Development of Easy-to-Disperse Aluminum Pigments for Waterborne and Solventborne Paint Systems

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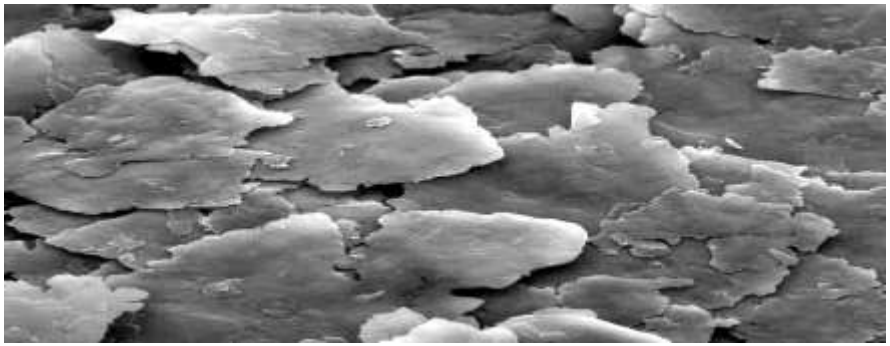
The Problem

- Use of Aluminum pigments requires pre-dispersion
- Pre-dispersion takes time and pre-dispersion steps may not be routine in the paint making process
- There is a need for an easily dispersible Aluminum pigment

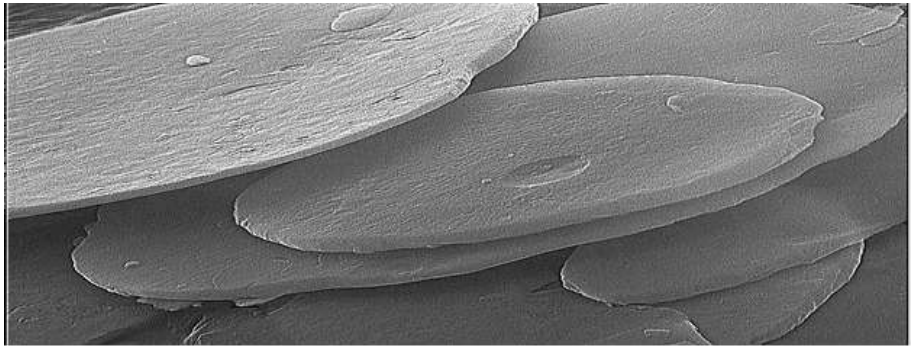
AGENDA

1. The Need for Proper Dispersion of Al
2. Al Passivation Approaches
3. Options for Easy Dispersion
4. Performance Comparisons

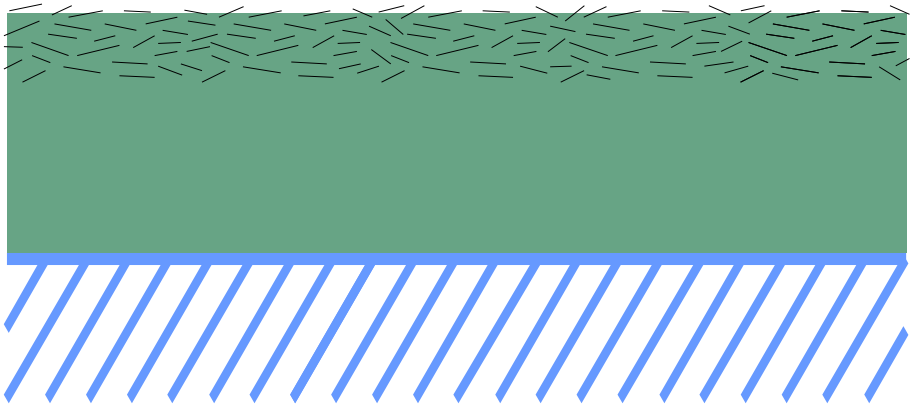
Pigment Characteristics
Morphology & Wetting Behavior



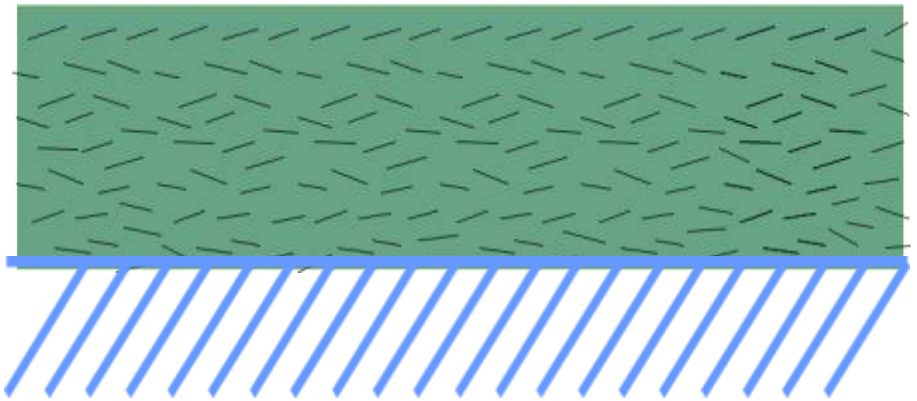
Conventional (Corn Flake)



