytic stability
Poor UV resistance



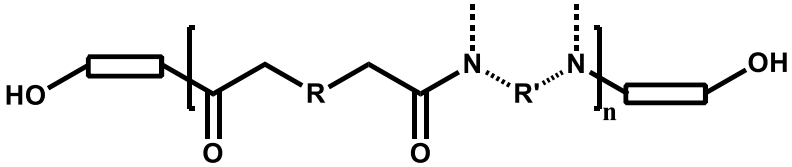
Polyester polyol
Good mechanical properties and UV resistance
Poor hydrolytic stability



Polycarbonate polyol
Good UV and hydrolytic stability
High price and limited composition variability



Polyamide polyol – previously believed to be not suitable for soft segment, no commercial availability

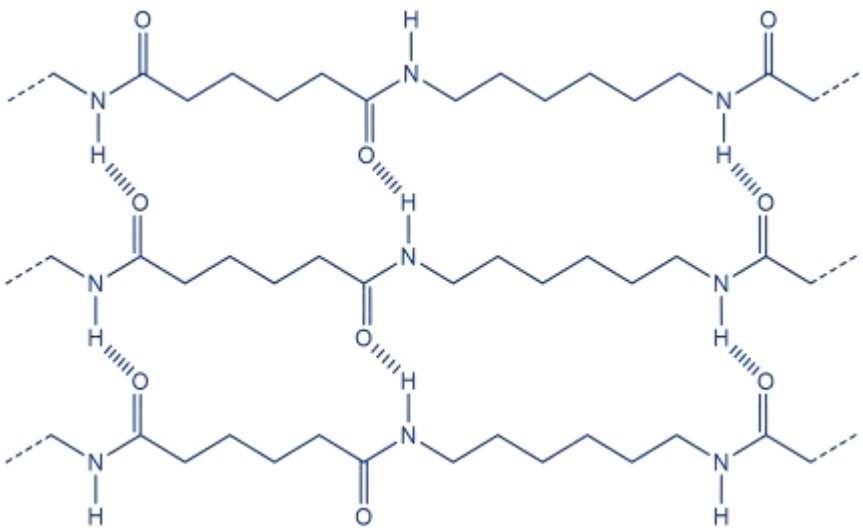


Lubrizol has invented a new building block for synthesizing polymers, in particular, new waterborne polyurethane dispersions.

PROBLEMS WITH POLYAMIDE OLIGOMERS

- Tendency to form crystalline, **high melting**, structures due to strong intermolecular hydrogen bonding
- **Viscosity** usually **too high** to handle in common PUD processes
- Additional synthesis step needed to convert amine or carboxyl chain-ends to hydroxyl (**cost**)
- Raw material **availability**
- Isocyanates may **react** with amide
- **Moisture** hold-up

Many reports on attempts to make polyamide-urethane polymers, but little commercial success so far…

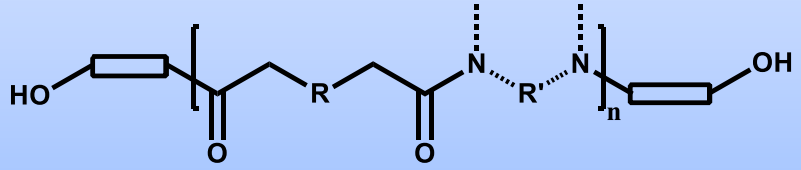


POLYMERS WITH POLYAMIDE SEGMENTS

FUNCTIONAL POLYAMIDES were developed with amine and/or hydroxyl terminations and controlled:

- Molecular weight
- Hydrophobicity
- Hydrogen bonding
- Branching/rings

URETHANE WITH A **CHEMICALLY INERT** SOFT SEGMENT AND VERY HIGH **HARD SEGMENT COMPATIBILITY**



POLYAMIDE based URETHANES are *NOT*:

- Impossible to process in any form …
- Water sensitive: swells/blushes at ambient …
- Brittle without any elongation or strength whatsoever …

ADVANTAGES OF POLYAMIDE POLYURETHANE

MECHANICAL & CHEMICAL

- High Hardness
- Excellent Chemical Resistance

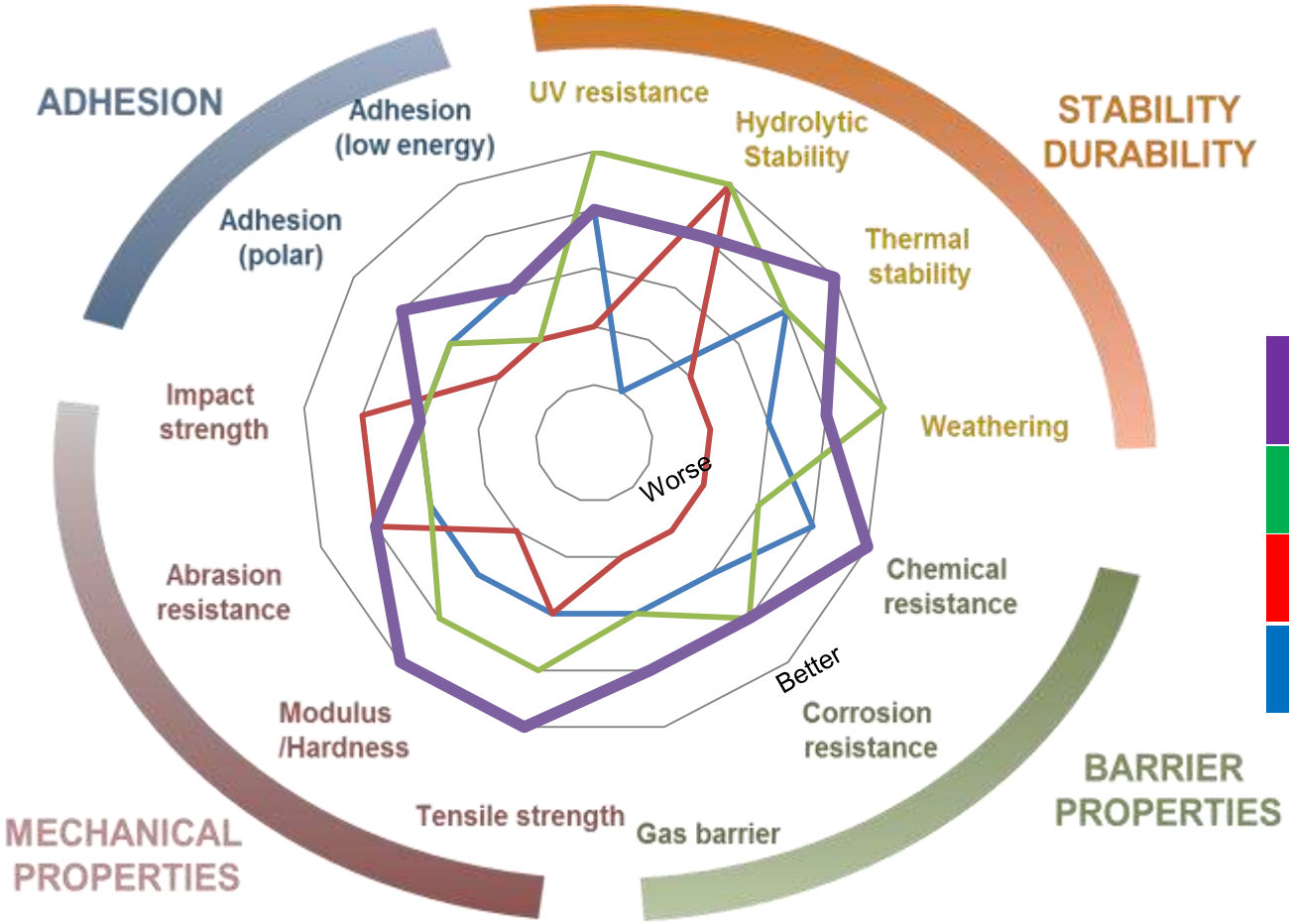
ADHESION

- Nylon/Polyamides
- Glass
- Polar surfaces

HYDROLYTIC & THERMAL STABILITY

- Hydrolytic:
  - AMIDE >> ESTER
- Thermal:
  - AMIDE >> ETHER

PERFORMANCE EVALUATION OF URETHANES



Waterborne PUD
Soft Segment Type:

