Chrome Replacement Technology – Waterbased Aluminum Pigments

CTT Conference 2025

Lombard, IL
September 2025 – Jason Kuhla – Technical Marketing Manager – Liquid Coatings / Head of Pilot Plant

Agenda

- ► Aluminum Flake Basics & Post Treatments
- ► Chrome Replacement for WB Coatings on Plastic – Comparison of Flakes & Applications
- ► Chrome Replacement for Higher Solids WB Coatings – Comparison of Flakes & Applications
- ► Summary of Findings – Future Work

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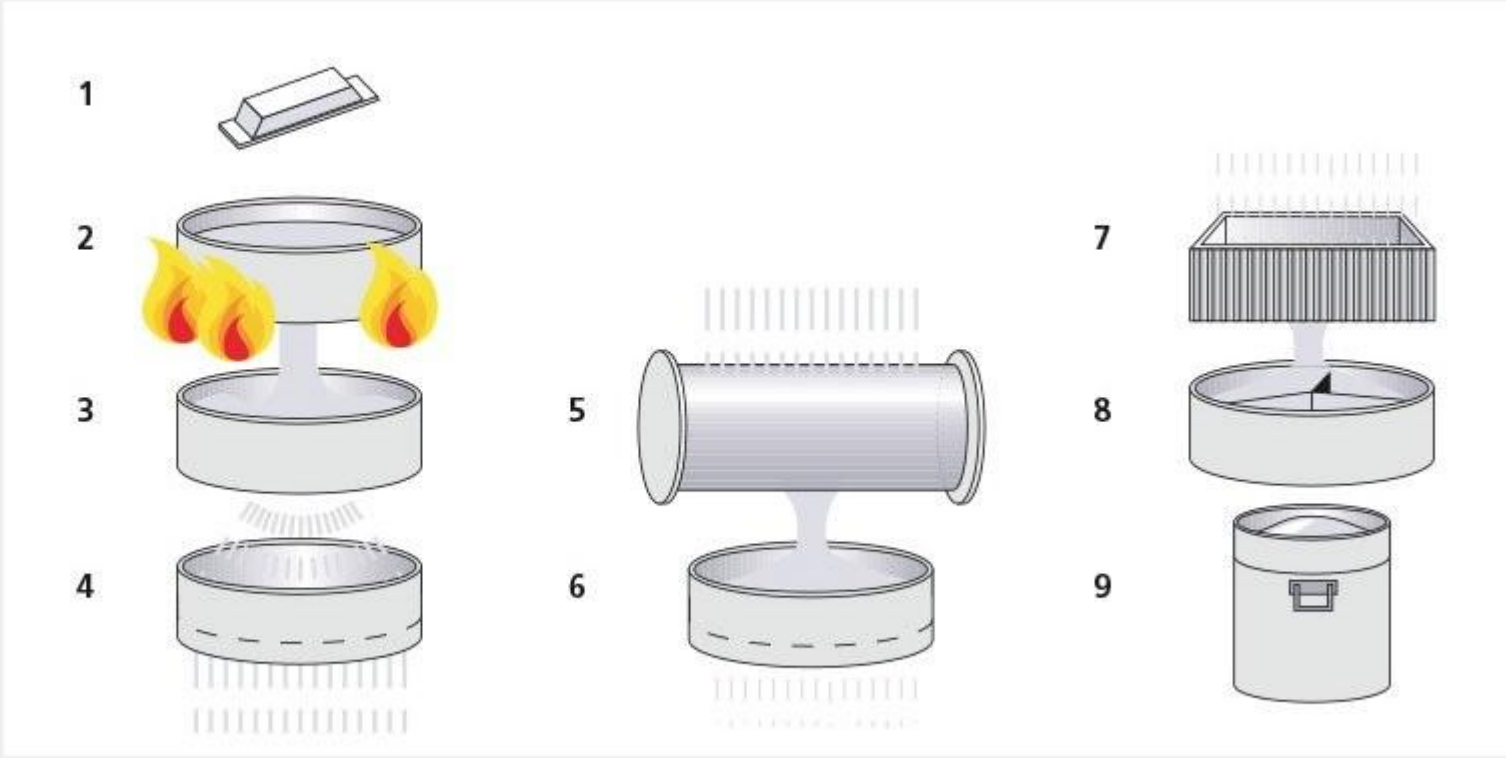
Aluminum Flake Basics
Manufacturing Process – Milled Aluminum Flakes

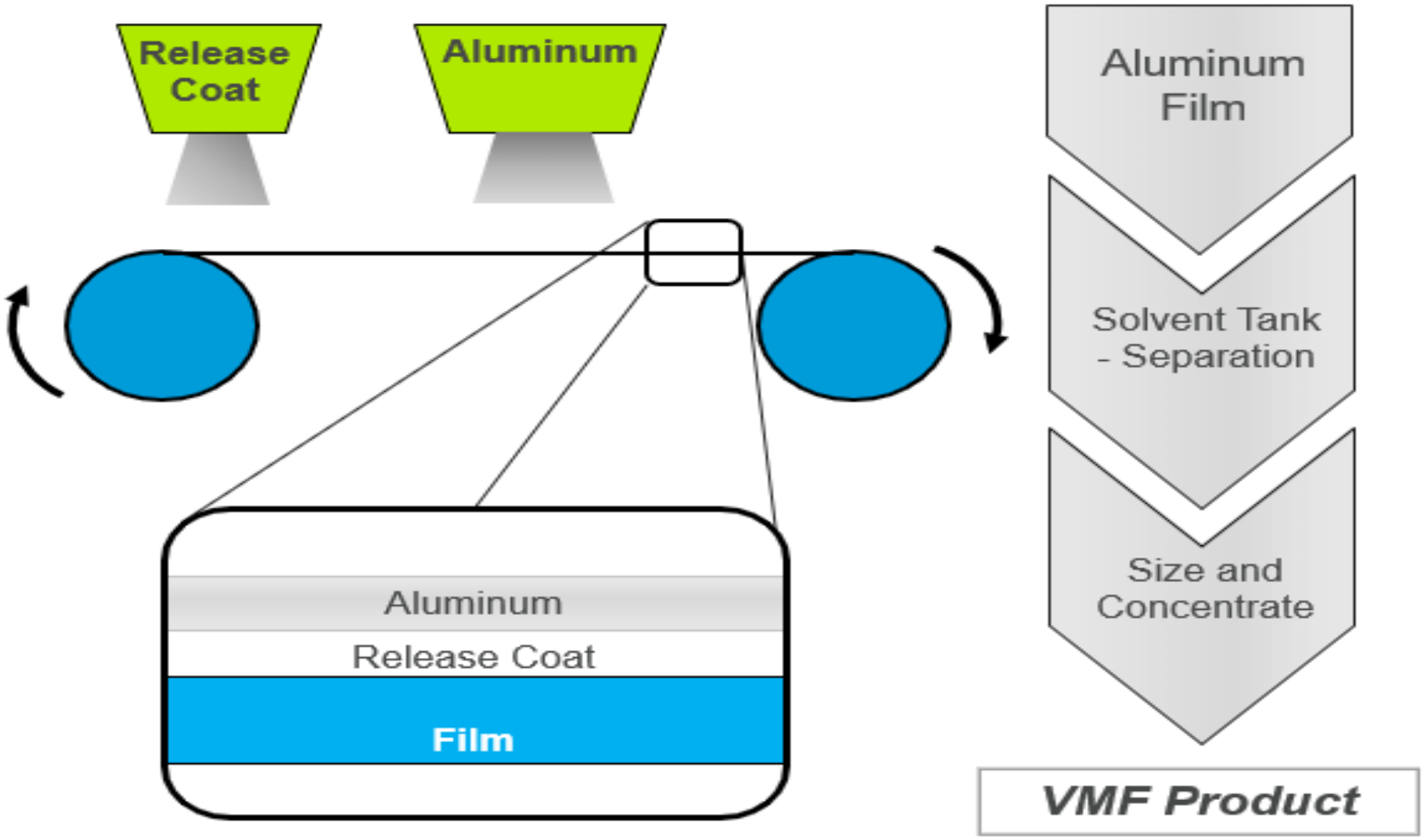
Production Process

1 **Al** min. 99,5% DIN 1712
2 **Melting**
3 **Atomizing**
4 **Sieving**
5 **Ball mill**
- Mineral spirit
- Lubricant
6 **Sieving**
7 **Filter press**
8 **Mixer**
9 **Aluminum paste**



Aluminum Flake Basics

Manufacturing Process – Vacuum Metallized Pigments (VMP)