Lenticular (Silver Dollar)

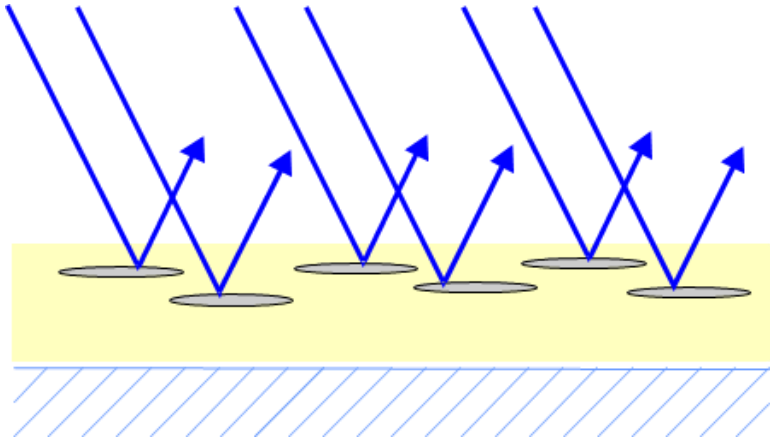


Leafing

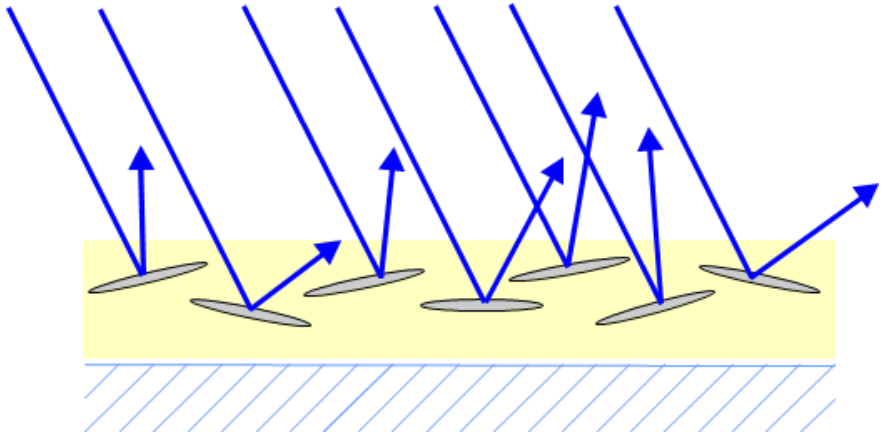


Non-leafing

Al Pigment Dispersion and Film Appearance



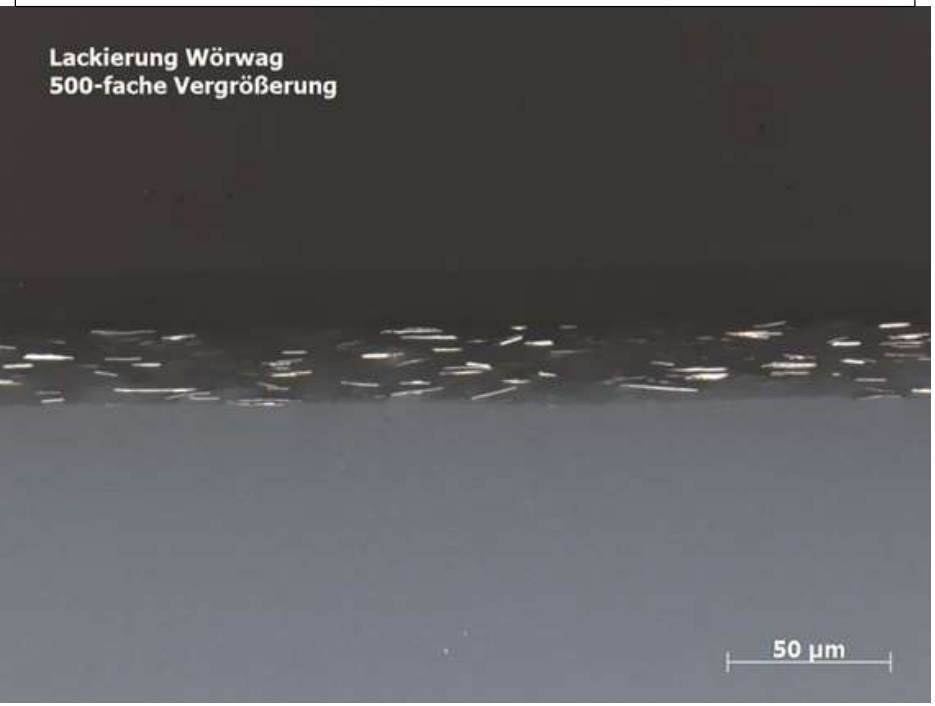
- Good orientation
- Uniform reflection
- Strong flop, high brilliance, good hiding power



