PTFE-free Solutions for Scratch resistance & Fine texturing in Powder Coatings

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Agenda

- PFAS and PTFE
  - What‘s the concern?
  - Regulatory restrictions and impact
  - PTFE role in Coatings
- PTFE-free Alternatives
  - for scratch resistant Powder Coatings
  - for fine textured Powder Coatings

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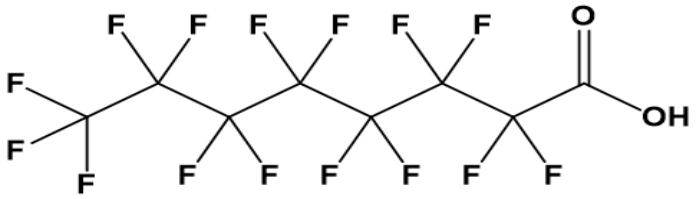
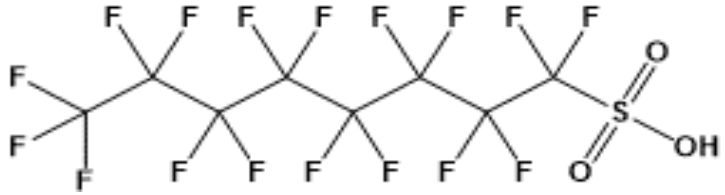
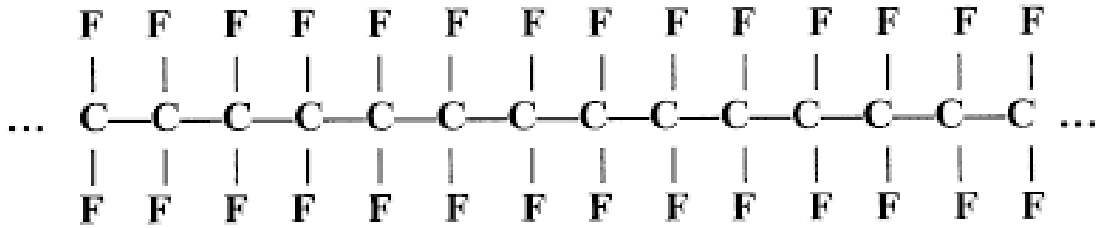
What are Per- & Polyfluoroalkyl Substances (PFAS)?

Broad term describing **10,000+ chemical substances** containing at least one perfluorinated Carbon atom (CF3- or –CF2-) [ECHA definition]





Perfluoroalkyl Substances – e.g., PFOA, PFOS



Fluoropolymers (Carbon only backbone) – e.g., PTFE

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What's the concern?

Combination of

Inability to break down

→ long term pollution of environment („forever chemicals“)

and

Health risks

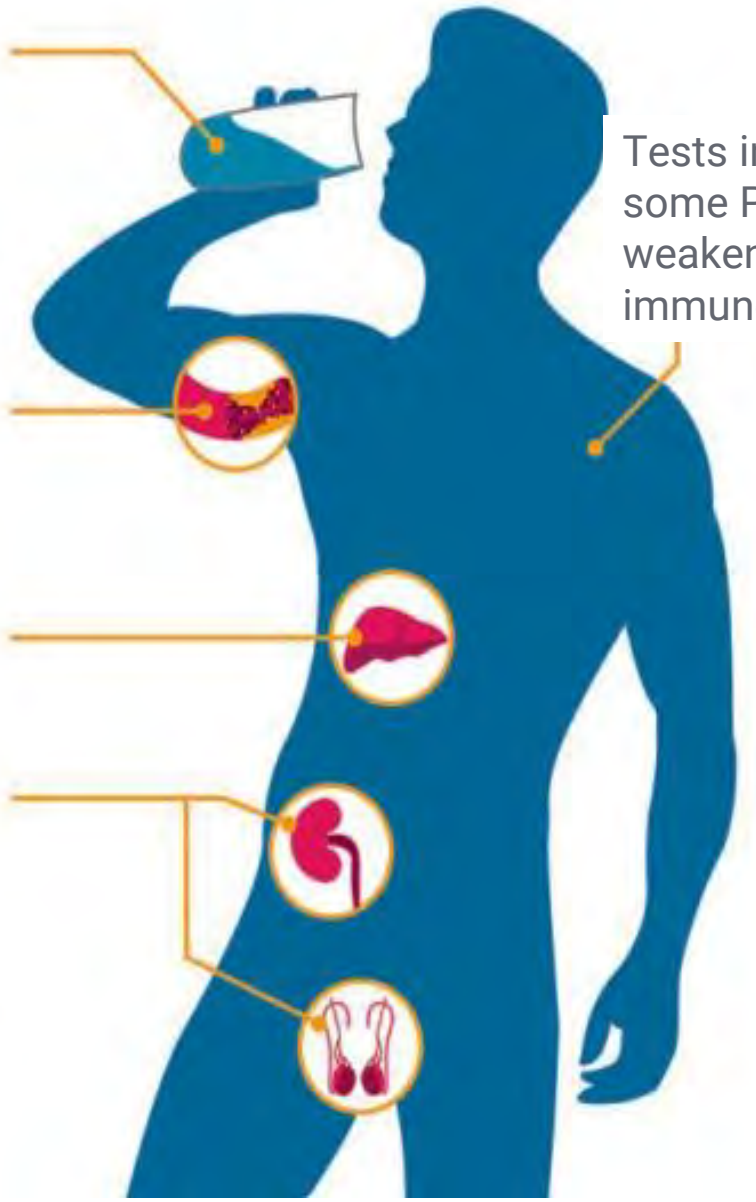
→ suspected to be carcinogen, reprotoxin and to cause other diseases

Studies have shown that PFAS have contaminated rainwater, drinking water and ground water.

PFAS can also be found in most people's blood and is linked to elevated cholesterol levels.

Some PFAS can damage the liver.

Studies show that some PFAS contribute to the development of kidney and testicular cancer.



Tests indicate some PFAS weaken the immune system.