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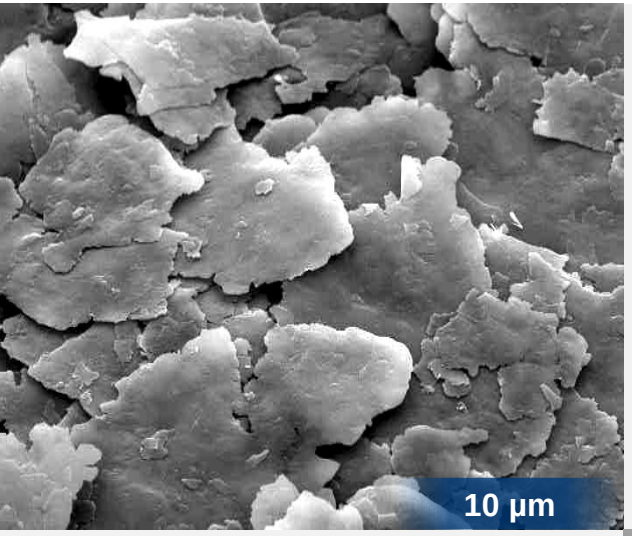
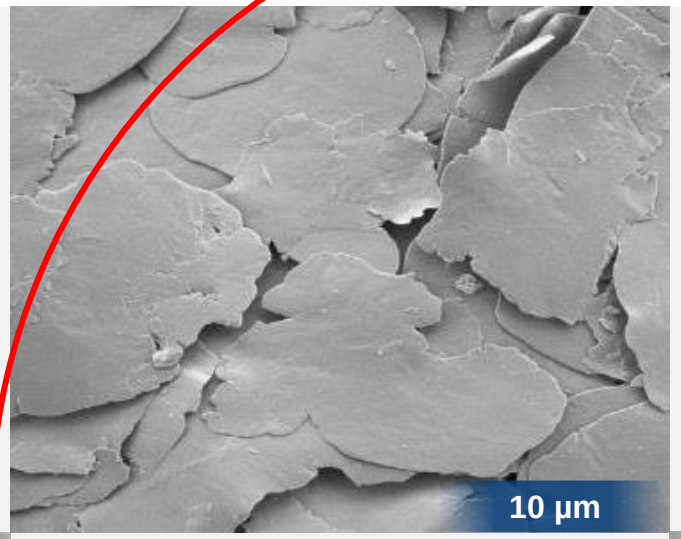
Aluminum Flake Basics
Morphology & Geometry



Silver $

Good hiding Power
Strong Metallic Character

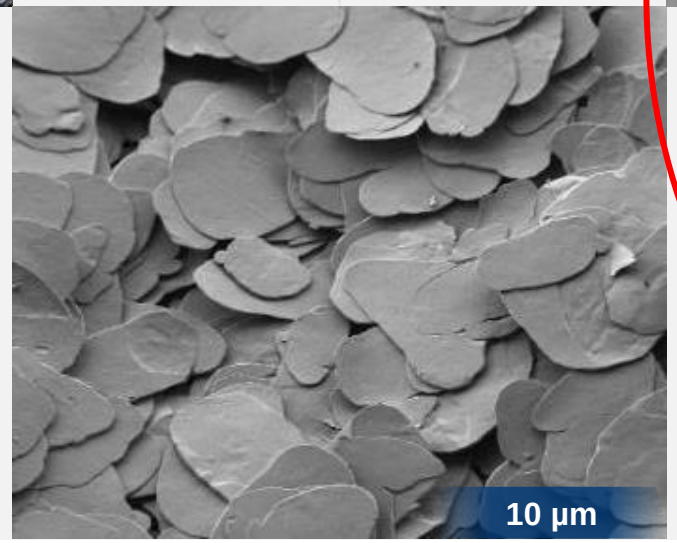


PVD/VMP

Good hiding Power
Strong Metallic Mirror

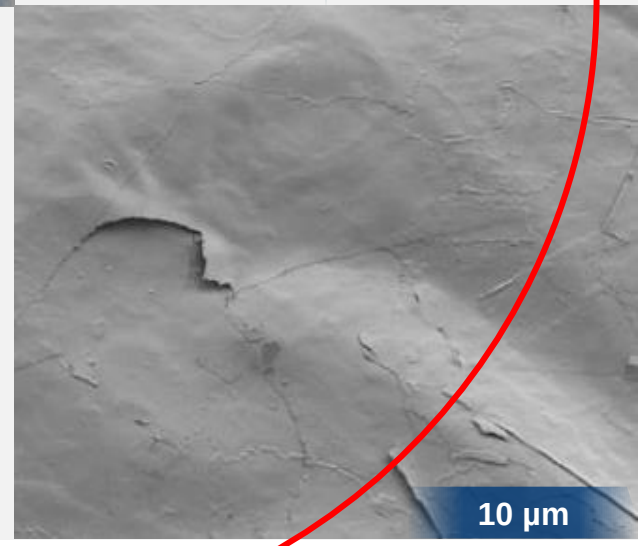
Cornflake

Excellent Hiding Power
Good Metallic Character



Platinum $

Good hiding Power
Balanced Metallic/Mirror Effect



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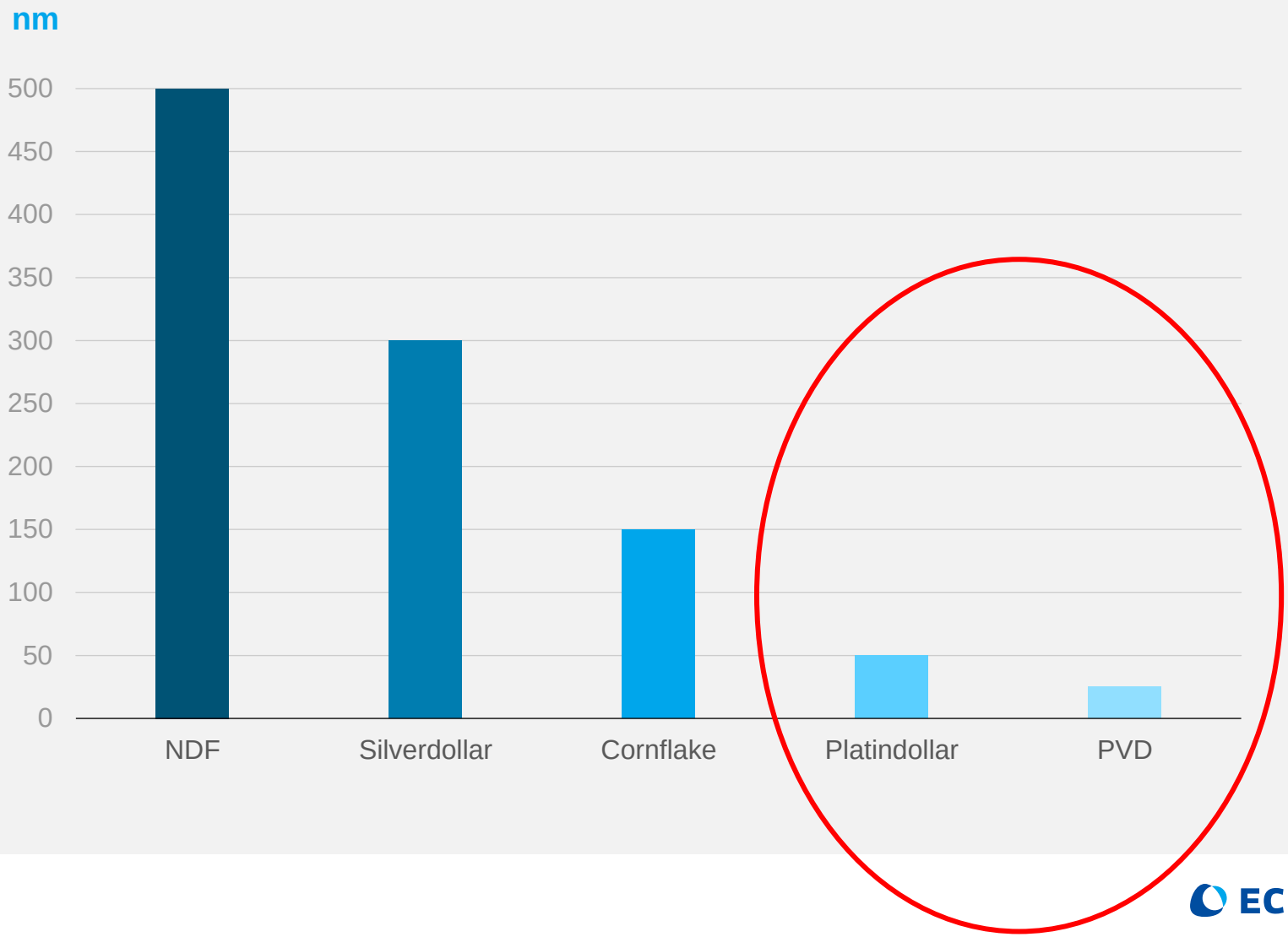
ECKART Effect Pigment Basics

Particle Thickness Plays a Role – Thinner Flakes = Better Chrome Appearance



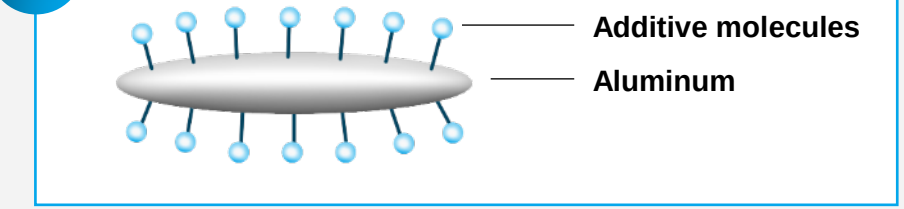
Aluminum & Water
Post Treatment is Necessary for Safe Use in WB Systems