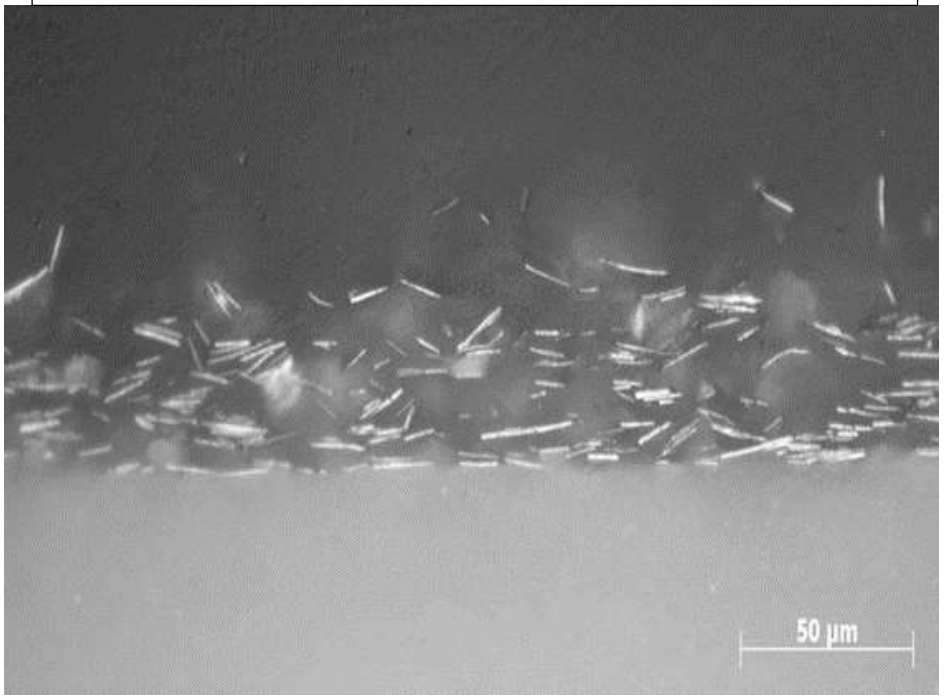
- Poor orientation
- Disordered reflection
- Weak flop, "salt-and-pepper" effect

Al Pigment Dispersion and Film Appearance

Perfect pigment predispersion
Perfect pigment orientation



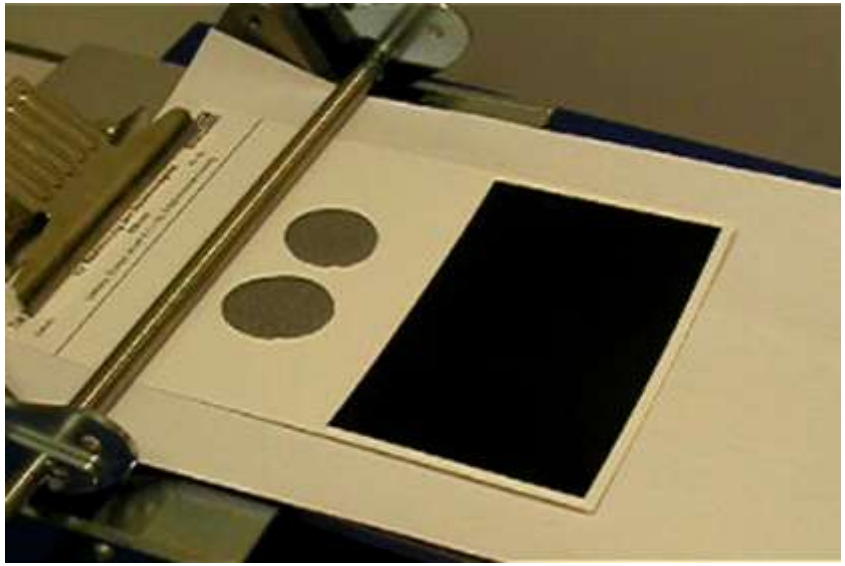
Aluminium flakes stick together
Aluminium flakes are aggregated