- POLYAMIDE
- POLYCARBONATE
- POLYETHER
- POLYESTER

POLYAMIDE TECHNOLOGY
CURRENT APPLICATIONS

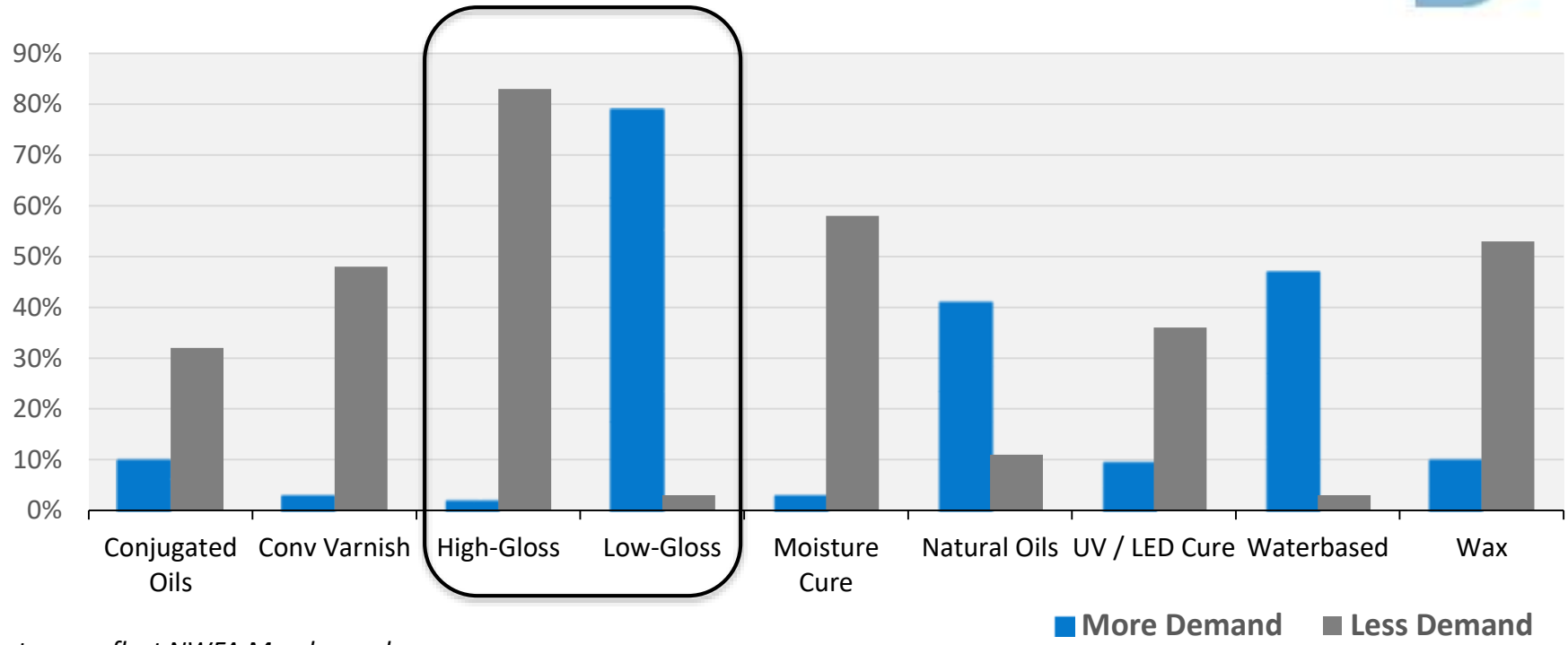
Applications:

- Industrial Metal Coatings
- Wood Coatings
- Masonry Flooring Systems

Features:

- High Hardness
- Excellent Chemical Resistance
- Film Clarity

NWFA – INDUSTRY OUTLOOK
EXPECTED DEMAND – FINISH TYPE



Percentages reflect NWFA Members who anticipate a higher or lower demand for finish types. Source: 2018 NWFA

Current Trend --- Lower Gloss; Natural-Look Coatings for Wood Flooring

TRADITIONAL MATTING TECHNIQUE

- Matte appearance is caused by a reduction in the amount of specular reflected light; this is *linked to surface roughness*

- One of the more common techniques of matting uses the addition of large, non-soluble particles to create a micro-texture surface during film formation (i.e. Silica, Kaolin, Bentonite, Waxes)

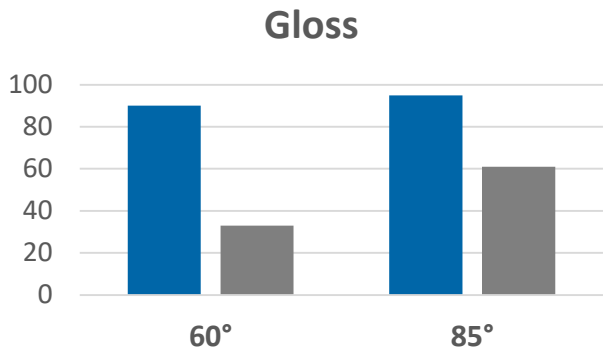
- Develop resins with very large particles mixed in to create surface roughness and generate topography on the surface

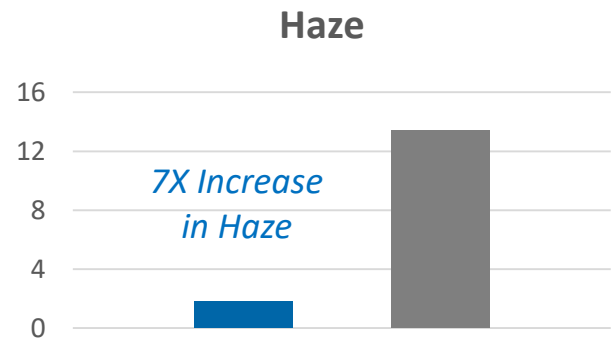
PRO AND CONS OF TRADITIONAL MATTING ADDITIVES

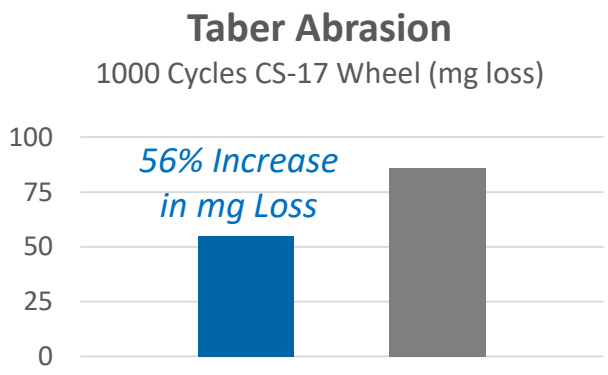
+	−
Wide variety of matting additives allow formulation flexibility for specific applications	Tend to negatively impact performance properties Soft settling of non-soluble particles leads to stability issues and shelf life constraints