FOR WATER-BASED COATINGS, STABILIZED ALUMINUM FLAKES ARE REQUIRED.

$$2\,Al + 6\,H_2O \rightarrow Al_2(OH)_3 + 3H_2$$

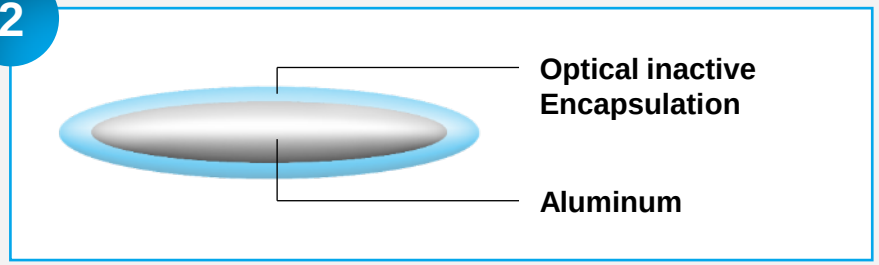
There are two basic concepts of stabilization for water-based coatings:

1



Adsorption of **corrosion inhibitors** on the active surface of the pigment surface **(additive technology)**

2



Encapsulation of the aluminum pigments with metal oxides or a transparent silica layer **(encapsulation technology)**

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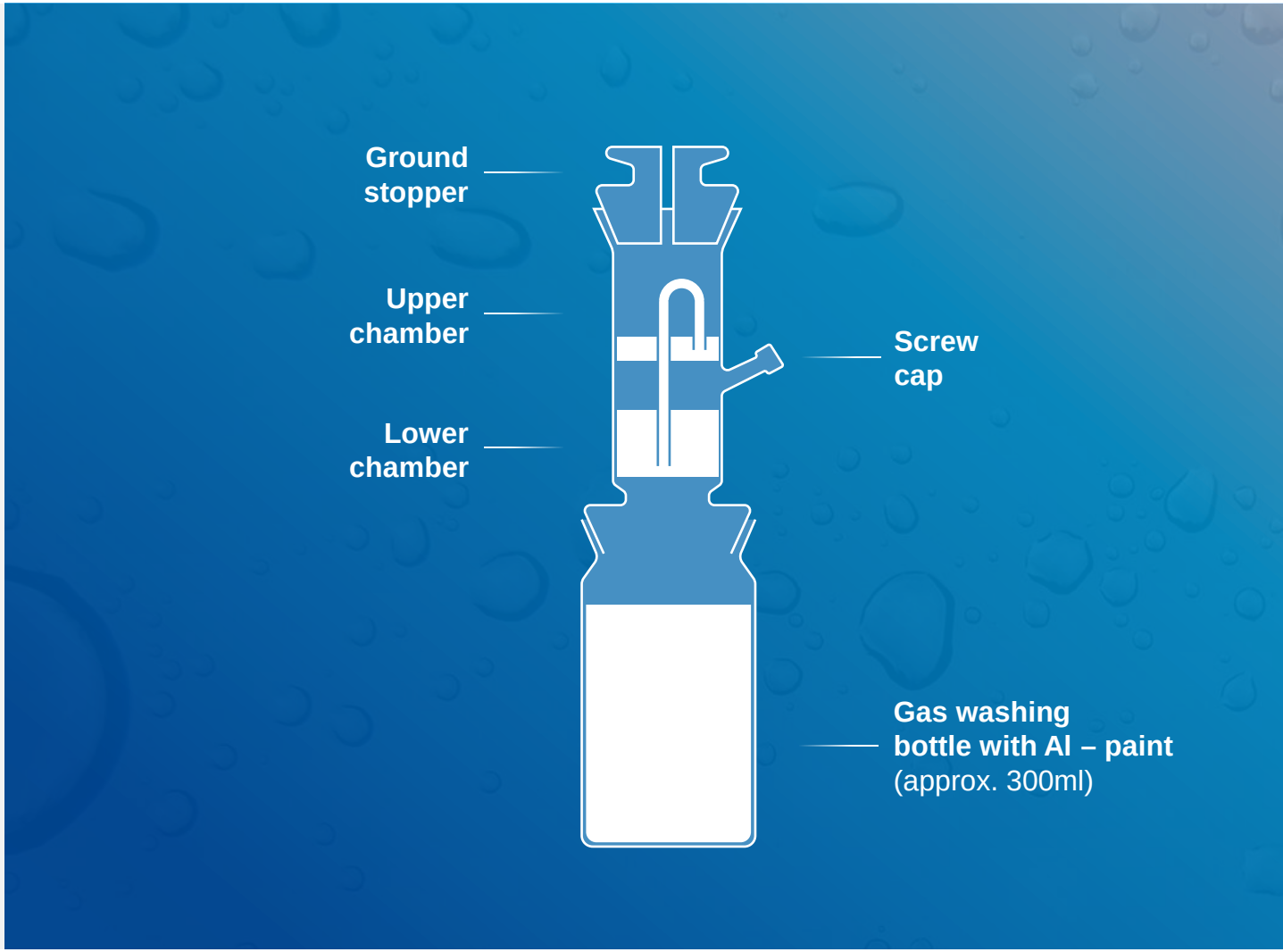
Aluminum & Water
Water Stability – Gassing Test Method

Test setup for evaluation of gassing tendency



Chrome Replacement in WB Coatings Systems
Flake Types Chosen for Study

Name	Pigment Type	Surface Treatment	Median Particle Size (d50 – Microns)
Pigment A	Platinum Dollar	Encapsulation	11
Pigment B	Platinum Dollar	Encapsulation	20
Pigment C	VMP	Additive Stabilized	10
Pigment D	VMP	Encapsulation	10

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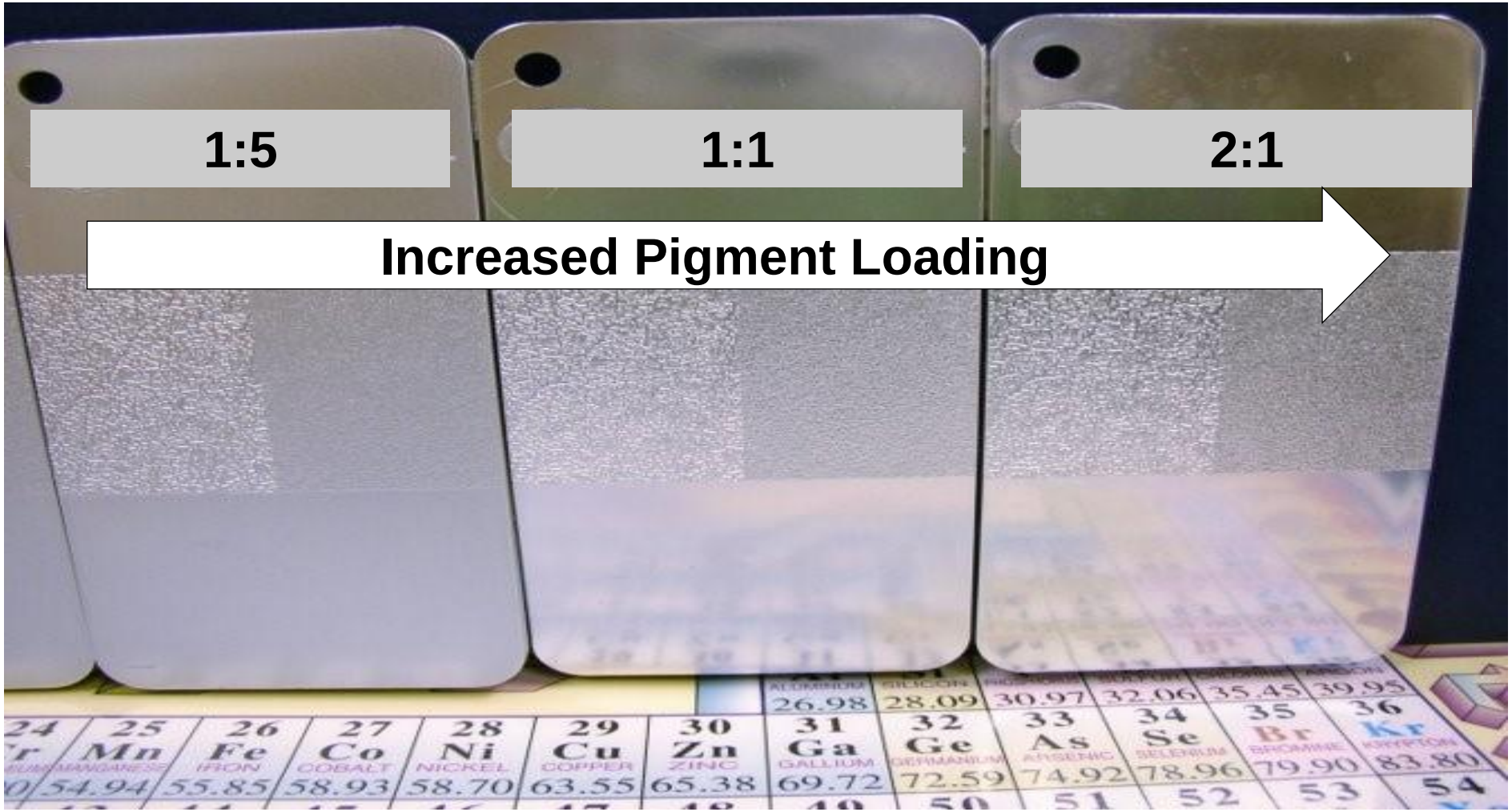
Low Solids WB Coatings on Plastic (ABS)
Pigments A (Pt$), C (VMP - Additive) & D (VMP - Encapsulation)