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Differentiation within “PFAS”

- **Variation in molecular size and chemical composition leading to differences in stability, mobility and toxicity**
- **Hence, different HSE impact**
  - Non-polymeric (small molecule) PFAS’s → Substances of Very High Concern (SVHC)
  - Polymeric PFAS’s (Fluoropolymers like PTFE) → Typically safe
    - Fluoropolymers meet OECD Polymer of Low Concern (PLC) criteria:
      - Non-toxic, Non-bio accumulative, Non-mobile, Insoluble in water
      - Thermally, chemically & biologically stable

      → Not a SVHC

      → Long-lasting history of safe use in many industrial applications

→ **Explaining sequence of regulatory actions on PFAS substances**

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PFAS – PFOA – PTFE – simplified EU regulatory History

- **REACH restriction** (Annex XVII, July 5th, 2022) **<25ppb** on **PFOA** (Perfluoro Octanoic Acid) and **PFOS** (Perfluoro Octanoic Sulfonate), being the main surfactants used in the polymerization process of PTFE
- **Extension of this REACH restriction to C6 and C9-14 PFCA's** (Perfluoro Carboxylic Acids) due to "regrettable solution" by PTFE industry, using these, chemically similar, substances as replacement for the restricted PFAS's
- Both EU REACH restrictions have been adapted by the **Stockholm Convention** adding these substances to their list of **"POP's" (persistent organic pollutants)** making this nearly a **global standard (ratified by ~180 countries).**
- Upcoming **EU PFAS restriction** will address **all PFAS's incl. Fluoropolymers like PTFE** because of the continued involvement of low MW PFAS's in PTFE polymerization and post-treatment (irradiation, "washing")
- **Various other regulations being implemented and prepared outside the EU**

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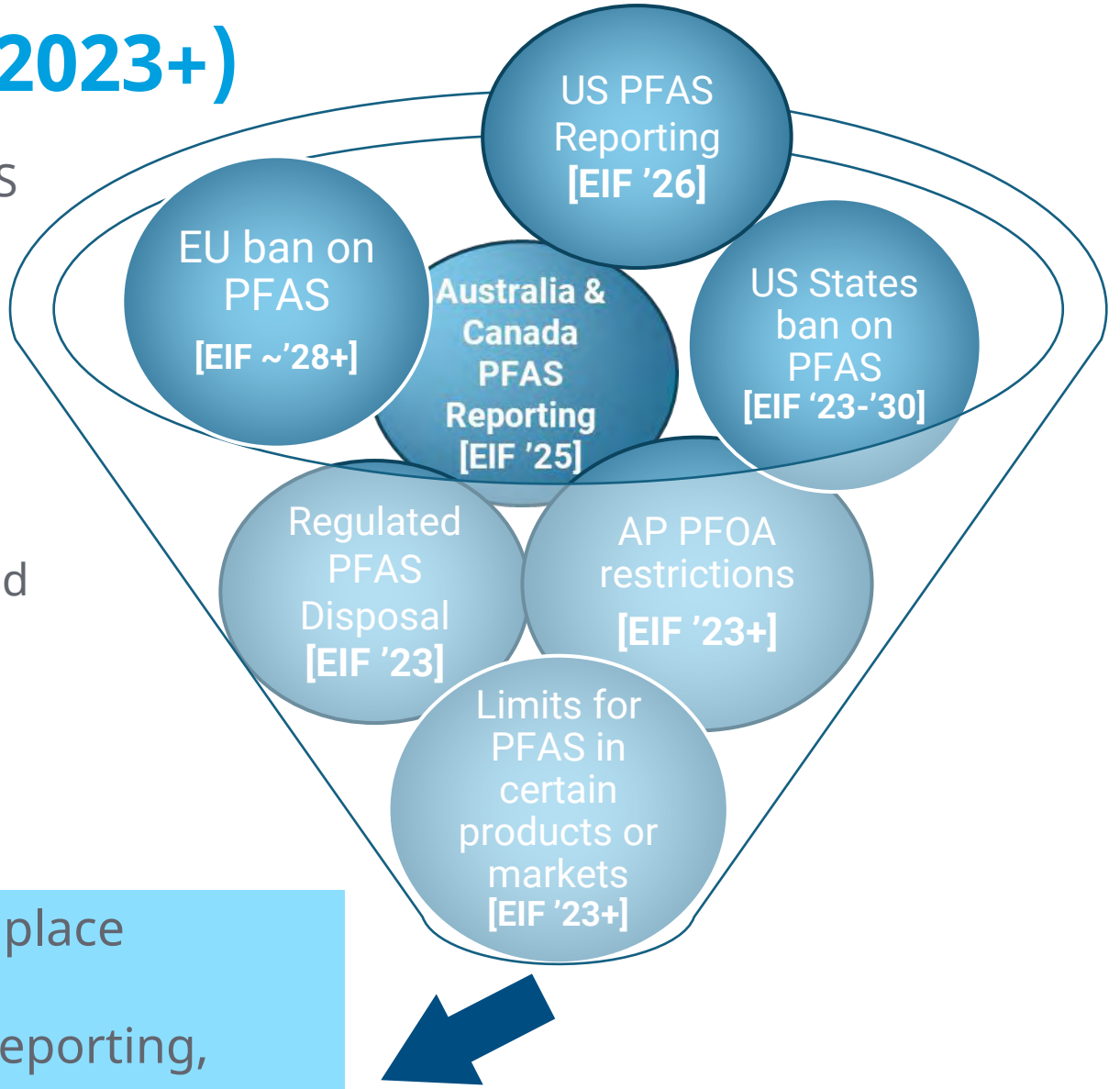
PFAS Regulatory Landscape (2023+)

- Global actions in force today addressing specific PFAS chemicals (e.g., low MW PFAS – PFOA, PFOS, PFHxA (C6 PFCA), C9-C14 PFCA's)
- Global efforts to regulate entire PFAS group ongoing
  - Most strict in EU: comprises chemistry with "at least one CF2 or CF3 moiety" (incl. fluoropolymers like PTFE)
  - Deviations in scope are emerging (e.g., UK seeks to separate fluoropolymers from other concerning PFAS)
- Across U.S. states legislative uncertainty exists around scope, definition or practicalities of enforcement.