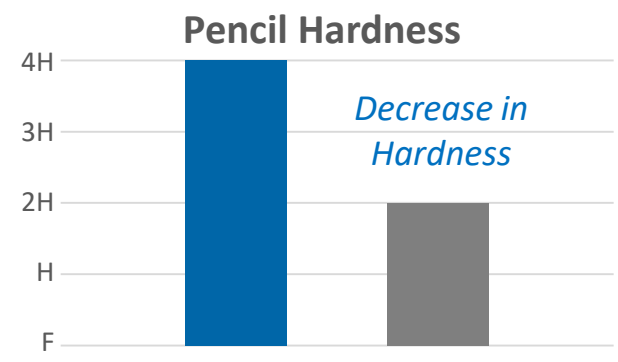
Traditional matting agents are efficient, but have a large opportunity for improvement

IMPACT OF MATTING ADDITIVES ON A TYPICAL RESIN









3 coats on Maple laminate panels
Formulated to ≤275g/L US VOC

PUD

PUD Matted w/Silica

Using matting additives to lower gloss has a significant NEGATIVE impact on both durability & appearance

SELF-MATTING POLYAMIDE POLYURETHANE APPLICATIONS AND PROPERTIES

Recommended Applications

- Wood interior applications requiring high performance in a matte finish
- Metal and general topcoat applications needing a flat look with great color saturation

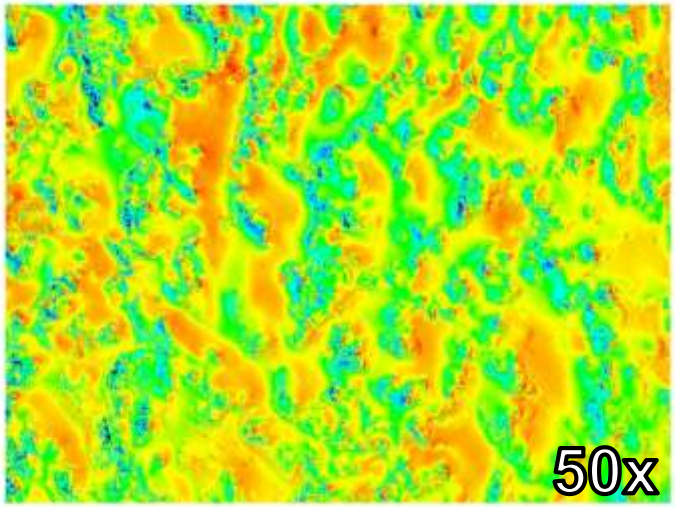
Polymer Physical Characteristics*

Appearance (wet)	Milky White Dispersion
Total Solids by Weight, %	35.0 ± 1.0
Total Solids by Volume, %	34.2 ± 1.0
Density, lbs. /gal (g/ml)	8.69 (1.04)
Brookfield Viscosity, cps	< 500
pH	7.5 – 8.5
Volatile Organic Compounds, wt. %	0.85 TEA
Freeze-Thaw Stability	Protect from freezing
NMP, NEP, and APEO-Free	
VOC - Can formulate to <275 g/L (USA) / 110 g/L EU VOC	

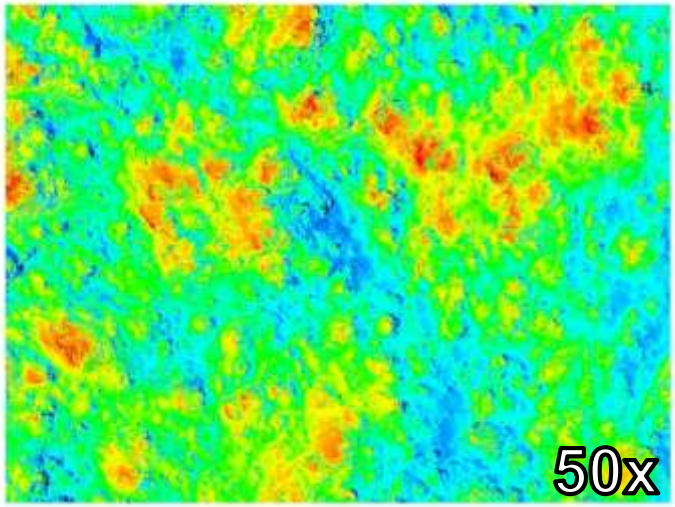
*Property values represent typical results only and are not to be considered specifications

NEW SELF-MATTING PUD

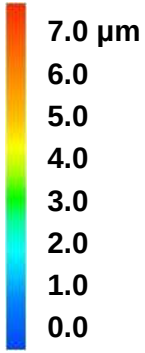
- As the self-matting coating dries, micro scale viscosity and surface tension abnormalities generate a matted surface
- This resin does NOT contain large particles commonly used to create self matting coatings, leading to improved stability
- This resin can reach a 60° gloss of 16 GU without the use of matting additives (gloss can be reduced further with a small amount of polymeric matting agent)