- Pigment A & D were formulated into low solids (~5%) WB PU coatings at varying P:B – 1K & 2K
- 1K vs 2K compared at same P:B
- Same application method – robot air spray
- Low dry film build (DFT) of ~5-7µm
- Applied over glossy black ABS
- Effect of clear coats & diluent choice examined
- Effect of surface chemistry on chemical resistance in monocoat explored

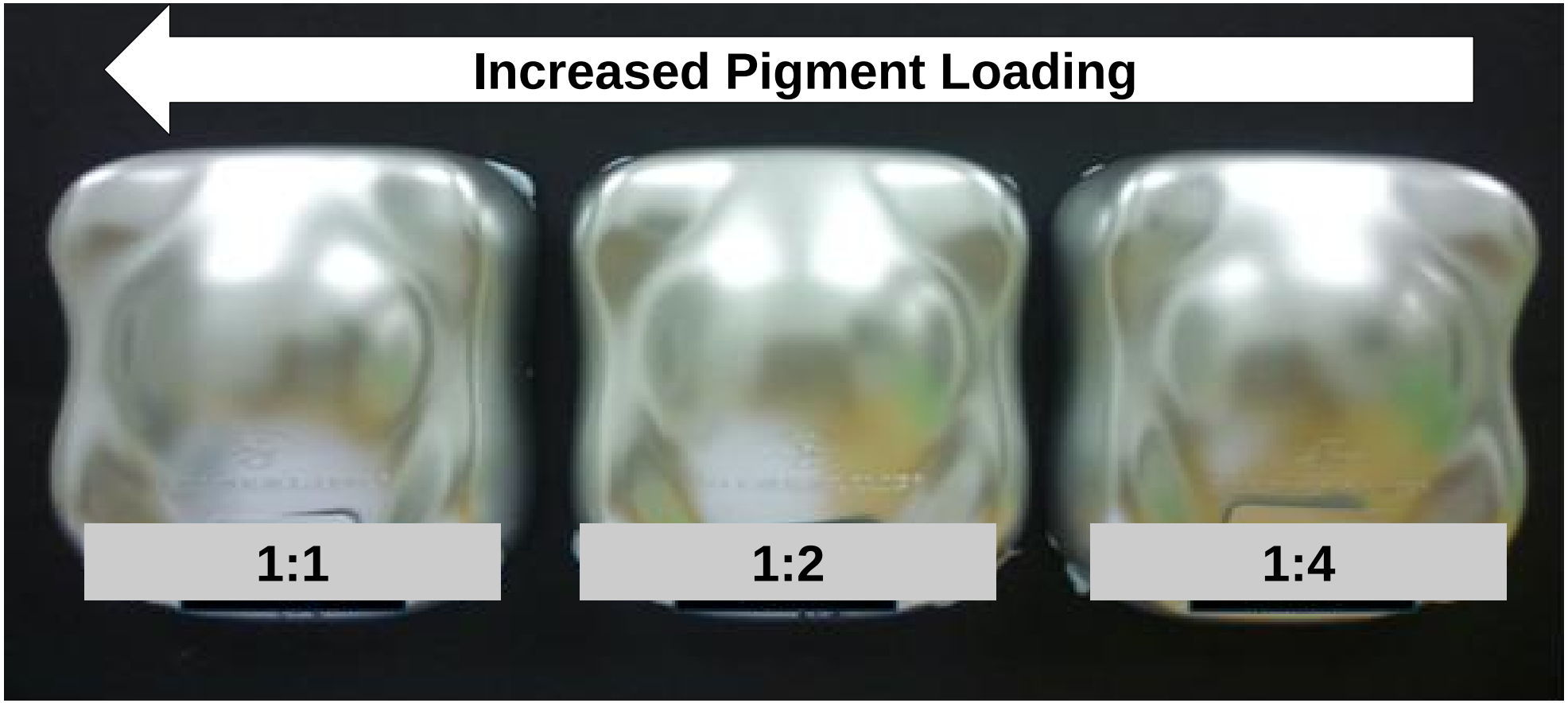
Low Solids WB Coatings on Plastic (ABS)

Effect of Varying Pigment to Binder Ratio (P:B) 1K WB PU - Pigment D (VMP)



Low Solids WB Coatings on Plastic (ABS)

Effect of Varying Pigment to Binder Ratio (P:B) 2K WB PU - Pigment A (Pt$)



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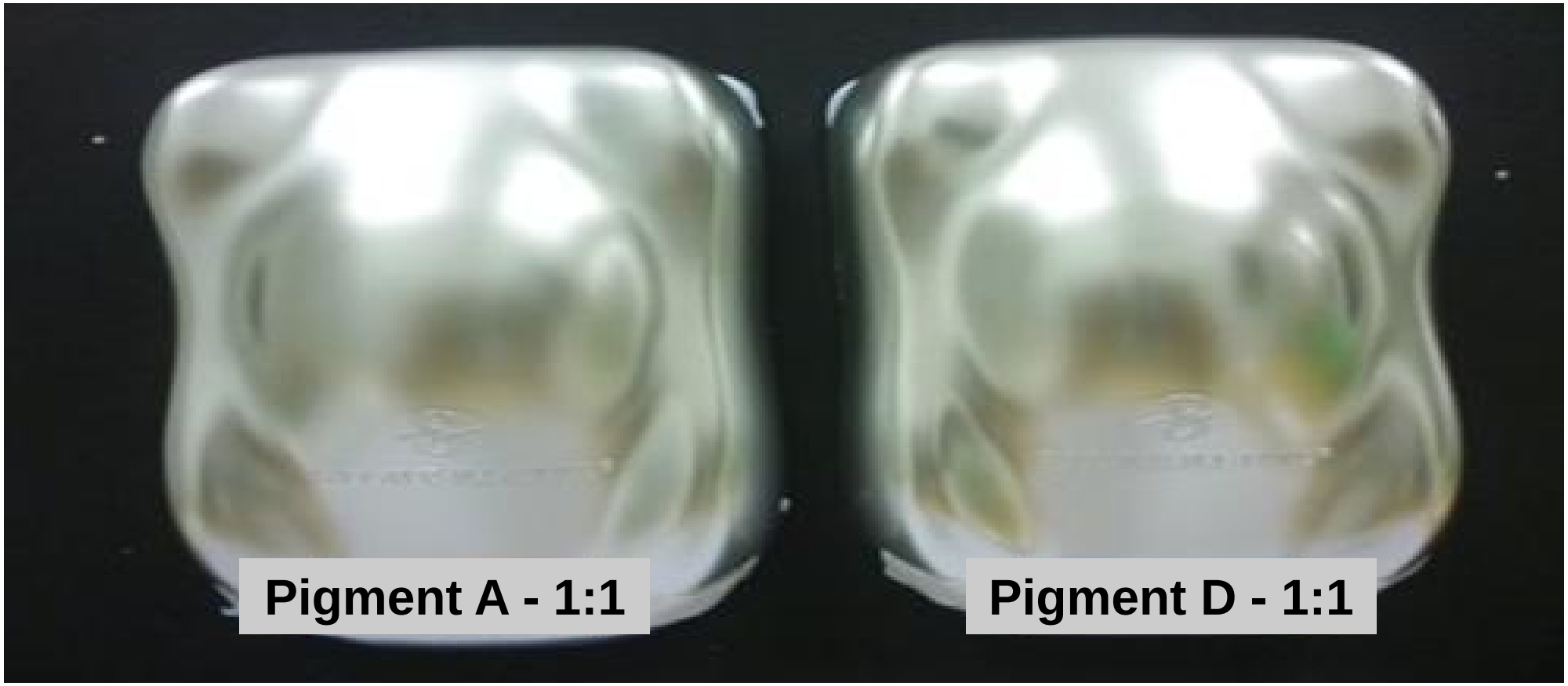
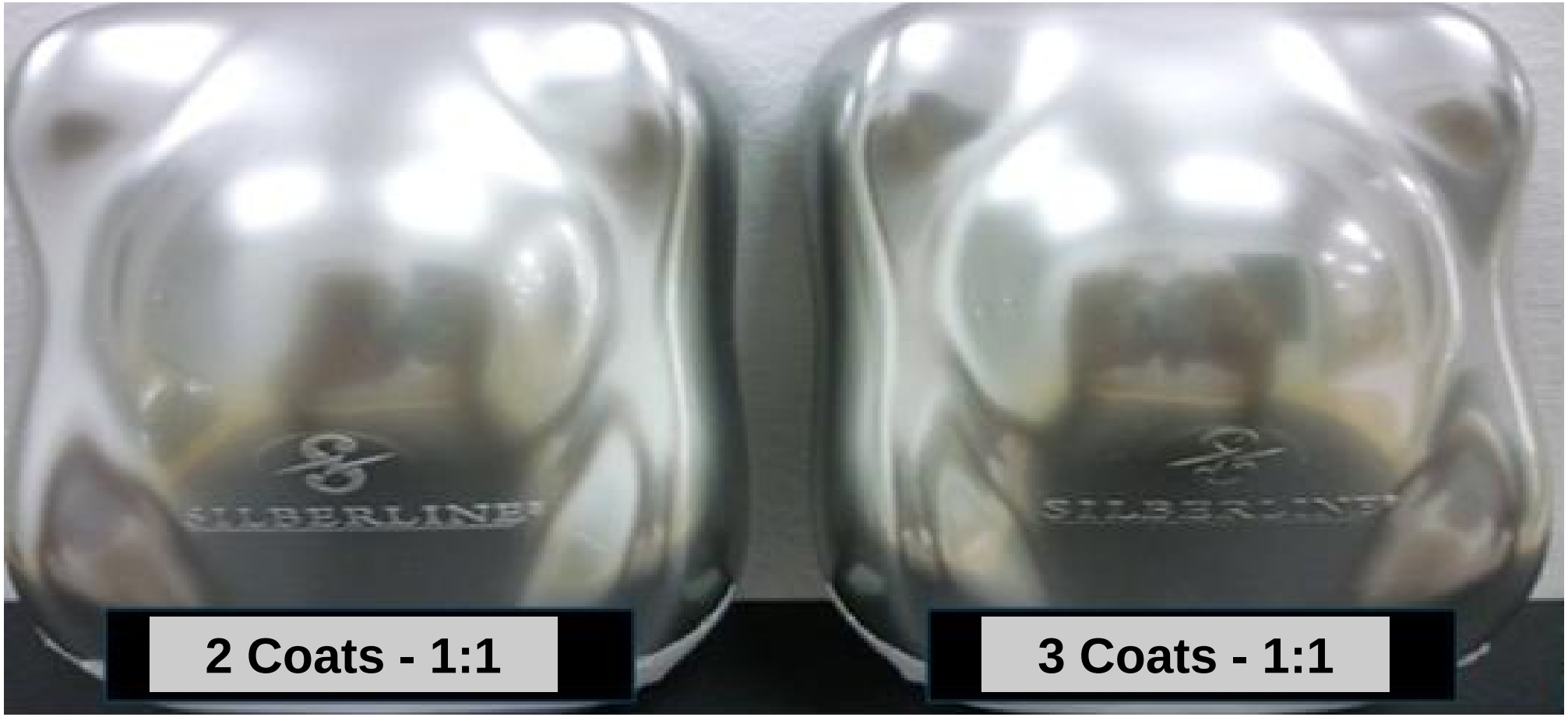
Low Solids WB Coatings on Plastic (ABS)