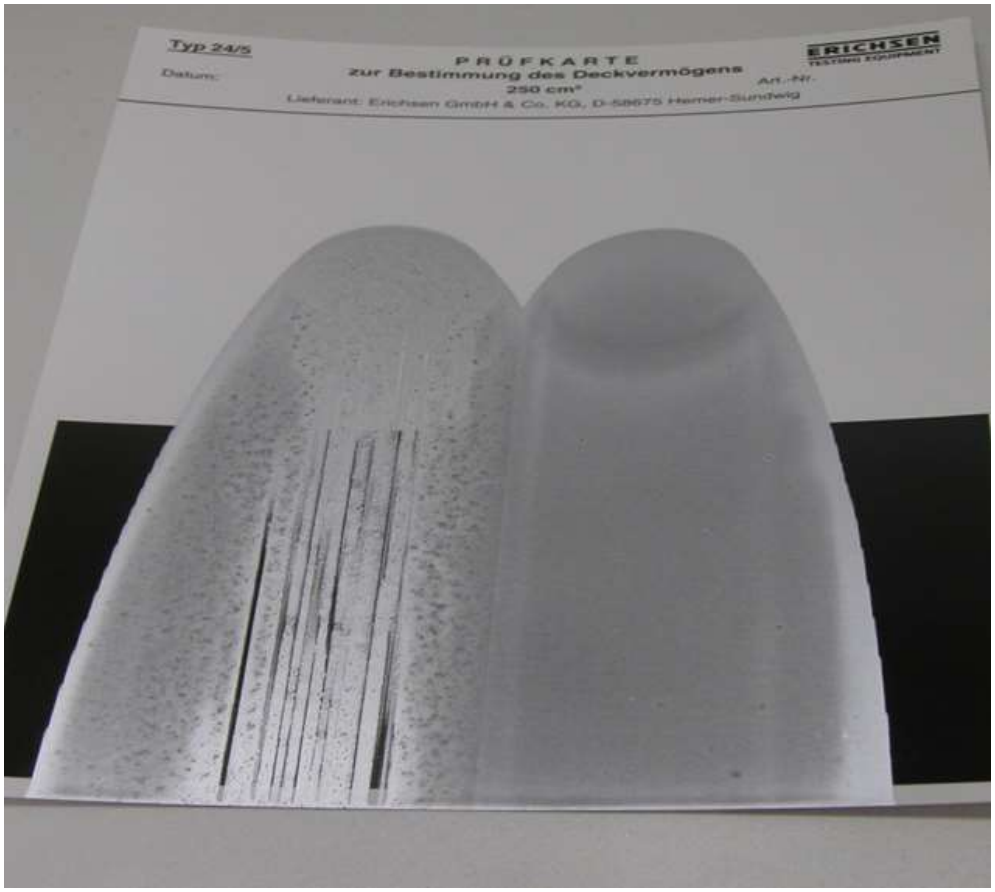


Al Pigment Dispersion and Film Appearance

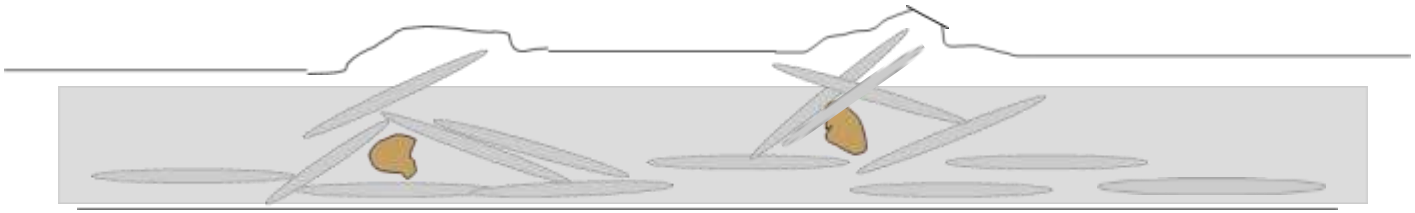
Dispersing the Al Paste

Al Pigment Dispersion and Film Appearance

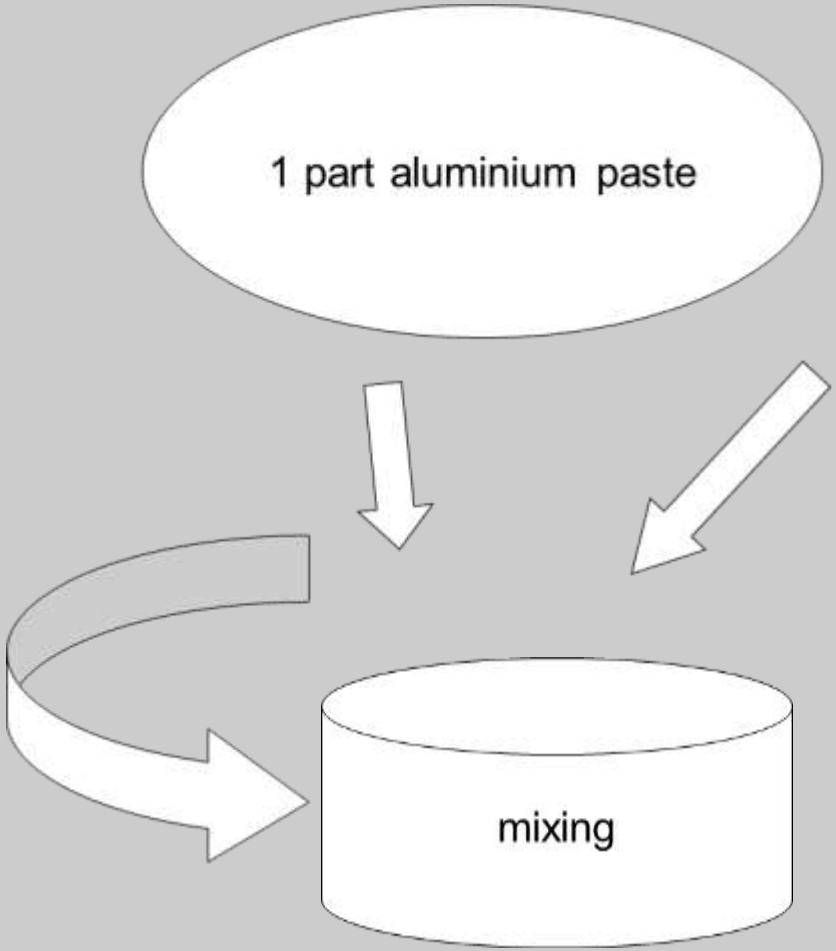




Al Pigment Dispersion and Film Appearance



Al Pigment Dispersion Recommendations



avoid high shear forces

Usually used solvents:
- aromatic hydrocarbons
- aliphatic hydrocarbons
- esters
- ketones
- alcohols

Usually used wetting agents:
- Disperbyk 2000
- Disperbyk 110
- Disperbyk 163

Al Pigment Dispersion Recommendations

- Pre - disperse in adequate co-solvent and amount
- Overnight soak is sometimes used
- Solvent : Pigment ratio: 1:1 up to 2:1 (pre-mix)
- Avoid too high shear stress (pre-mix):
  - Pigment deformation leads to loss in brilliancy