- *Latest News: ECHA's updated PFAS Restriction Proposal (08/25) does NOT list any derogated uses for fluoropolymers in major coatings and inks markets!*



- Legally forced transition to „PFAS-Free" taking place
- EU will have to become PFAS and PTFE-Free
- + Voluntary global transition expected due to reporting, testing, managing burdens and end-user request

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Impact on Coatings & Inks Market

- Transfer to PFOA/PFCA-compliant PTFE's
  - Completed in EU countries
  - In different stages for countries outside of EU
- PTFE users in EU have achieved compliance by use of
  - PTFE grades with no detectable PFCA (<10 ppb), made by:
    - MW reduction by specific thermal degradation process (instead of irradiation)
    - Purposeful polymerization to low MW
  - PTFE grades with detectable PFCA levels (<25ppb) coming from post-treatment ("washing")
- EU Coatings & Inks Market preparing for the PTFE ban in 2028+
  - Replacing PTFE completely
  - Some segments more advanced than others

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PTFE use and how to replace it in Powder Coatings

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PTFE in Powder Coatings

Scratch Resistance & Slip

Fine Surface Texture

Scratch Resistance
&
Slip

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Test Formulations

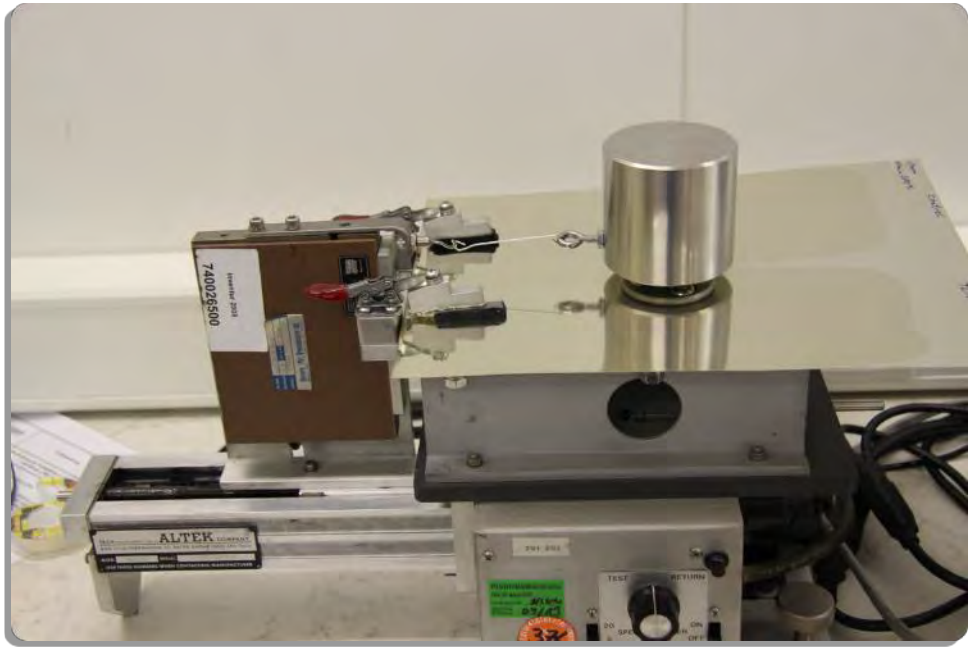
Black Polyester/HAA	
Raw Material	
Uralac P 865	617,5
Primid XL-552	32,5
Blanc Fixe F	339,0
Special Black 6	8,0
Benzoin	3,0
	1000,0
0,2% Alu C postadded	

White Polyester/HAA	
Raw Material	
Uralac P 865	617,5
Primid XL-552	32,5
Kronos 2310	300,0
Blanc Fixe	47,0
Benzoin	3,0
	1000,0

Black 70:30 Hybrid			
Raw Materials	1	2	3
Uralac P 2681	461	420	420
Eposir 7175 PG	197	180	180
Blanc Fixe F	325	-	-
Omyacarb 5 SV	-	388	-
Omyacarb 2 SV	-	-	388
Special Black 6	8	8	8
Benzoin	4	4	4
Lanco™ Flow P 10	5	-	-
	1000	1000	1000
0,2% Aeroxide Alu C post added			

Coefficient of friction (COF) / Slip

- Describes the smoothness of a coating surface and is important for the in-line processing. The COF can be determined by using an ALTEK lubricity tester.
- Test method according to ***ASTM D1894.***



Most Lanco™ and PowderAdd™ wax types lead to a reduction of the COF.

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Brush Test

The brush is moved across the coating surface and the scratch formation is evaluated visually

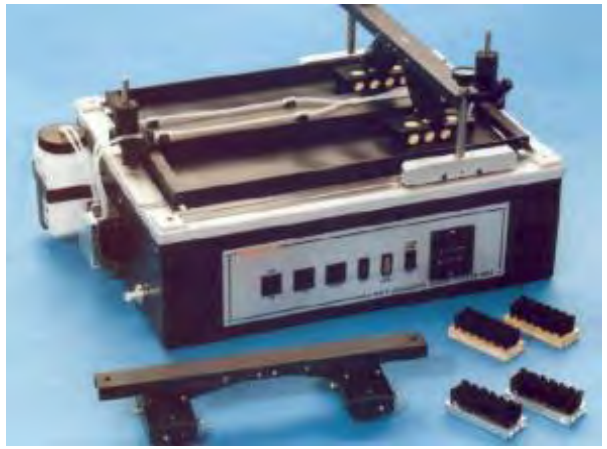
Parameters:

Number of scratch-moves, type of brush:

- ASTM 2486 brush (softer)
- DIN 53778 brush (harsher)