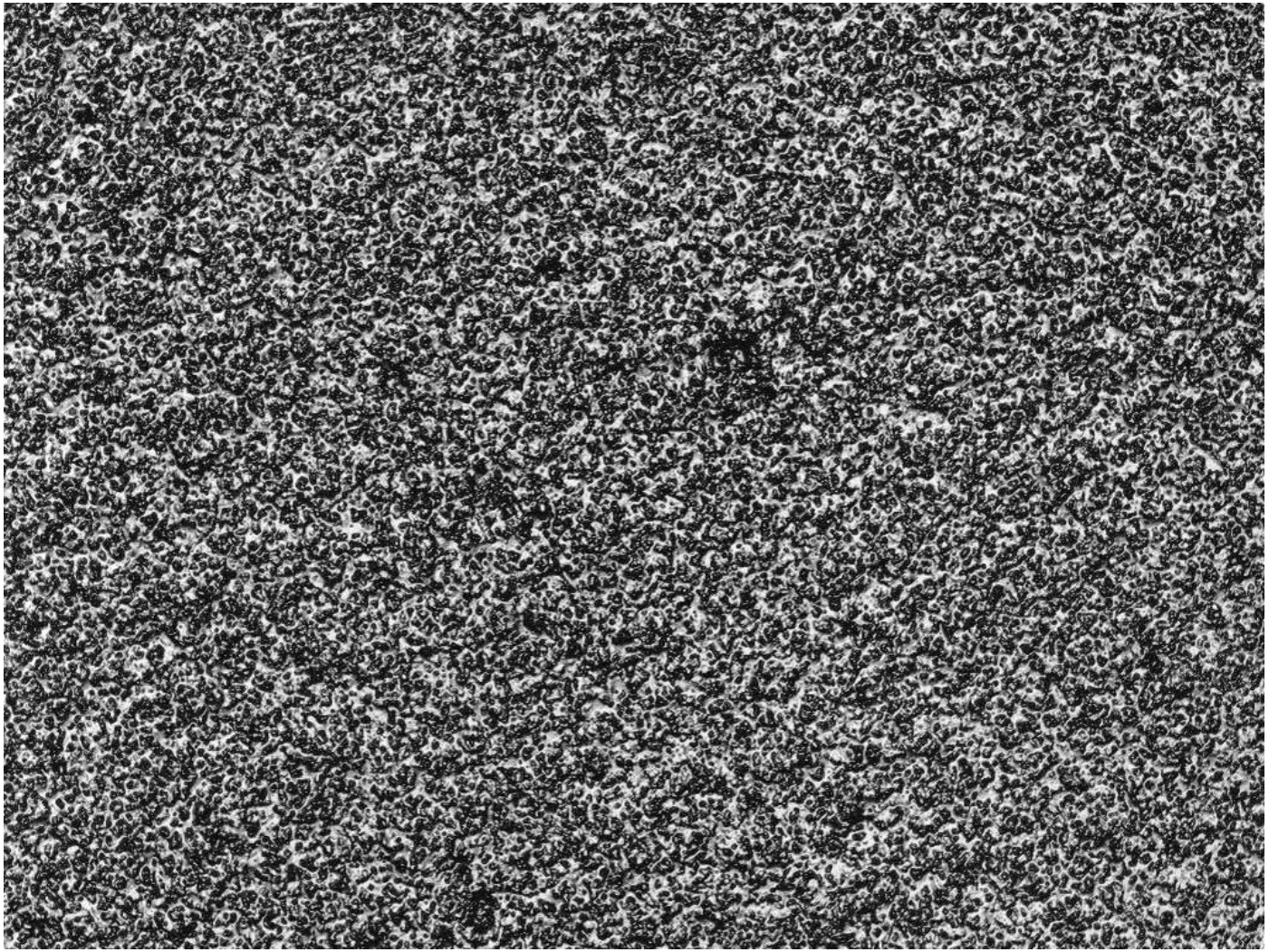
Self-Matting Polyamide PUD



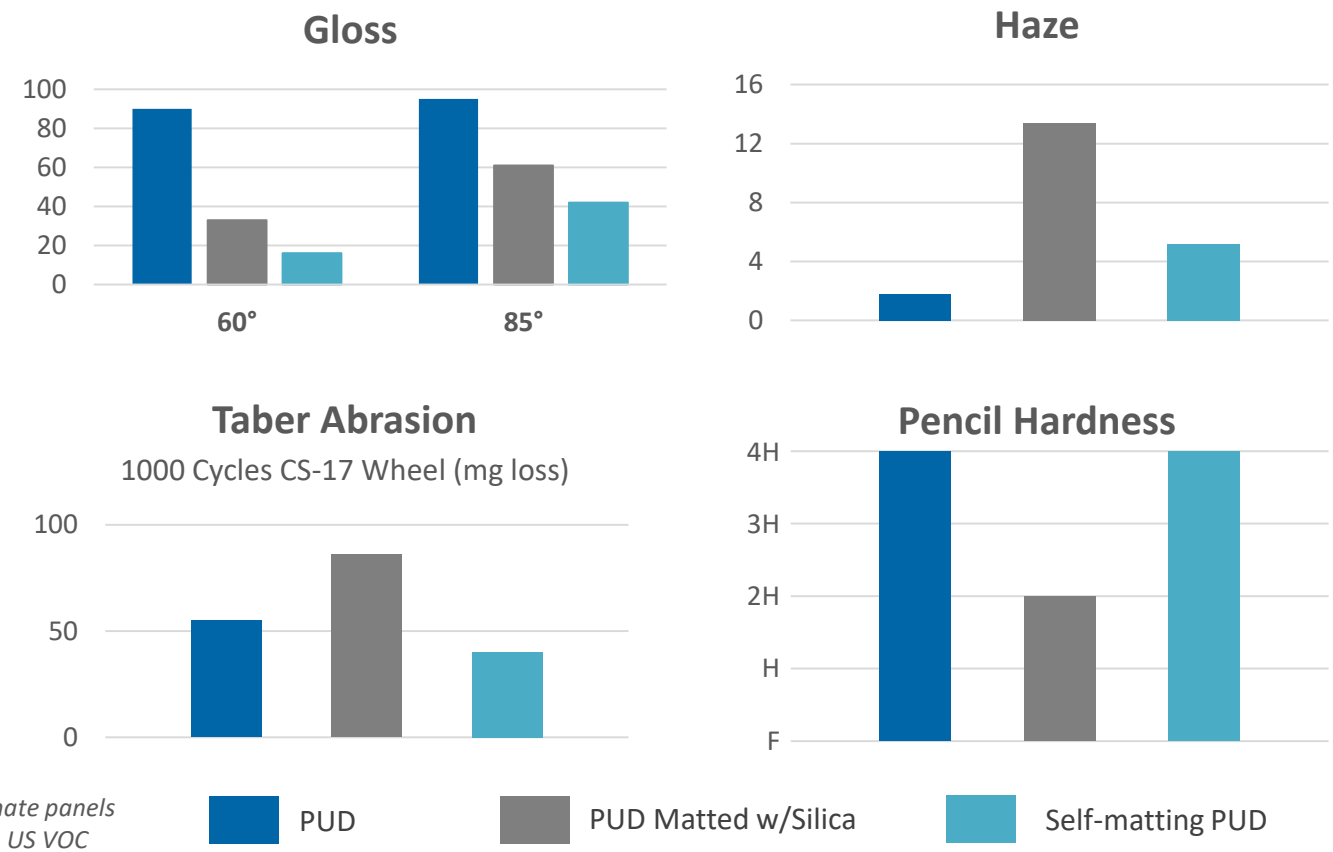
Matted Commercial Control



SELF-MATTING TIME LAPSE VIDEO
10X MAGNIFICATION



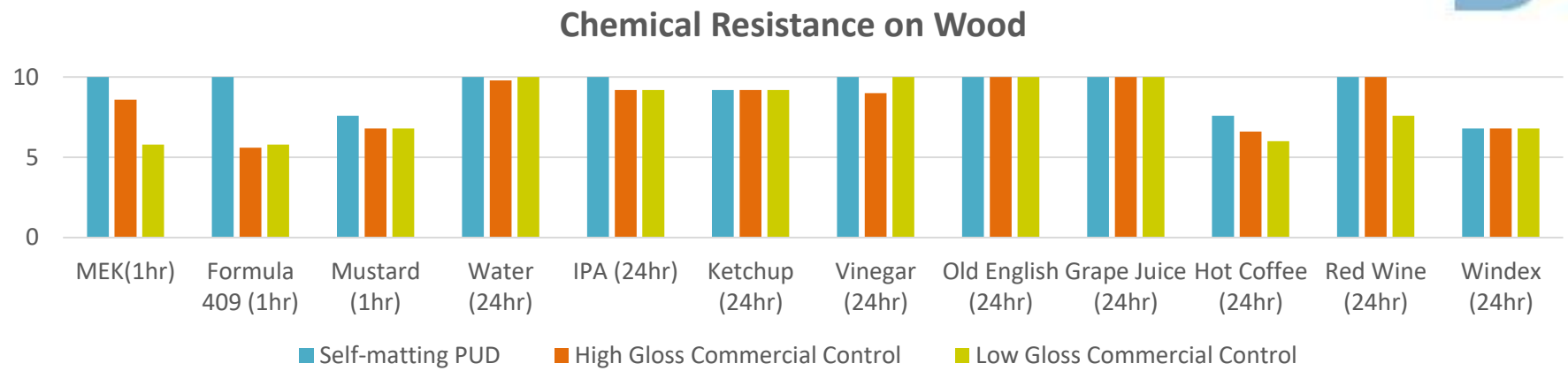
SELF-MATTING VS. TRADITIONALLY MATTED PUD RESIN