  - In water systems, pigment stabilisation can be fractured → Aluminium is exposed to water

Al Pigment Dispersion Recommendations

- Stirring time: approx. 20 – 30 min
- Check on agglomerates after recommended stirring time with a drawdown.
- Keep viscosity mainly constant during completion with formulation elements.
- Make sure the clear binder / solvent / additive mix is free of dirt.

Al Pigment Dispersion Recommendations

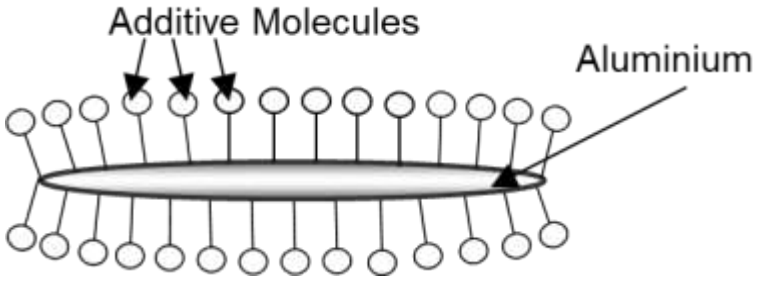
proper dispersion poor dispersion

Slurry poured over glass plate to check degree of dispersion

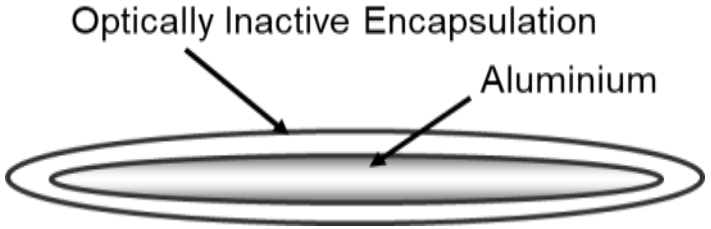
Al Pigment Dispersion Recommendations

Approach to an Easily Dispersible Al Flake Pigment Starts with Passivation

Additive Technology
•Adsorption of corrosion inhibitors on the active surface of the pigment surface
•Phosphate esters
•Molybdate esters