Measurements: visual evaluation

0 – 10 vs. control without wax; 0 = no scratches, 10 = perfect



Brush tester

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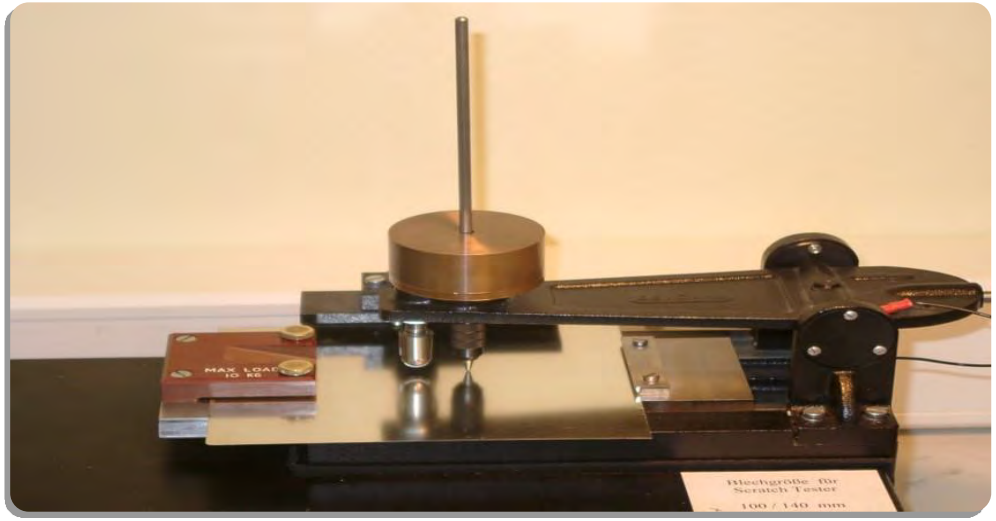
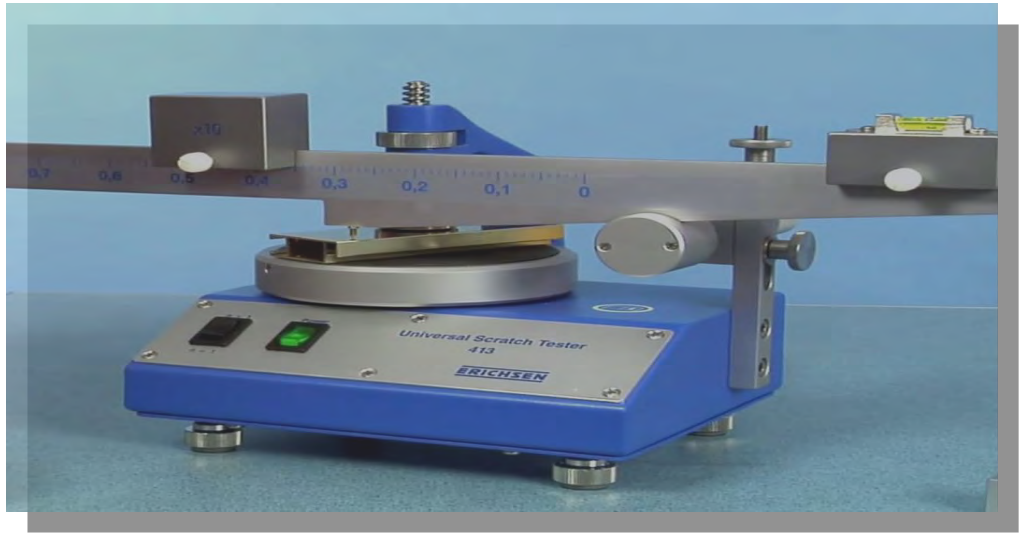
Scratch resistance – Sheen (“Needle”) & Erichsen

Describes the resistance of a coating versus mechanical stress. The scratch resistance can be evaluated using for example: Sheen scratch tester and Erichsen test 413



Sheen scratch resistance
ASTM D5178, D2197 – Mar resistance of organic coatings.



Erichsen test 413
Test tip acc. To Bosch (0.75 mm)

Martindale Abrasion Test

Test method according to

DIN EN 16611:2023 – Furniture

DIN EN 16094:2021 – Laminate floor coverings

QUALICOAT Specifications 2021 – Powder coatings

Assessment of the surface resistance to microscratching.

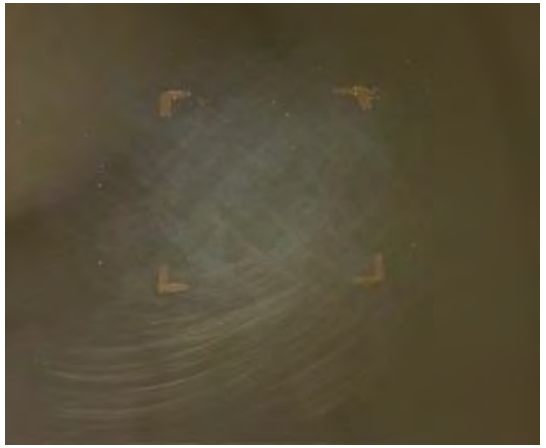
The test surface is exposed to a scrub material for a predetermined number of rubs carried out with a defined movement pattern (1Lissajous figure= 16 rubs).

Scrub material: Scotch Brite Fleece 7448 is usual.