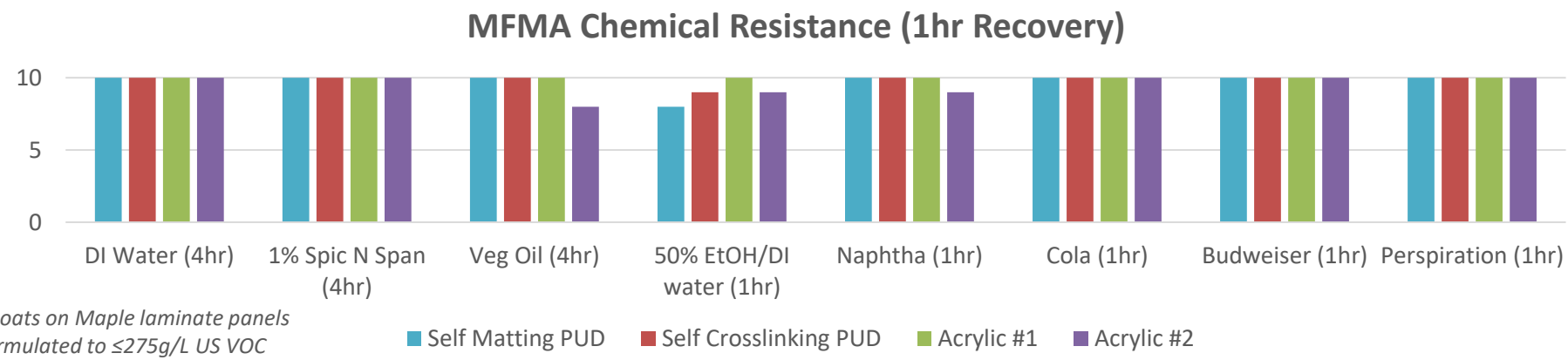


3 coats on Maple laminate panels
Formulated to ≤275g/L US VOC

Self-matting PUD reaches lower gloss than traditionally matted PUD without sacrificing either durability or appearance

SELF-MATTING PUD CHEMICAL RESISTANCE



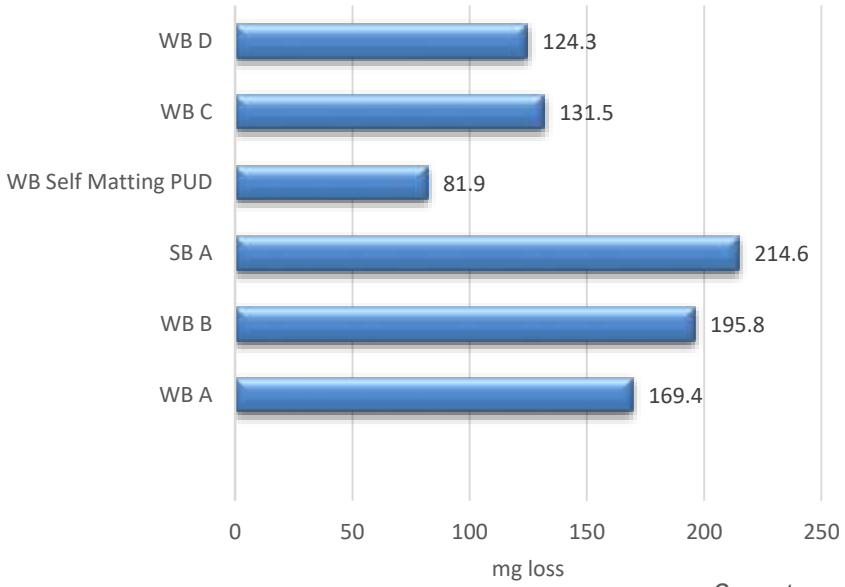


3 coats on Maple laminate panels
Formulated to ≤275g/L US VOC

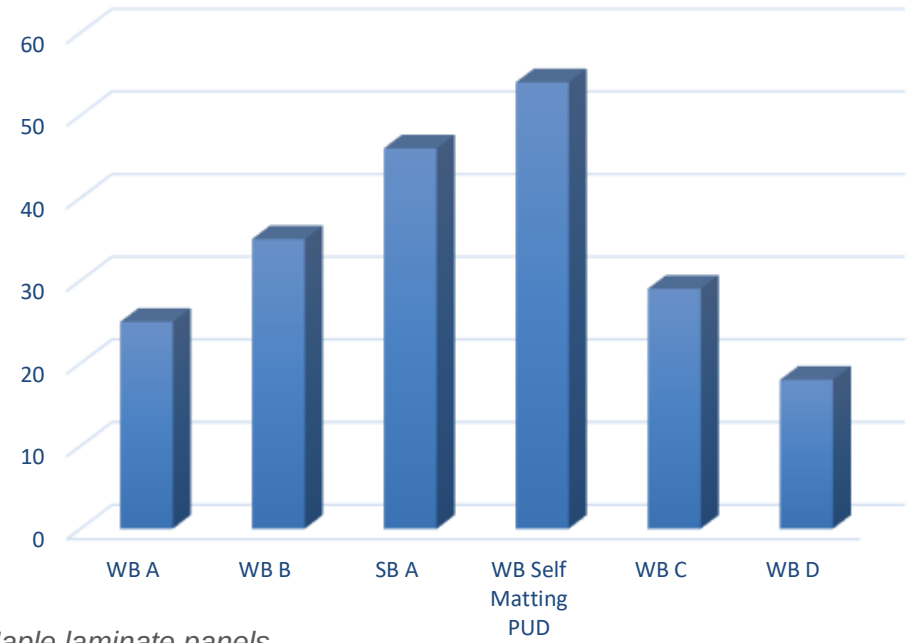
Self-matting PUD outperforms traditionally matted commercial products and performs on par with high gloss coatings

SELF-MATTING PUD TABER ABRASION AND HARDNESS

Taber Abrasion (CS-17 wheels 1000 cycles)