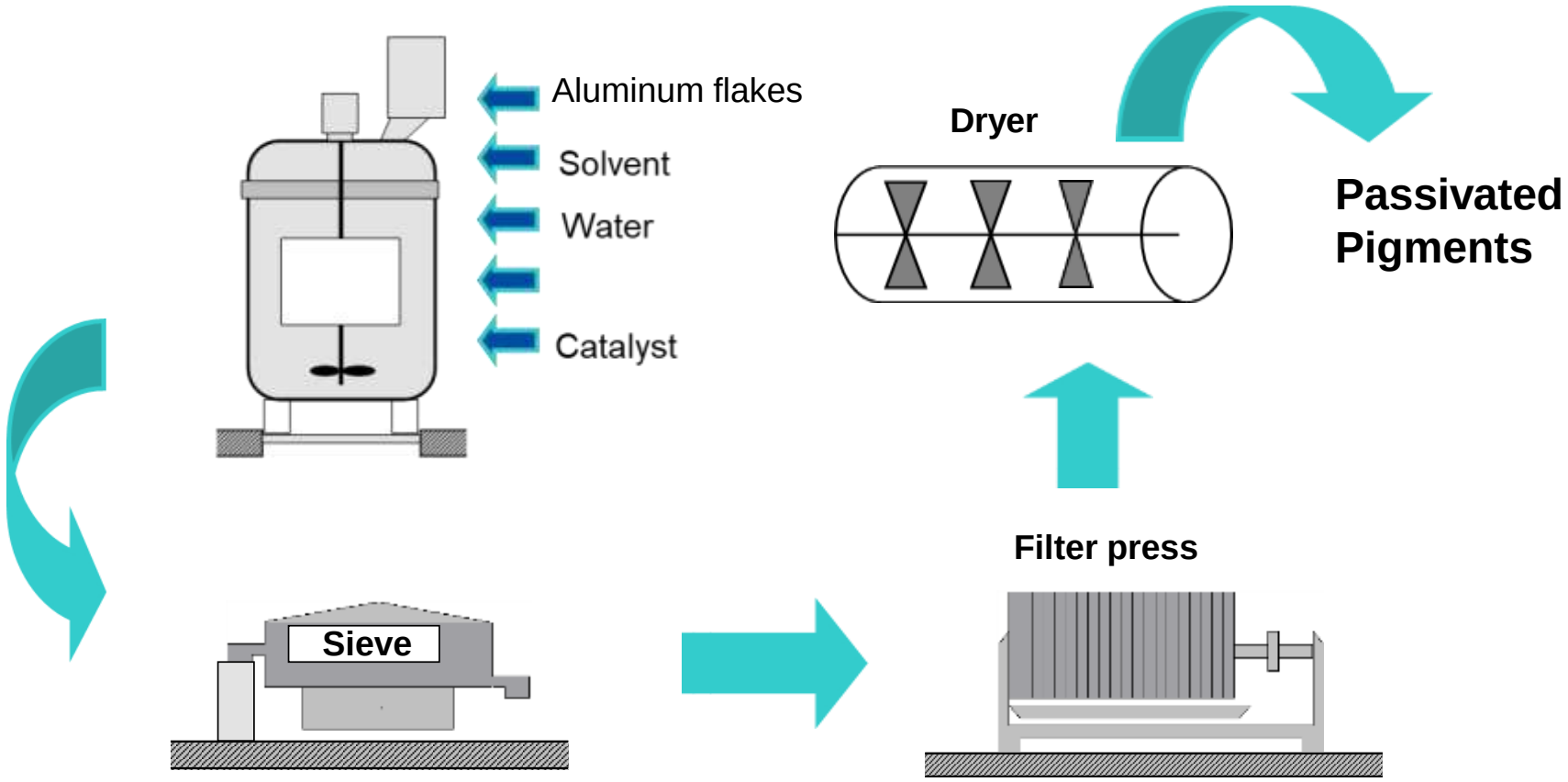


Encapsulation Technology
•Encapsulation of the aluminium pigments with
•metal oxides
•silica layer