Test conditions: 1.5 - 6 N force, 16 - 80 rubs

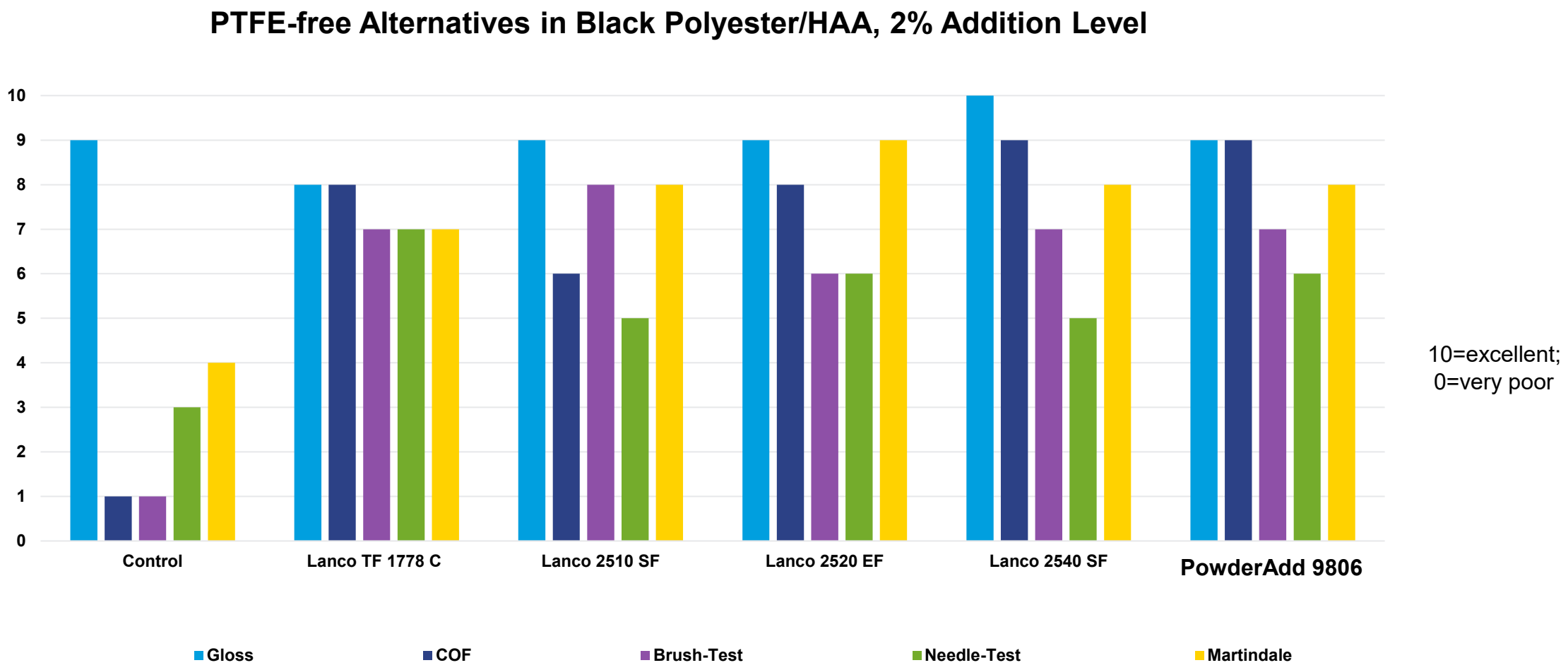
Measurements: Changes of the surface are determined by gloss measurement or visual assessment.

Martindale abrasion tester



Test panel after test
(WB Acrylic Coating
TL-06-19 without wax)

Performance Data – Polyester/HAA Powder Coating



10=excellent;
0=very poor

PTFE-Free Scratch Resistance & Slip in Powder Coatings

PowderAdd 9806

- Excellent performance compared to PTFE based and other PTFE-free additives designed for liquid coatings (e.g., Lanco 25xx series)
- Very robust performance across different resin chemistries and pigmentation
- Variant under development with improved surface adhesion (vs. PTFE) for adhesion of silicone sealants, labels and better recoatability

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Fine Texture

PTFE-Free Fine Texture in Powder Coatings

…is a much bigger CHALLENGE!

- Compared to PTFE based additives significantly higher dosages are needed
- Aspect and Matting performance vary between different resin chemistries and pigmentation
- PTFE more robust and forgiving vs. parameters in formulation and application process
- Much more formulation work needed for PTFE-free transition

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Performance of Fine Texturing Additives

- Various addition levels in different formulations & different colors tested
  - Polyester/HAA black/white (2 – 6%)
  - Epoxy/Polyester black/white (2 – 6%)

- Evaluation
  - Visual aspect (structure formation)
  - Matting efficiency
  - ΔE in white formulas
  - Mechanical impact resistance

- Results
  - Uniform matt, fine textures with some aspect variation
  - Performance leaps made it challenging to find the right dosage level
  - PowderAdd 9782 best for color stability (overbaking)
  - Mechanical impact test passed with all additives

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Test Formula Polyester/HAA – PTFE-Free Fine Texture

Black		
Parts by Weight	**Raw Material**	**Supplier**
617.5	Uralac® P 865	Covestro
32.5	Primid® XL-552	EMS
339.0	Blanc Fixe™ F	Sachtleben
8.0	Special Black 6	Orion
3.0	Benzoin	Various
1000.0		

White		
Parts by Weight	**Raw Material**	**Supplier**
617.5	Uralac® P 865	Covestro
32.5	Primid® XL-552	EMS
300.0	Kronos™ 2310	Kronos
47.0	Blanc Fixe™ F	Sachtleben
3.0	Benzoin	Various
1000.0		