Same Pigment to Binder Ratio (P:B) 2K WB PU - Pigments A (Pt$) & D (VMP)

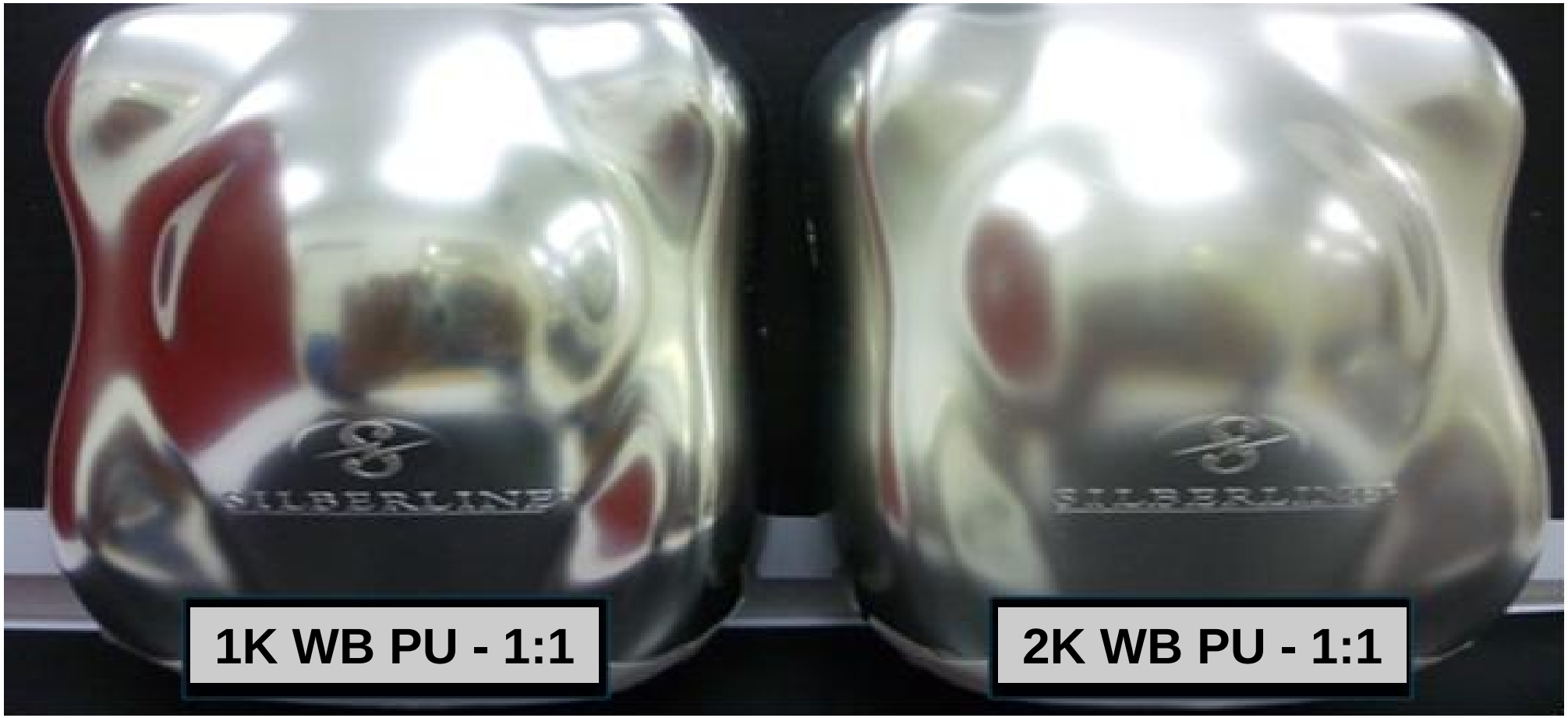


Low Solids WB Coatings on Plastic (ABS)

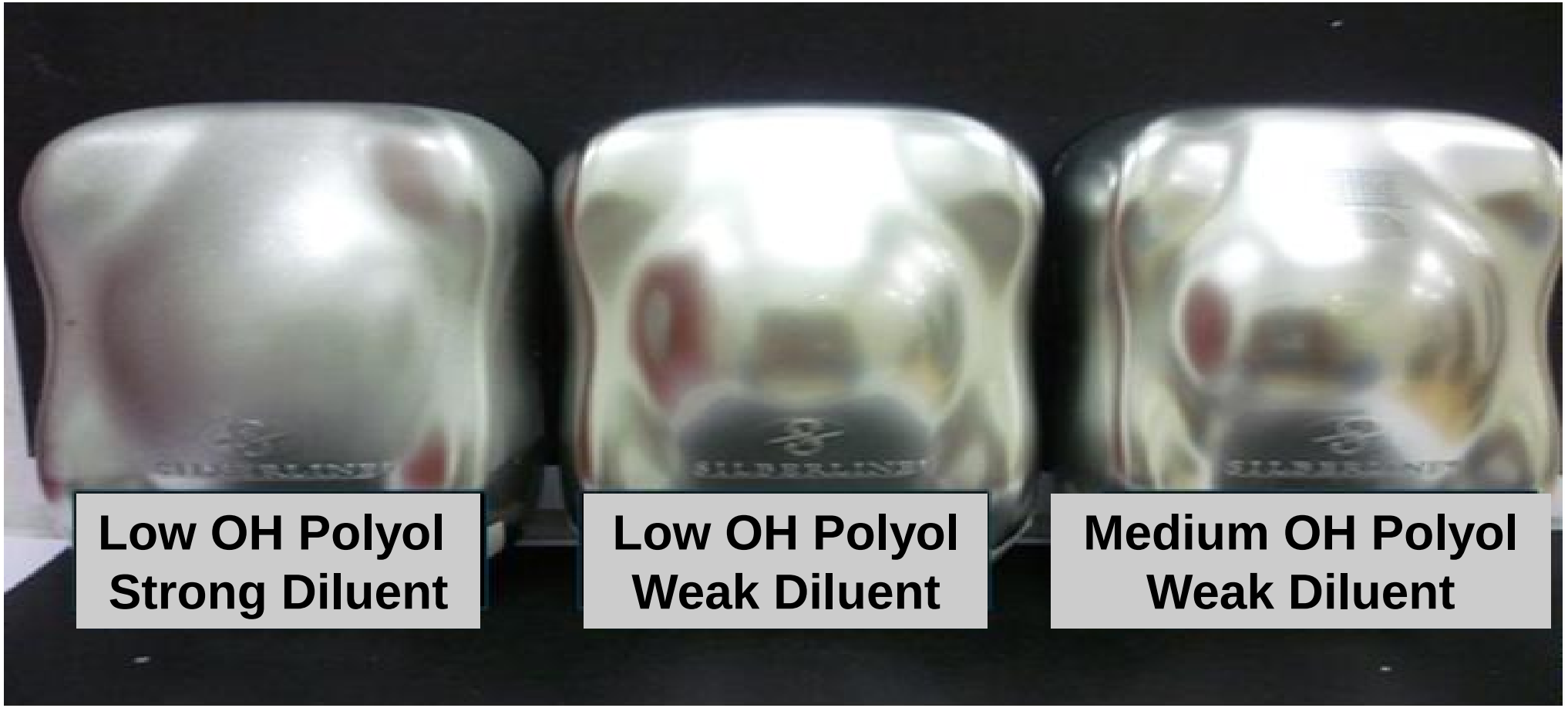
Effect of Multiple Coats to DFT at same P:B - Pigment D (VMP)