$$2\,Al + 6\,H_2O \rightarrow 2(Al)OH_3 + 3H_2$$

Al Pigment Passivation Process



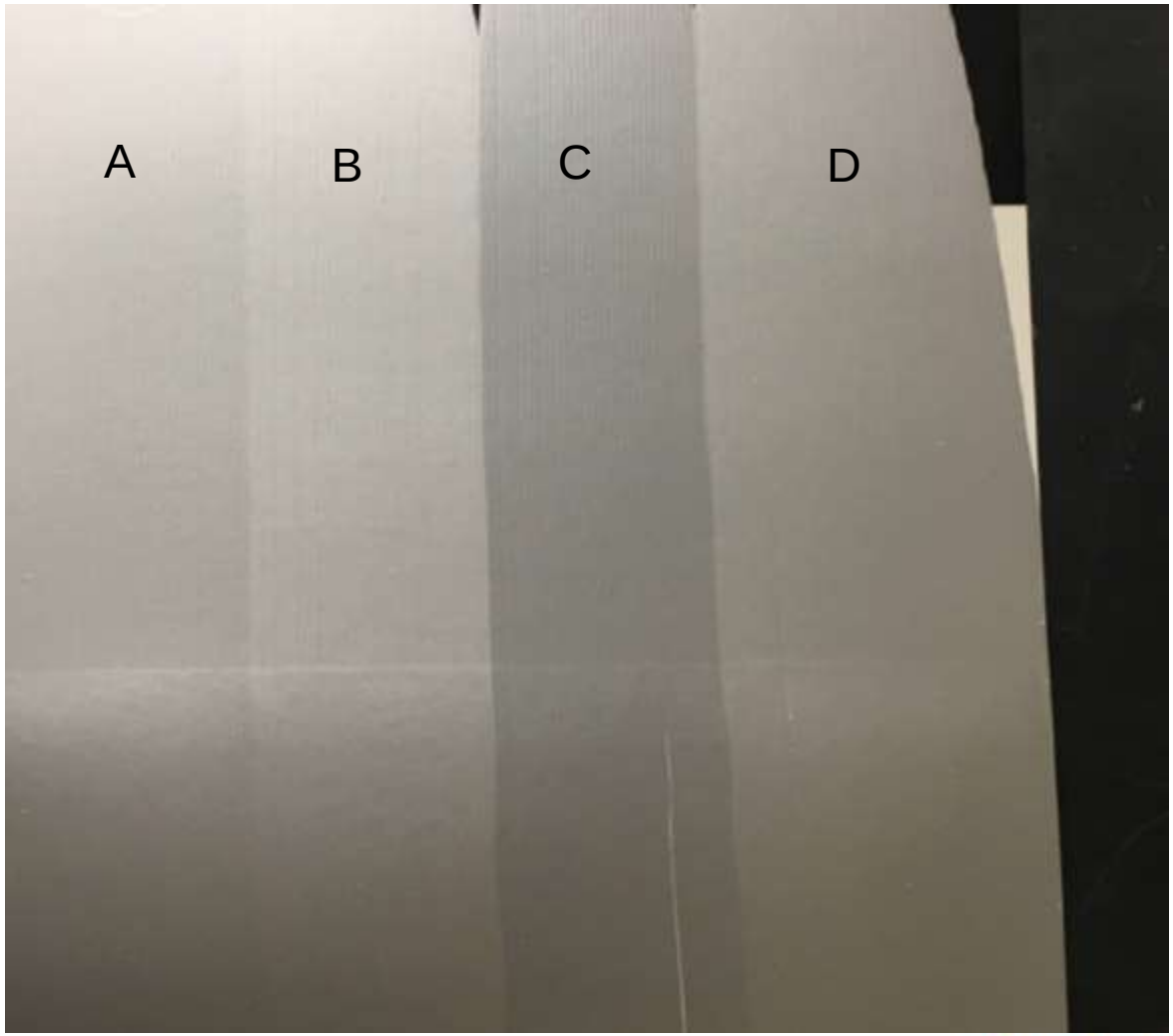
Approaches to an Easily Dispersible Al Flake Pigment

Choice	Preferred
Encapsulated or Passivated	Either
Paste or Solid	Solid
Leafing or Non-Leafing	Both
Compatible with solvents	Yes

Path Forward:
- Evaluate various dispersing chemistries
- Determine physical form

Approaches to an Easily Dispersible Al Flake Pigment – Passivation Chemistry

- Several combinations of resin and wax provide dispersibility in water.
- We see variations in appearance based on these combinations.
- C is the control leafing pigment



Approaches to an Easily Dispersible Al Flake Pigment – Physical Form

- 10% pigment to 90% Aquacron 380
- Stir in and Drawdown after
  - 1 min
  - 2 min
  - 5 min

1 Minute Mix Time

Physical Form Summary

Property	Granular	Pelletized
Dispersibility	5	4
Viscosity	5	4
Foam	3	4
Settling	4	5
Compatibility with Solvents	4	3
Brightness	5	4
Cost	5	3