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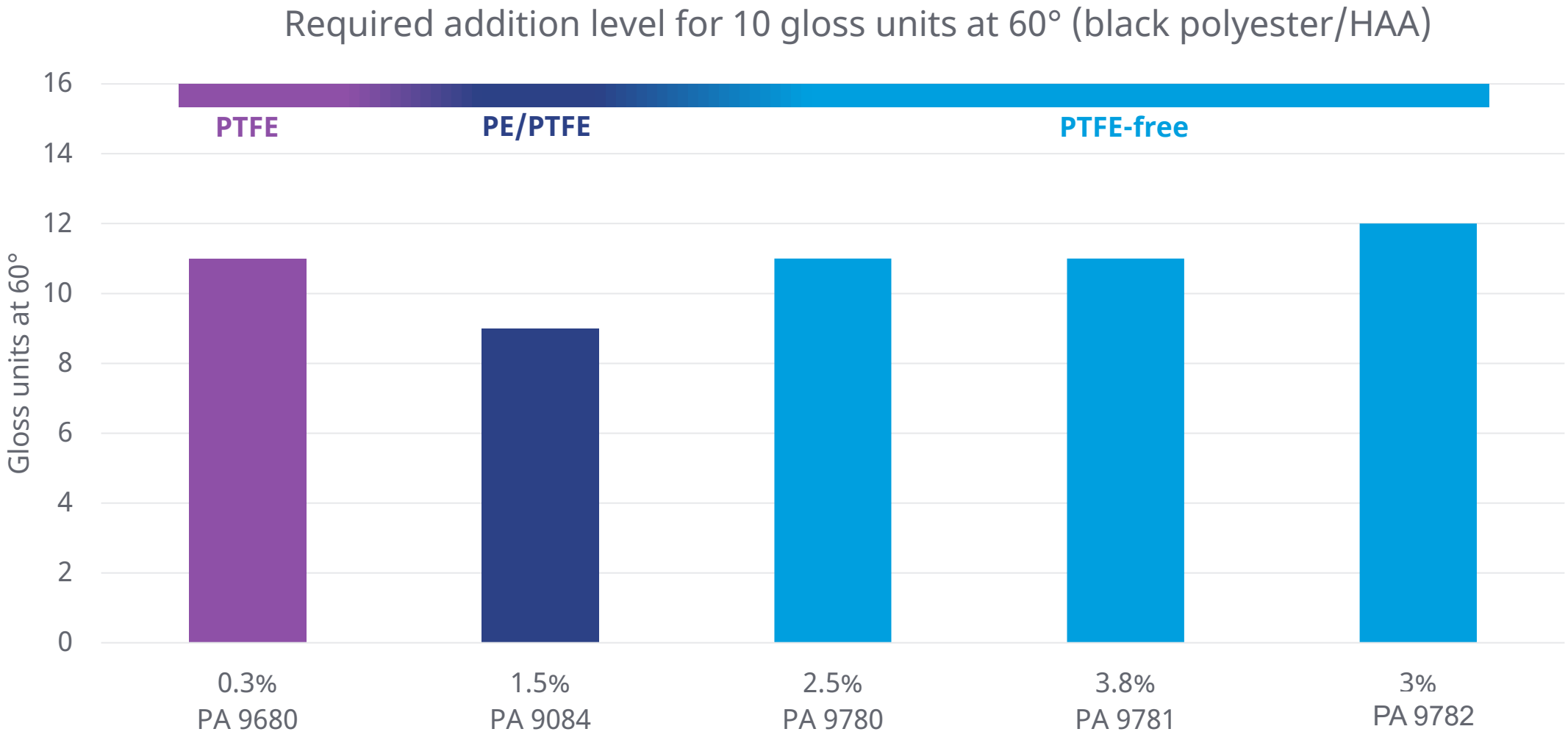
PTFE-Free Additives for Fine Texturing



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Fine Texture Appearance in Black Polyester/HAA

0.5% PowderAdd™ 9680