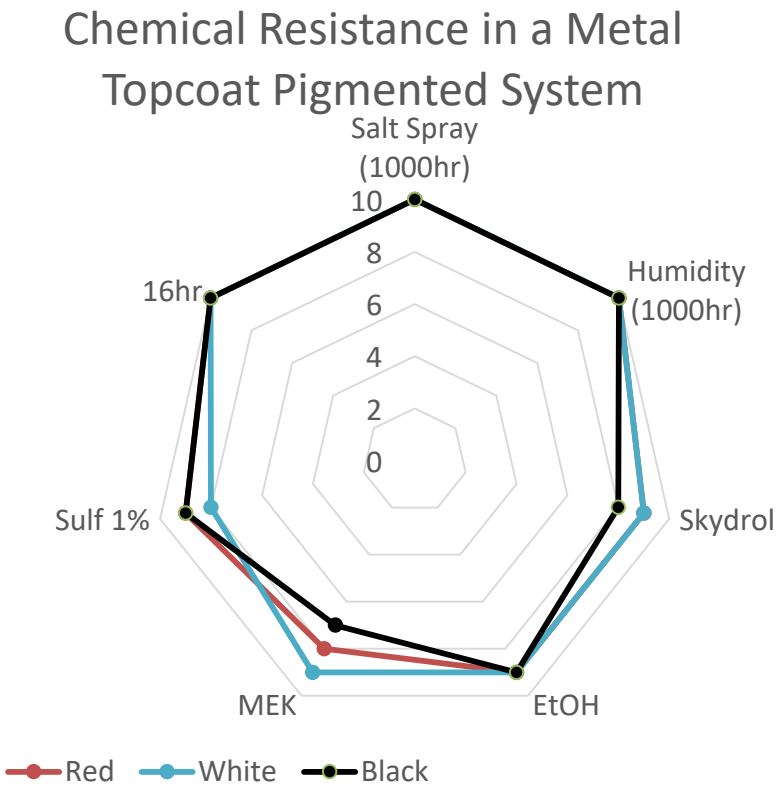
Konig Hardness – ASTM D4366

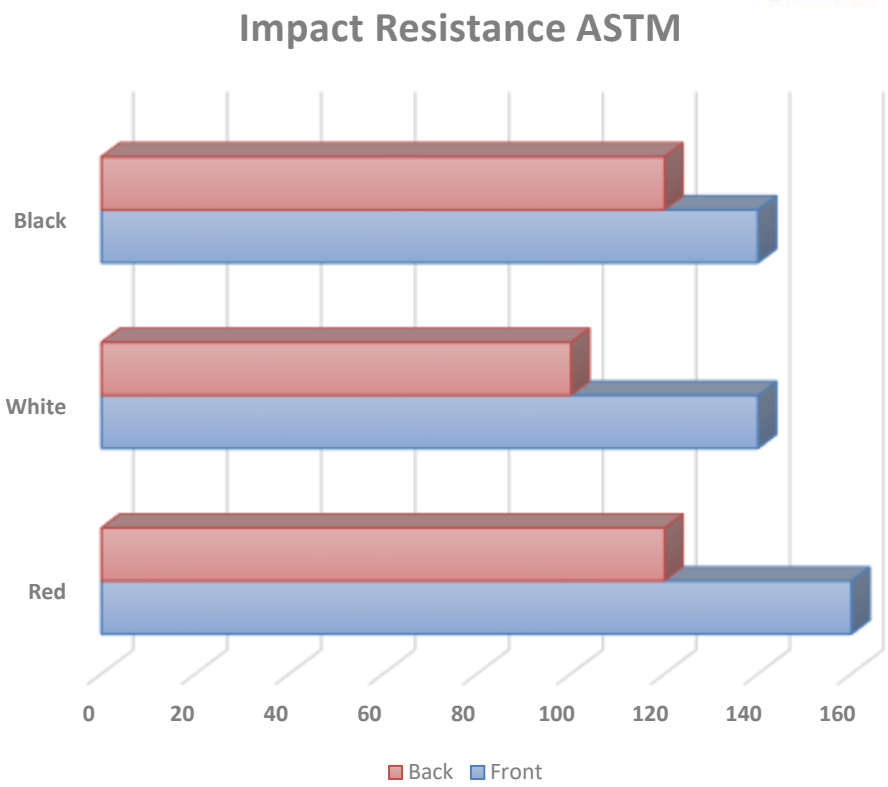


3 coats on Maple laminate panels
Formulated to ≤275g/L US VOC

Self-matting PUD performs significantly better for both hardness and abrasion resistance compared to SB and WB commercial products

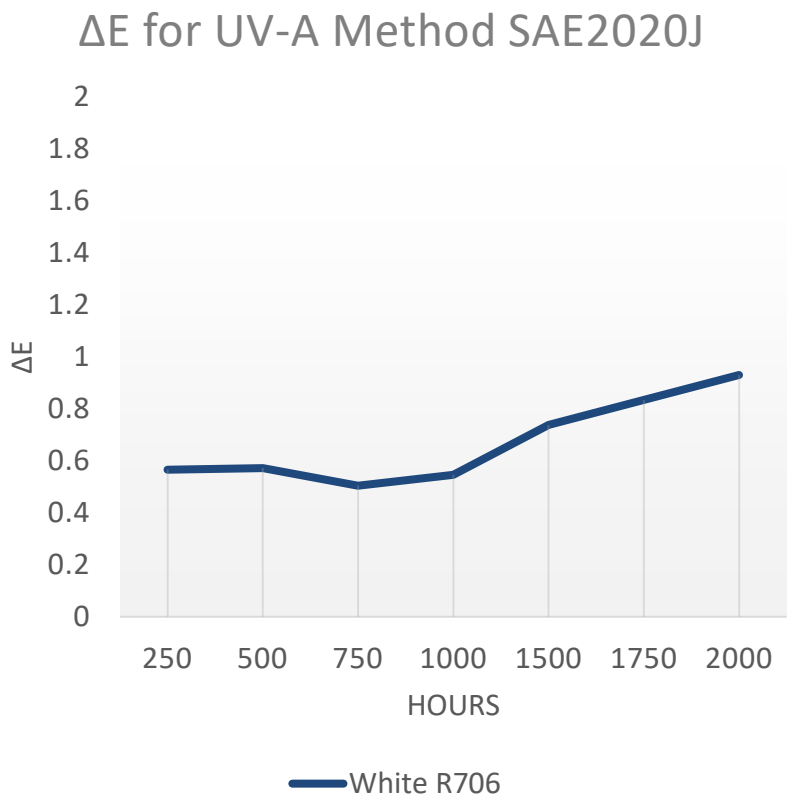
PIGMENTED SELF-MATTING PUD IN A PIGMENTED TOPCOAT

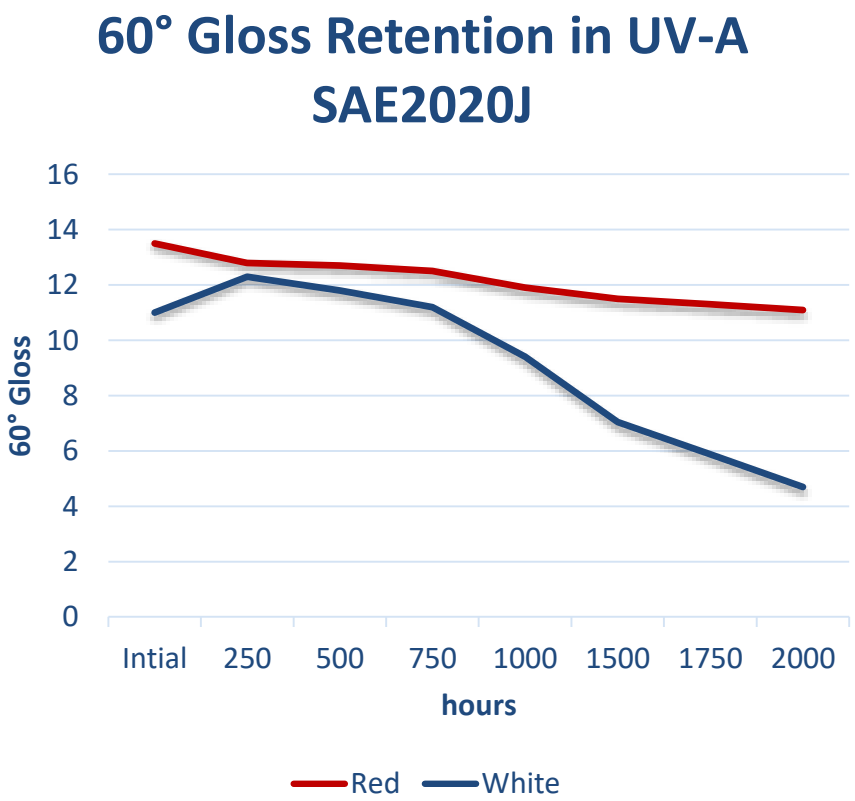




Pigmenting the self-matting PUD improves chemical and corrosion resistance and maintains color when exposed to UV