Low Solids WB Coatings on Plastic (ABS)
Effect of 1K vs. 2K at same P:B - Pigment D (VMP)

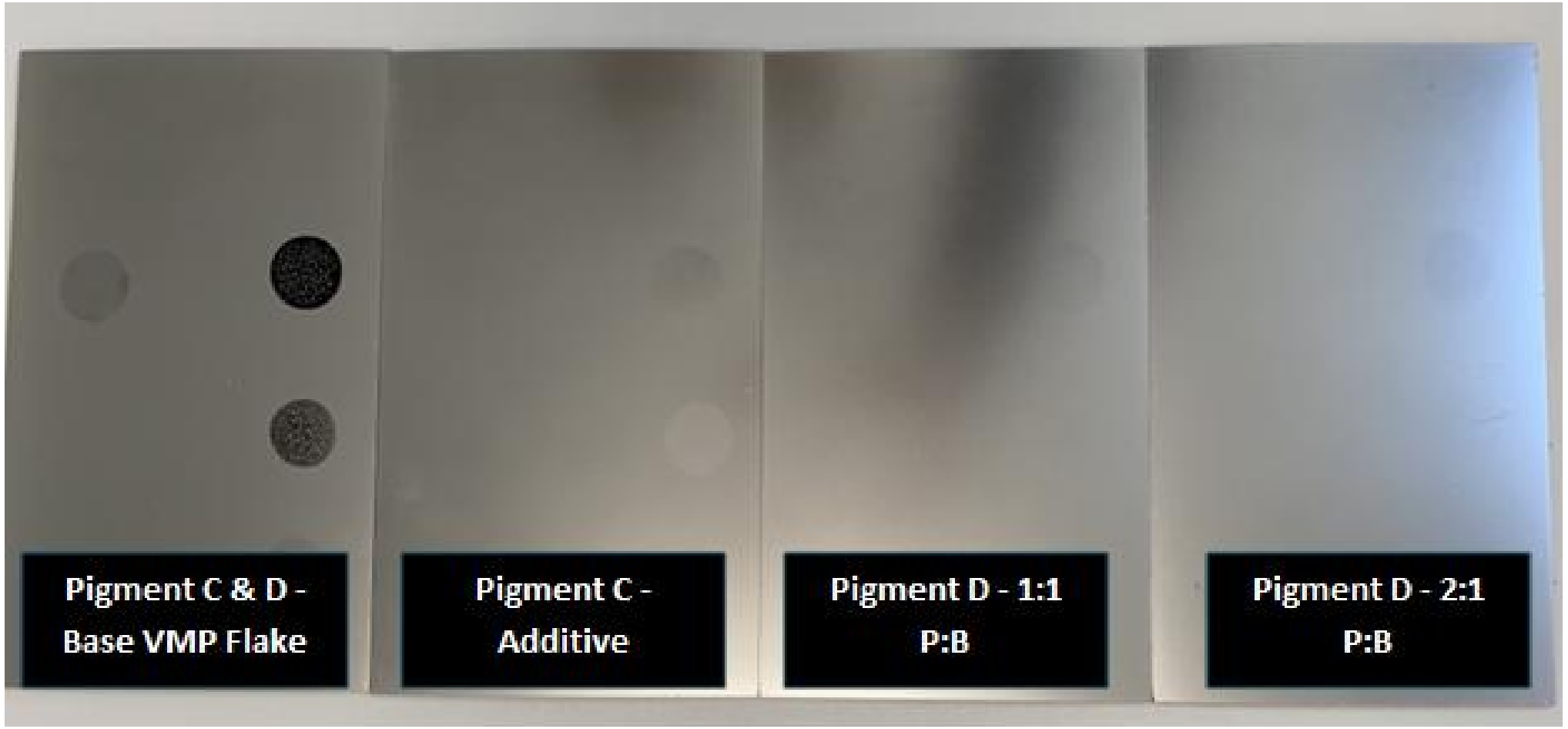


Low Solids WB Coatings on Plastic (ABS)
Effect Clear Coat – Chemistry & Diluents - Pigment D (VMP)



Low Solids WB Coatings on Plastic (ABS)

Effect Stabilization on Chemical Resistance in Monocoat - Pigments C&D (VMP)



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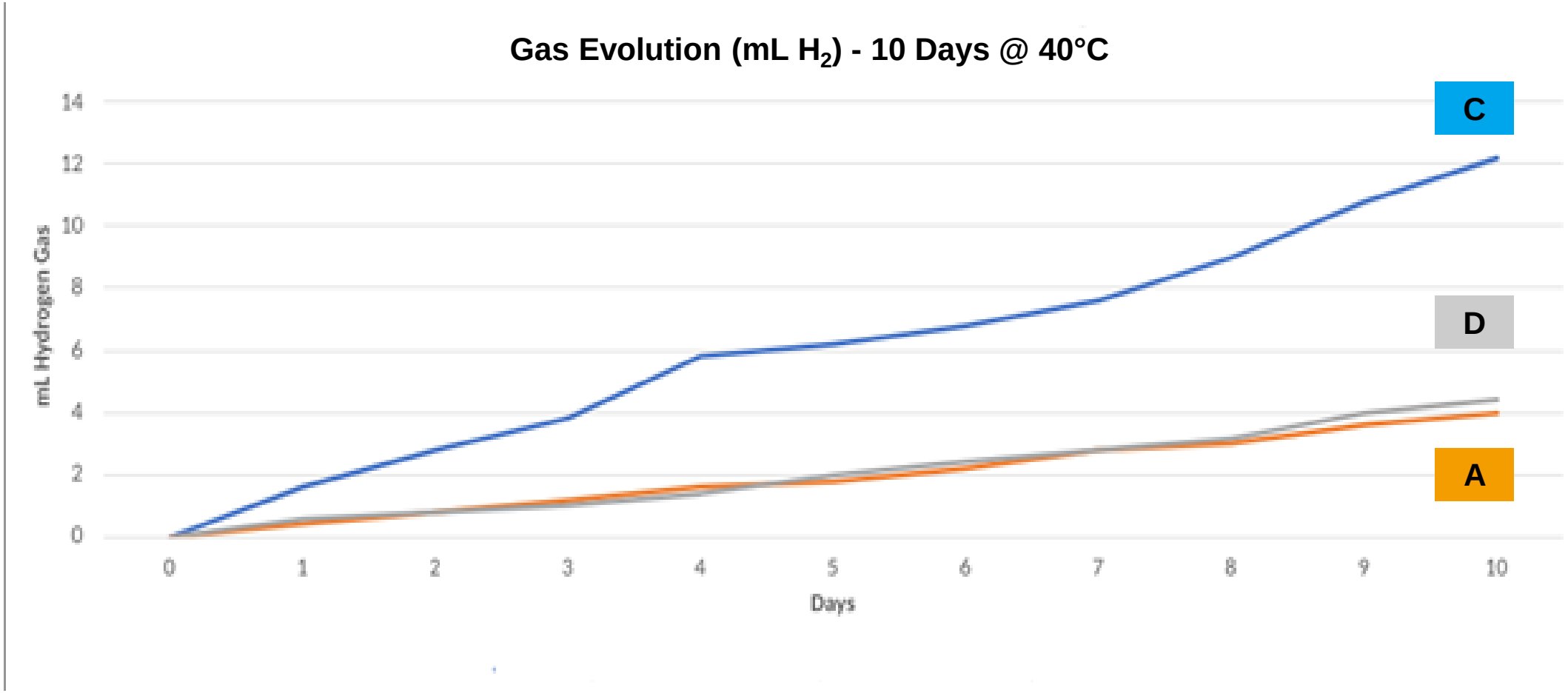
Medium/High Solids Automotive OEM WB System
Pigments A (Pt$), B (Pt$), C (VMP – Additive) & D (VMP – Encapsulated)