60° Gloss: 6 GU
PTFE-containing

3% PowderAdd™ 9780
60° Gloss: 6 GU
PTFE-Free

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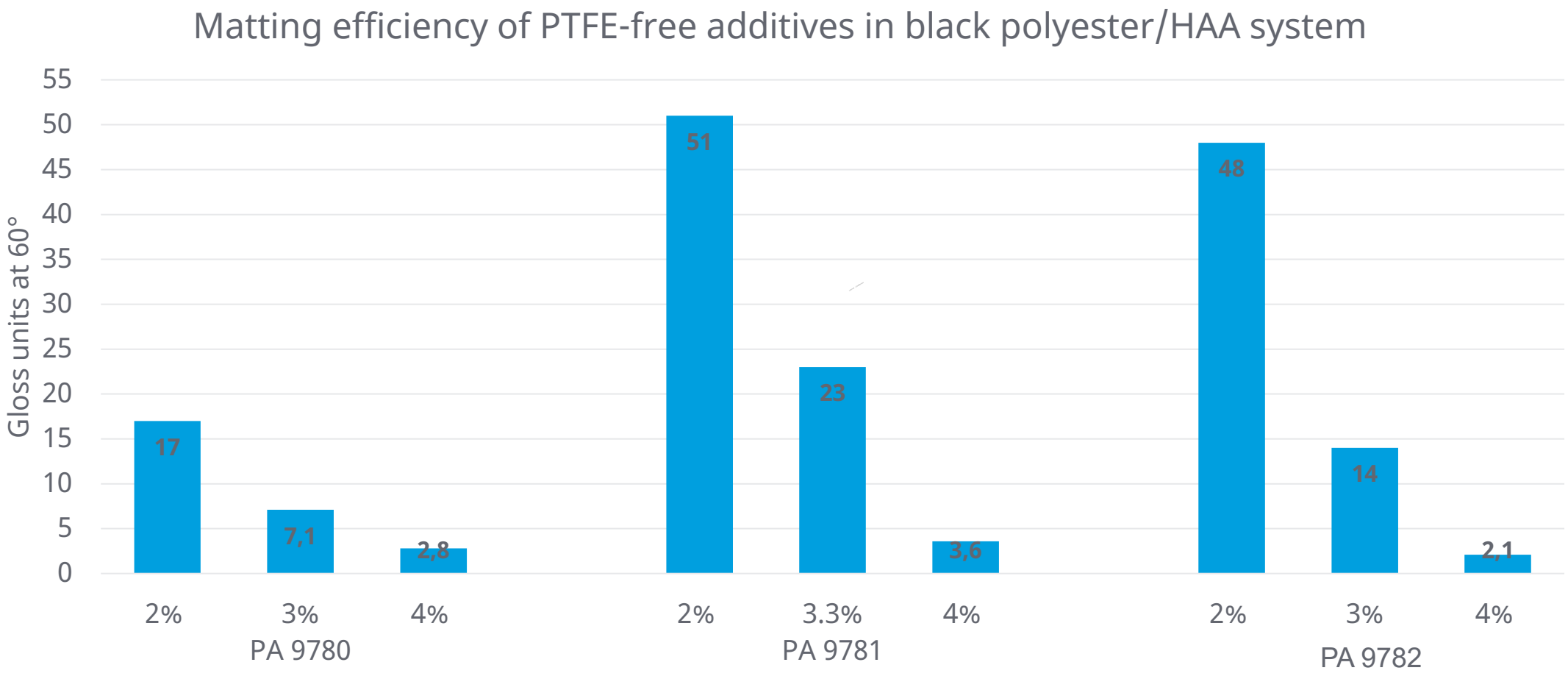
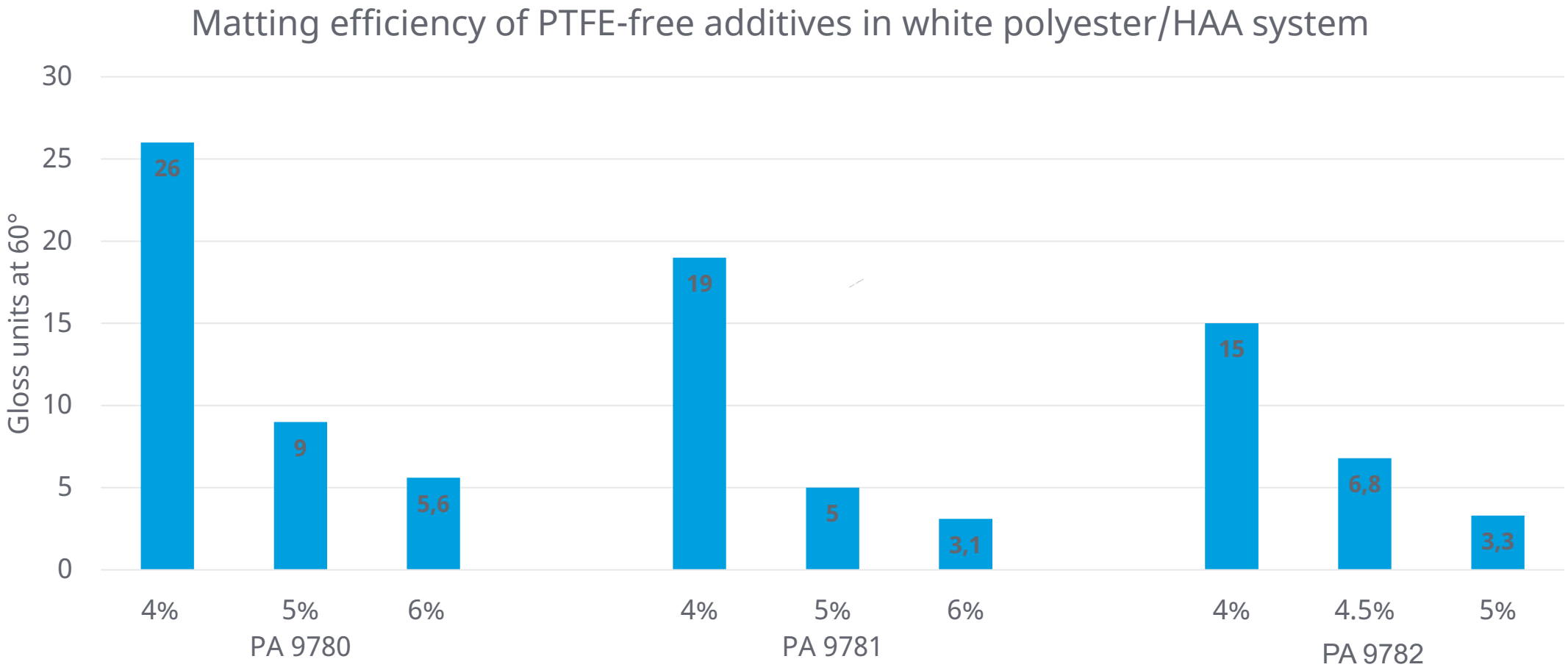
PTFE-Free Additives for Fine Texturing