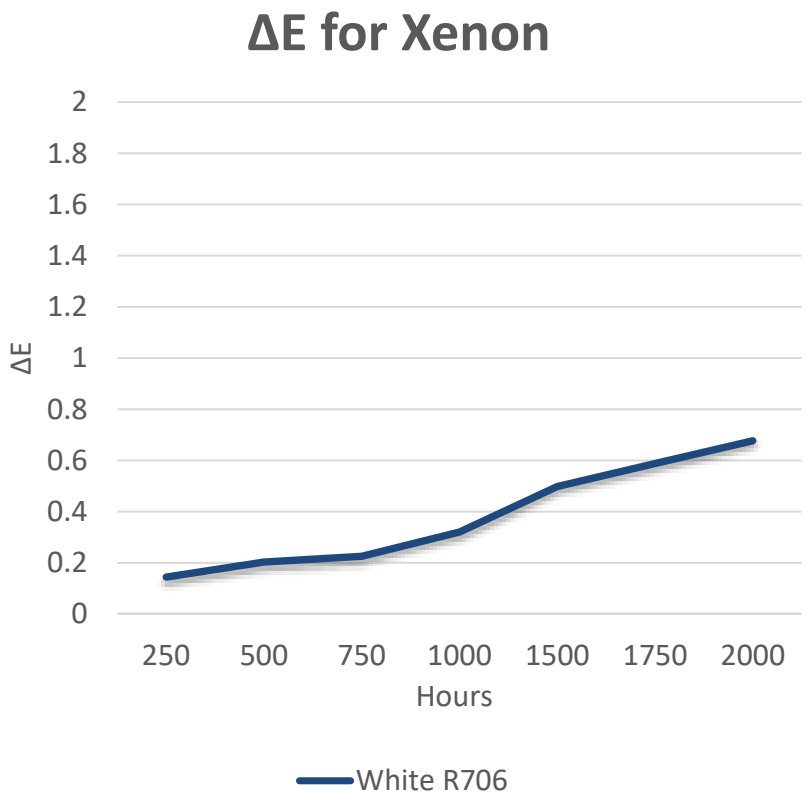
ACCELERATED WEATHERING (UV-A METHOD SAE2020J)

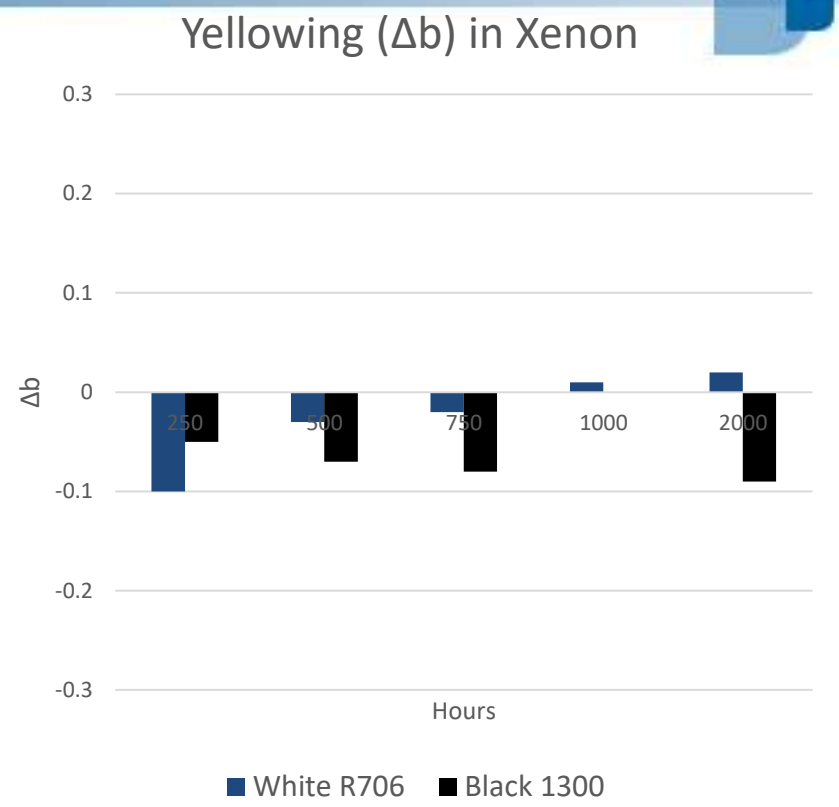




ΔE is under 1.0 after 2000 hours of exposure without the use of weathering agents

ACCELERATED WEATHERING (XENON ASTM D6695-03B CYCLE 6)





Δb is under 0.5 after 2000 hours of exposure without the use of weathering agents