- Pigment A , B, C & D were formulated into a medium to high solids automotive OEM type WB paint system – at equal P:B ratio
- Electrostatic rotary bell application – standard vs modified formulation
- Effect of pigment and surface chemistry on gassing resistance compared
- Effect of varying encapsulation thickness on gassing and shear resistance explored
- Standard automotive DFTs
  - ~0.6 mils BC
  - ~1.8 mils CC
- Applied direct to primed steel panels

Medium/High Solids Automotive OEM WB System

Pigments A (Pt$), C (VMP – Additive) & D (VMP – Encapsulated) - Gassing



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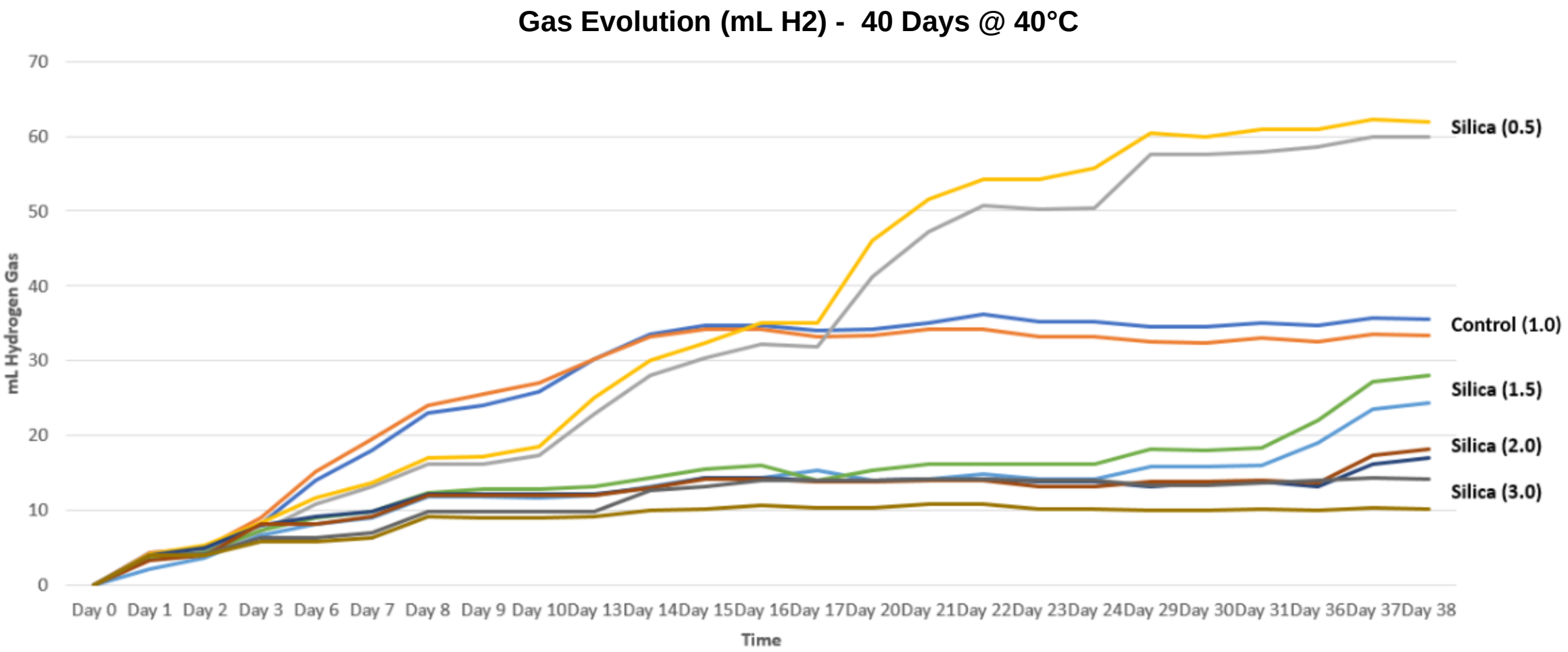
Medium/High Solids Automotive OEM WB System

Effect of Encapsulation Layer Thickness on Gassing - Pigment B (Pt$)



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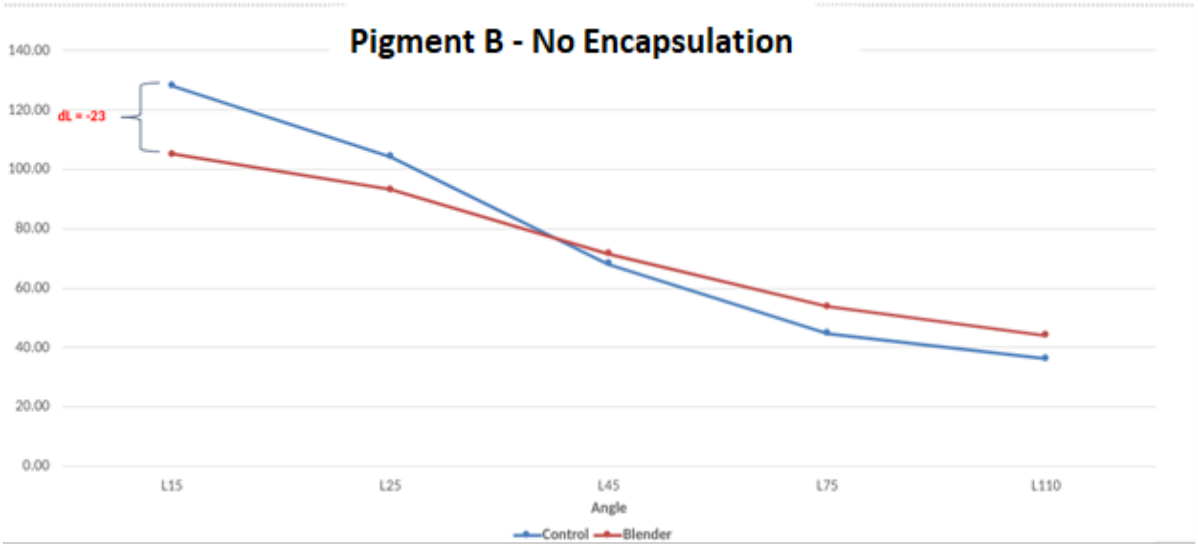
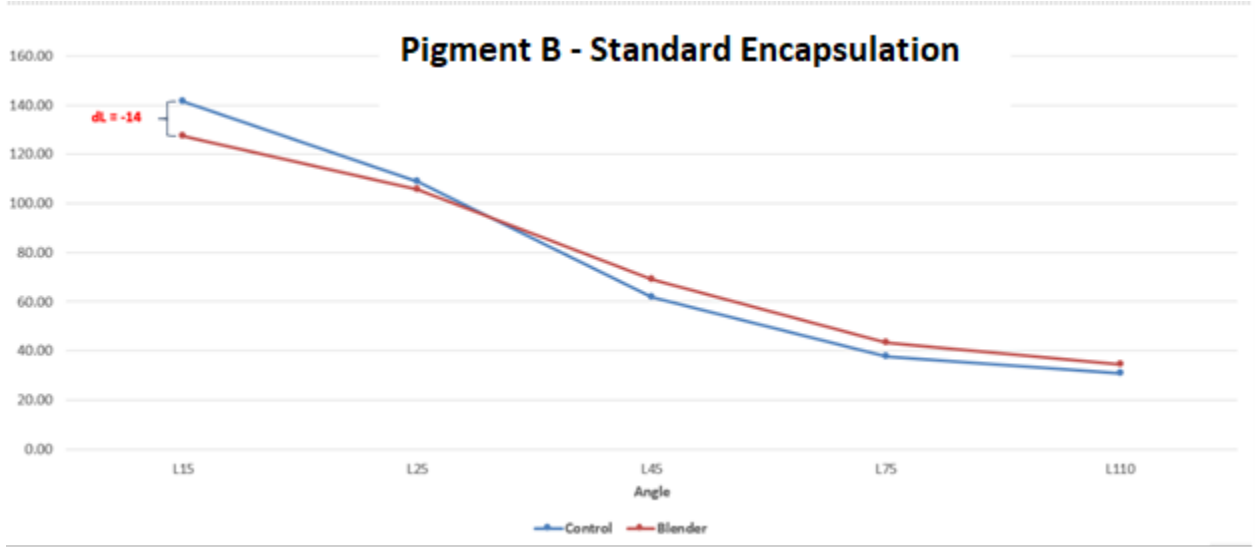
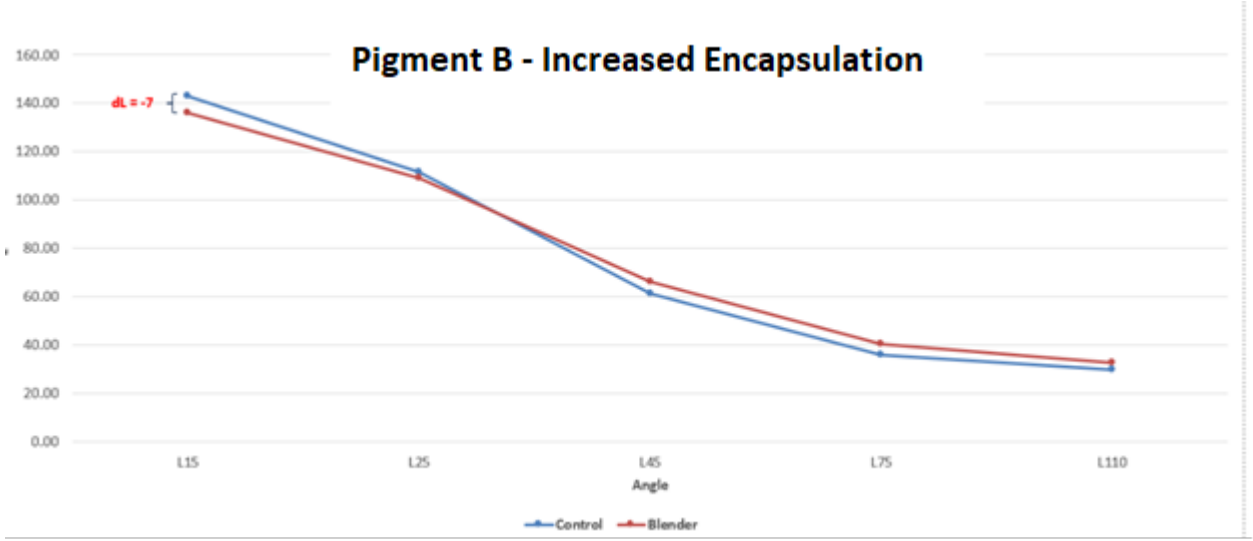
Medium/High Solids Automotive OEM WB System