PTFE-Free Additives for Fine Texturing



Test Formula Epoxy/Polyester – PTFE-Free Fine Texture

Black		
Parts by Weight	**Raw Material**	**Supplier**
420	Uralac® P 2681	Covestro
180	Araldite® GT 7004	Huntsman
388	Omyacoat® 850 OG	Omya
8	Special Black 6	Orion
4	Benzoin	Various
1000		

White		
Parts by Weight	**Raw Material**	**Supplier**
490	Uralac® P 2681	Covestro
210	Araldite® GT 7004	Huntsman
297	Kronos™ 2310	Kronos
3	Benzoin	Various
1000		

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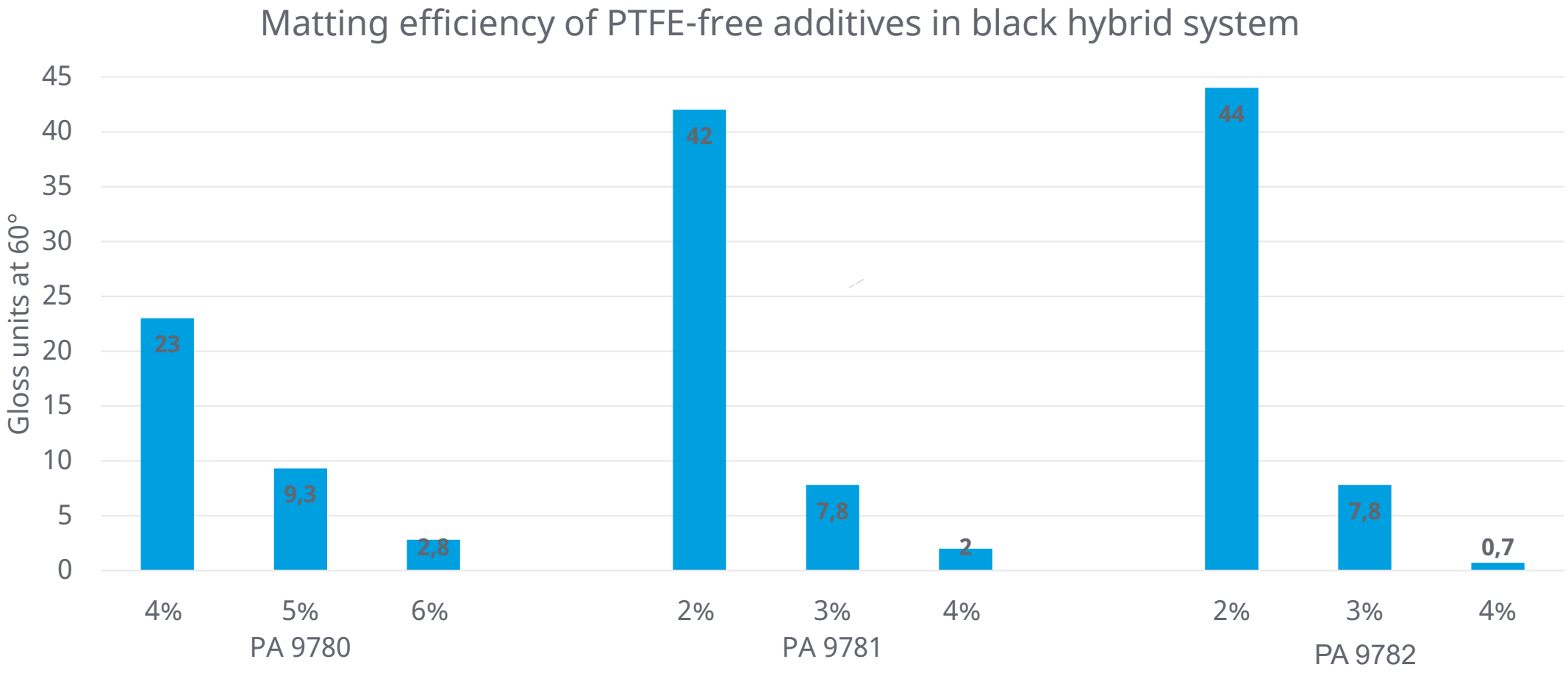
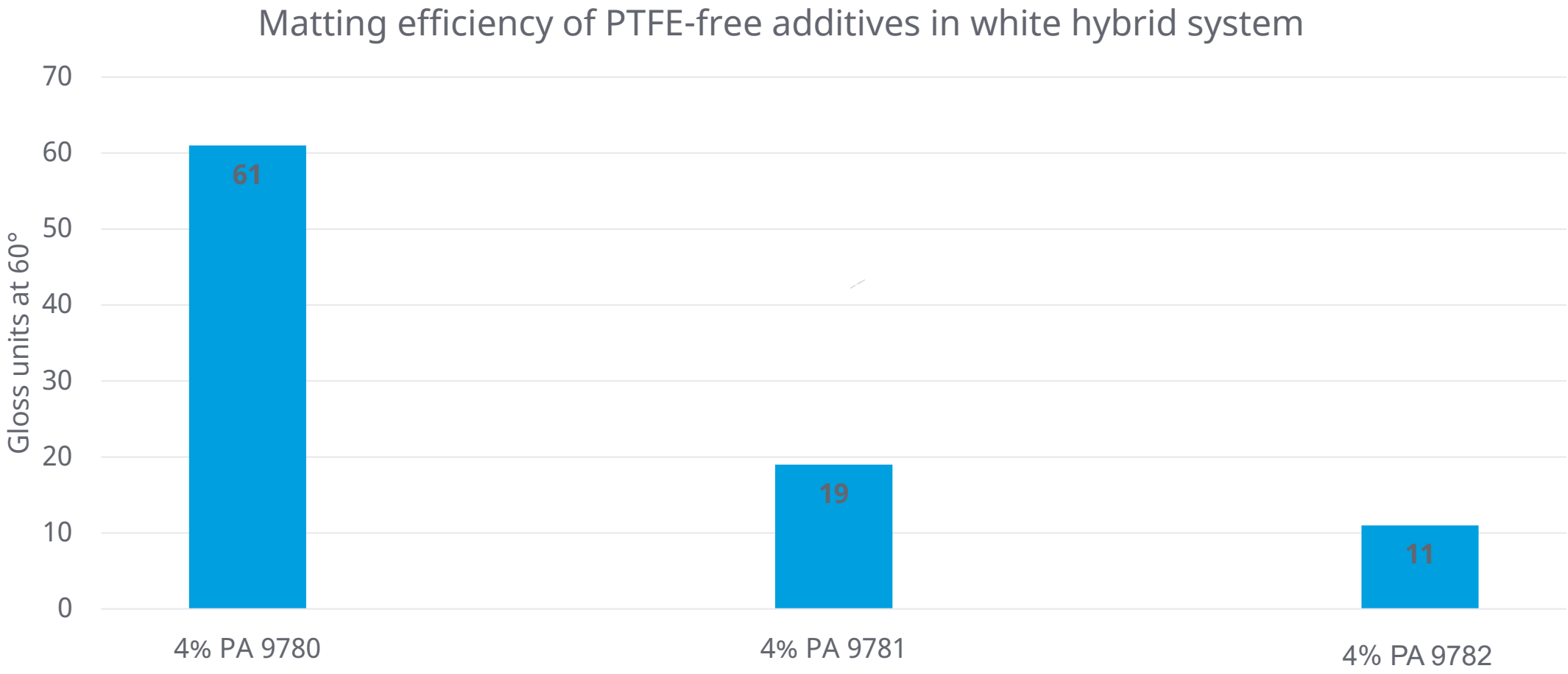
PTFE-Free Additives for Fine Texturing



PTFE-Free Additives for Fine Texturing



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PTFE-Free Additives for Fine Texturing

	PowderAdd™ 9780	PowderAdd™ 9781	PowderAdd™ 9782
Appearance	Off-white powder	Off-white powder	Off-white powder
Particle Size Dv50 [µm]	≤ 15	≤ 30	≤ 20
Density [g/cm³]	1.3	1.6	1.6
Use Level in Polyester/HAA* [%]	2 – 4 (black) 6 – 7 (white)	4 – 5 (black) 5 – 6 (white)	3 – 4 (black) 5 – 6 (white)
Use Level in Epoxy/Polyester* [%]	4 - 6	3 – 4	3 – 4

* to obtain deep matt surface (<5-10 gloss units at 60°)

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Summary – PTFE-Free Additives for Fine Texture

	Black Polyester/HAA	White Polyester/HAA	Black Epoxy/Polyester	White Epoxy/Polyester
PowderAdd™ 9780	+++	+	+	o
PowderAdd™ 9781	+	++	+++	++
PowderAdd™ 9782	++	+++	+++	+++

- Best overall efficiency with PowderAdd 9782
- Enhanced slip, scratch & metal marking resistance with PowderAdd 9780
- Best color stability with PowderAdd 9782

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Summary – PTFE-Free Additives for Fine Texture

- New range of PTFE-Free texturing additives works
- Providing very similar surface textures
- Requiring higher addition levels vs. PTFE → 3 – 6% vs. of 0.5 – 2%
- More formula sensitive → Adjustments based on resin and pigment type

- Outlook:
  - ➢ Next generation under development matching PTFE aspect better and requiring lower dosage
  - ➢ Bio-based fine texturing agents

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