COLOR SATURATION OF SELF-MATTING PUD AS A TOPCOAT

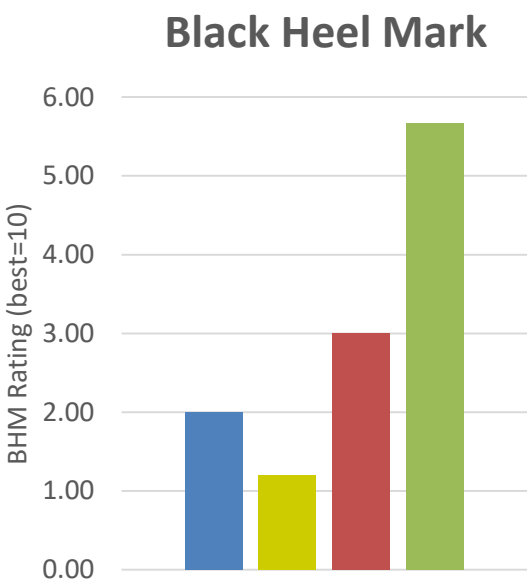
L*=26.01
a*=0.19
b*=-0.43

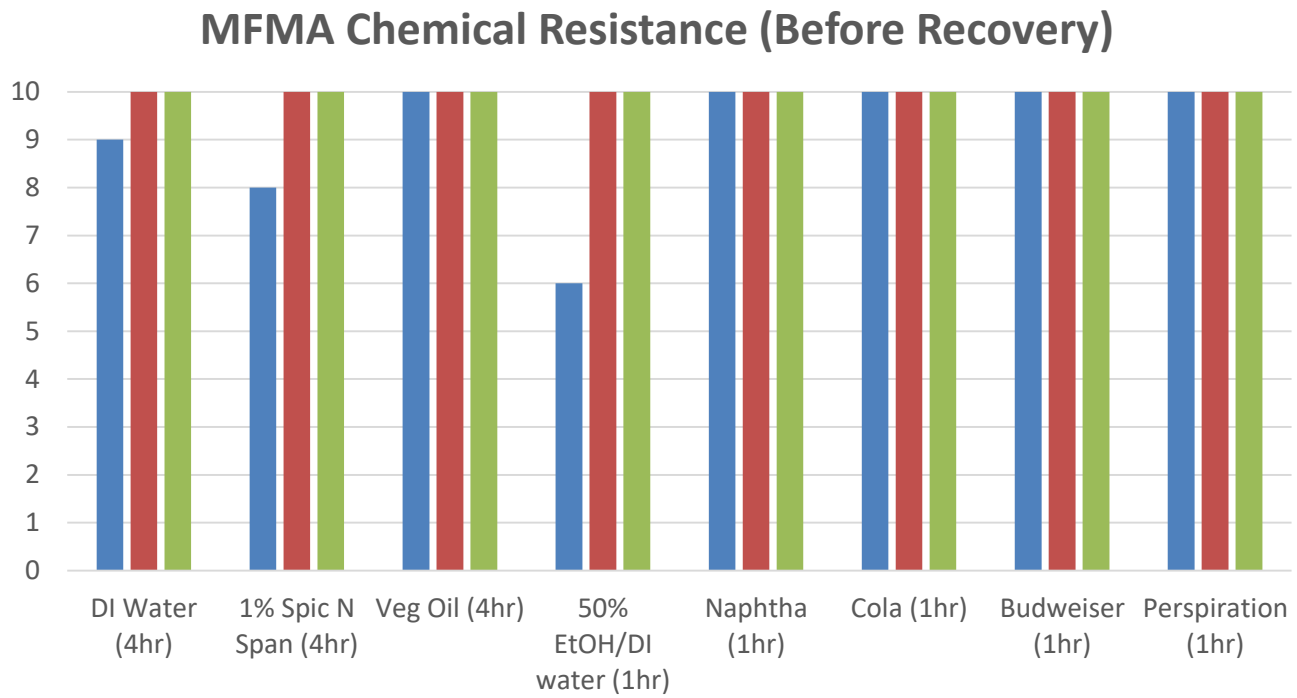
ΔE=0.56

L*=26.56
a*=0.22
b°=-0.36

Clear coat on top of black primer

SELF-MATTING PUD WITH EXTERNAL CROSSLINKER



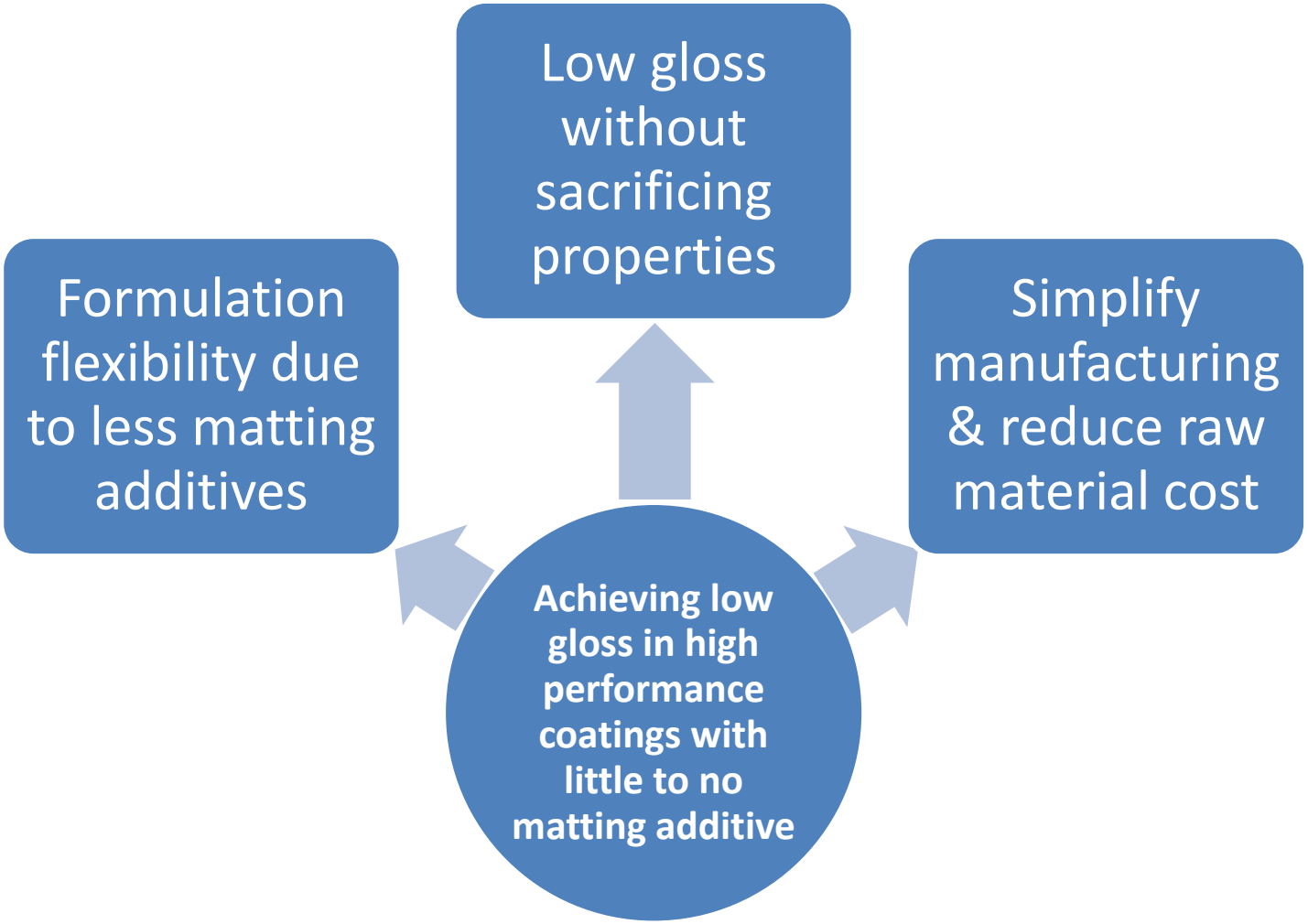


3 coats on Maple laminate panels
Formulated to ≤275g/L US VOC

Self-matting PUD | Low Gloss Commercial Control | Isocyanate Crosslinker | Aziridine Crosslinker

Addition of external crosslinker positively impacts black heel and barrier properties

FEATURES & BENEFITS



FEATURES & BENEFITS

Proven durability to protect high value end use

Forms a hard, tough film with exceptional abrasion resistance

Stain resistance maintains coating appearance in many environments

Superior Chemical Resistance

FEATURES & BENEFITS

Visual appeal of natural color & texture of wood

Topcoat preserves vibrant color for a more attractive finish

High clarity in a low gloss formulation

IN SUMMARY

Waterborne, self-crosslinking, self-matting polyurethane dispersion using patented polyamide polyol technology

- Naturally low gloss (16 GU @ 60°) with no matting additives*
- Exceptional hardness, abrasion, and chemical resistance
- Extremely clear film

*Gloss can be further reduced with small amounts of polymeric matting agent

This technology allows formulators to create coatings with beautiful matte finishes and superior durability and protection; while extending the service life

PERFORMANCE AND AESTHETICS?

If I only had one slide…..

NO need to sacrifice performance for matte aesthetics

ACKNOWLEDGEMENTS

Dechant, Amanda
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Erdodi, Gabor
Baron, Steve
Latas, Dan
Donati, Pete
Stanislawcyzk, Vic
Swech, Chris
Schneiders, Larry
Sterne, Nick
Wolfinger, Mark

THANK YOU

Questions?

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