Effect of Encapsulation Layer Thickness on Shear Resistance - Pigment B (Pt$)







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Medium/High Solids Automotive OEM WB System
Effect of Formulation & Application Parameters - Pigment D (VMP)

coating formulation			
raw materials			*processing*
Component 1	Amine pH adjuster	2,00	mix comp. 1 and comp.2 with a spatula . add comp. 3 while stirring → 5 min additional steering add comp. 4 und 5 one by one while stirring slowly (avoid foam formatation) →10 min additional steering add comp. 6 drop by drop → 10 min additional steering add comp. 7 while slowly stirring → 10 min additional steering
Component 2	Butylglycol	4,00	
Component 3	1K Polyacrylate Dispersion	5,60	
Component 4	Rheology modifier	40,00	
Component 5	Water demin.	28,00	
Component 6	Butylglycol	0,40	
Component 7	Slurry**	20,00	
		100,00	

*Laponite RD-solution			
raw materials			*processing*
Component 1	Water demin.	47,00	add comp. 1 in a suitable beaker add comp. 2 while stirring slowly → 30min additional stirring add comp. 3 while stirring → 5min additional stirring
Component 2	Rheology modifier	1,50	
Component 3	Polypropylene Glycol	1,50	
		50,00	

**Slurry			
raw materials			*processing*
Component 1	Dispersing Additive	0,75	pour comp. 1 und comp. 2 in a suitable beaker mix comp. 3 and 4 and add while stirring add comp. 5 while slowly stirring → 10 min additional steering below splash limit
Component 2	Butylglycol	7,00	
Component 3	Alkali Swellable Emulsion	0,25	
Component 4	Water demin.	7,00	
Component 5	Pigment D (10% solids)	15,00	
		30,00	

Technical Data

- pH- value 8,6
- Application viscosity: 30,5 mPas/1000 s^{-1}
  Diluent: water demin.

Medium/High Solids Automotive OEM WB System
Effect of Formulation & Application Parameters - Pigment D (VMP)

Equipment		
application machine	Oerter APL 6.3	Oerter GmbH & Co KG
atomizer	ecobell 2 external charge	Dürr AG
Spray bell	N163100009 M-Bell ø65mm	

Parameters Basecoat 1			Parameters Basecoat 2		
discharge rate	250	cm³/min	discharge rate	100	cm³/min
turbin rotation	60	krpm	turbin rotation	70	krpm
shaping air 1	350	Nl/min	shaping air 1	---	Nl/min
shaping air 2	---	Nl/min	shaping air 2	375	Nl/min
high voltage mode	current		high voltage mode	current	
current	400	µA	current	400	µA
distance y-axis	250	mm	distance y-axis	250	mm
grid y-axis	133	mm	grid y-axis	33	mm
velocity x-axis	450	mm/s	velocity x-axis	600	mm/s
velocity y-axis	150	mm/s	velocity y-axis	150	mm/s
flash-off	180	s	flash-off	---	s
dry-film thickness	4	µm	dry-film thickness	1,5	µm

flash-off and stoving conditions

- flash-off time: 10 min air drying
- stoving time: 10 min at 80°C and 20 min at 140°C

over-paintable with 2K automotive clearcoat systems

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Medium/High Solids Automotive OEM WB System
Effect of Formulation & Application Parameters - Pigment D (VMP)

Product	Application	L*15°	L*25°	L*45°	L*75°	L*110°	Flop	S_a15°	S_a75°
Pigment D	Electrostatic Bell	147,4	86,1	35,6	18,8	13,8	28,5	2,0	8,2
	Robotic Air Spray	149,7	88,4	36,2	18,5	13,5	28,7	2,2	15,1
	Hand Air Spray	148,6	98,2	42,4	21,2	15,7	24,4	0,7	7,8

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Low Solids WB Coatings on Plastic (ABS)
Pigments A (Pt$), C (VMP) & D (VMP)

Summary of best path to a high chrome mirror finish:

- VMP Pigment
- High P:B – within reason for durability concerns
- 1K better than 2K – for appearance – durability will suffer
- Multiple thin coats to desired DFT
- If clear is required - medium OH polyol with weak diluents
- If monocoat chemical resistance is required – encapsulation

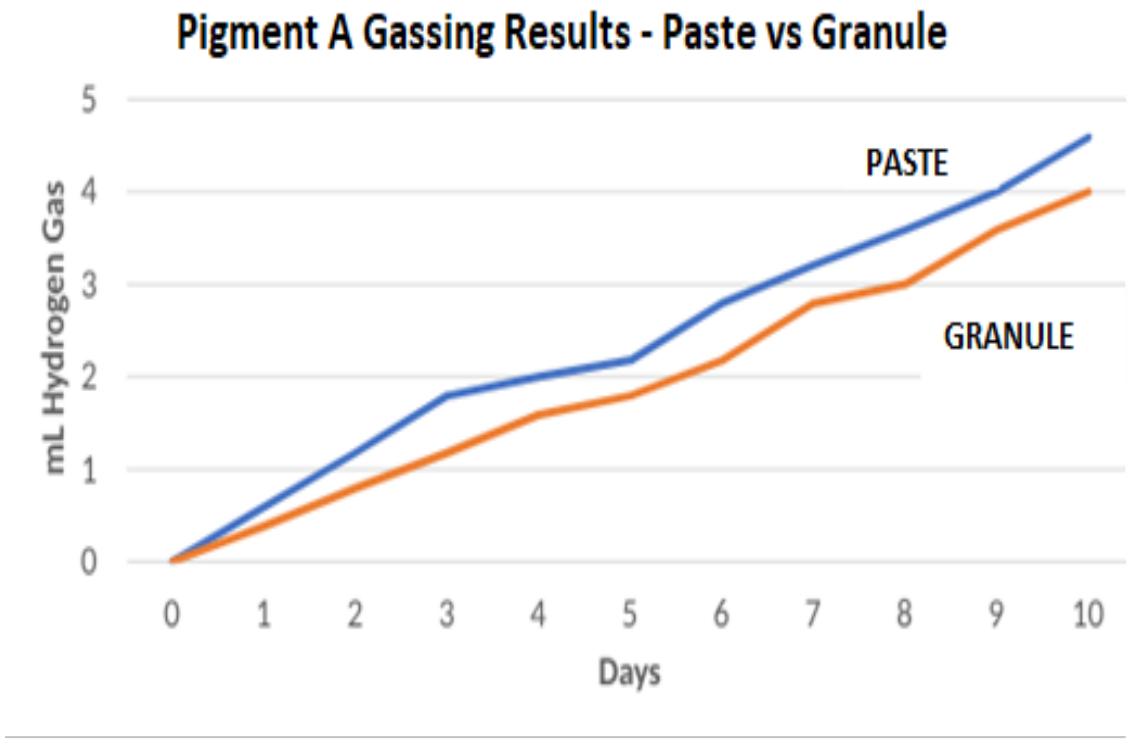
Medium/High Solids Automotive OEM WB System

Pigments A (Pt$), B (Pt$), C (VMP – Additive) & D (VMP – Encapsulated)

Summary of tips for best performance – fine & bright:

- VMP pigments show slight benefit over Pt$ for a fine & bright finish
  - Mirror finish is a challenge at higher solids
- Gassing and shear resistance is best with encapsulated pigments
  - Increasing layer thickness improves these results
- Formulation & application parameter changes can narrow the gap between air and bell applications
  - Also increases fine bright appearance
  - Possible negative effects for transfer efficiency

Future Work
Low VOC Effect Pigment Granules for Increased Sustainability



Thank you for your attention.