Ratings: 5 = best; 1 = worst

Prototype Development

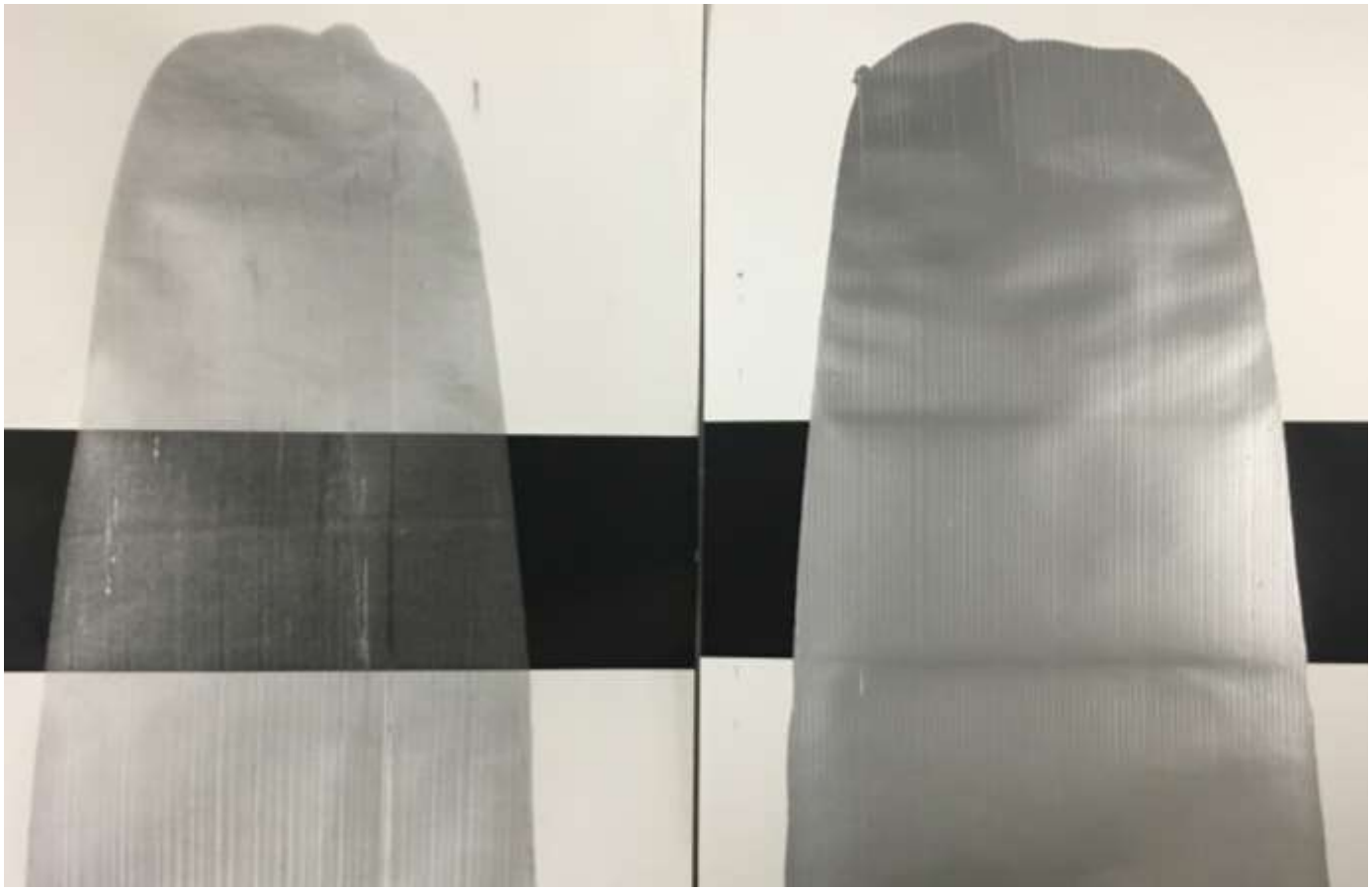
Flake Geometry	Type	D50, microns	Form
Cornflake	Leafing	20	Granulated Pellet
Cornflake	Leafing	27	Granulated Pellet
Cornflake	Non-leafing	9	Granulated Pellet
Cornflake	Non-leafing	19	Granulated Pellet
Silver Dollar	Non-leafing	26	Granulated Pellet
Silver Dollar	Non-leafing	52	Granulated Pellet

Content	%
Stabilized Aluminum	84 - 89
Resin	1
Waxes	10 - 15

Prototype Development

Comparison to WB Paste

Drawdown after 5 min dispersion in clear base



WB Paste Leafing 20 micron CF

Granulated Pellet Leafing 20 micron CF

Prototype Development - Dispersion Ease

Prototype Development - Dispersion Comparison to WB Paste

Performance Evaluations

Resin Compatibility

WB Resins	Resin Type	Ease of Dispersion	Film
Neocryl A 6016	Acrylic	Fast	Needs coalescing aid (DPM)
Macrynal SM 6826w/43WA	Acrylic	Fast	Good
Neocryl A 6075	Styrenated Acylic	Fast	Good
NeoRez R 4000	Aliphatic Urethane Hybrid	Fast	Good
NeoRez R 9029	Aliphatic Urethane Hybrid	Fast	Needs coalescing aid (DPM)
Daotan TW7010/36WA	Polyurethane Dispersion	Fast	Good
Resydrol AN 6617w	Polyester	Fast	Good
Rovace 661	Vinyl Acrylic	Fast	Whitening
Avicor 325	Vinyl Acetate - Acrylic	Fast	Good
EpiRez 6520-WH53	Epoxy	Fast	Good

Performance Evaluations

pH Stability

	Tested Material, % component				pH	
Pigment Type	Pigment	Di Water	NeoRez 9029		Initial	78 Days Ambient
19 micron Non-Leafing Cornflake	33	67	--		6.1	5.9
	10	20	70		7.2	7.2
20 micron Leafing Cornflake	33	67	--		5.8	5.7
	10	20	70		7.2	7

Aging Stability

A 9 micron non-leafing cornflake was aged 3 months at 120F and added to commercial clears

		Film Appearance	
Clear	Description	Initial	Aged
PPG Aquacron 870 LC HV	Acrylic urethane, low gloss	Good	Good
PPG Aquacron 380 WB	Acrylic paint	Good	Good
SW Kem Aqua 8710	Acrylic modified alkyd	Good	Good

Performance Evaluations

Humidity Resistance

Coating	Wt %
Mix 5 min to Uniform Dispersion	
Water	12
20 Micron leafing Granulated Pellet	8
Add	
SW Kem Aqua 8710	80

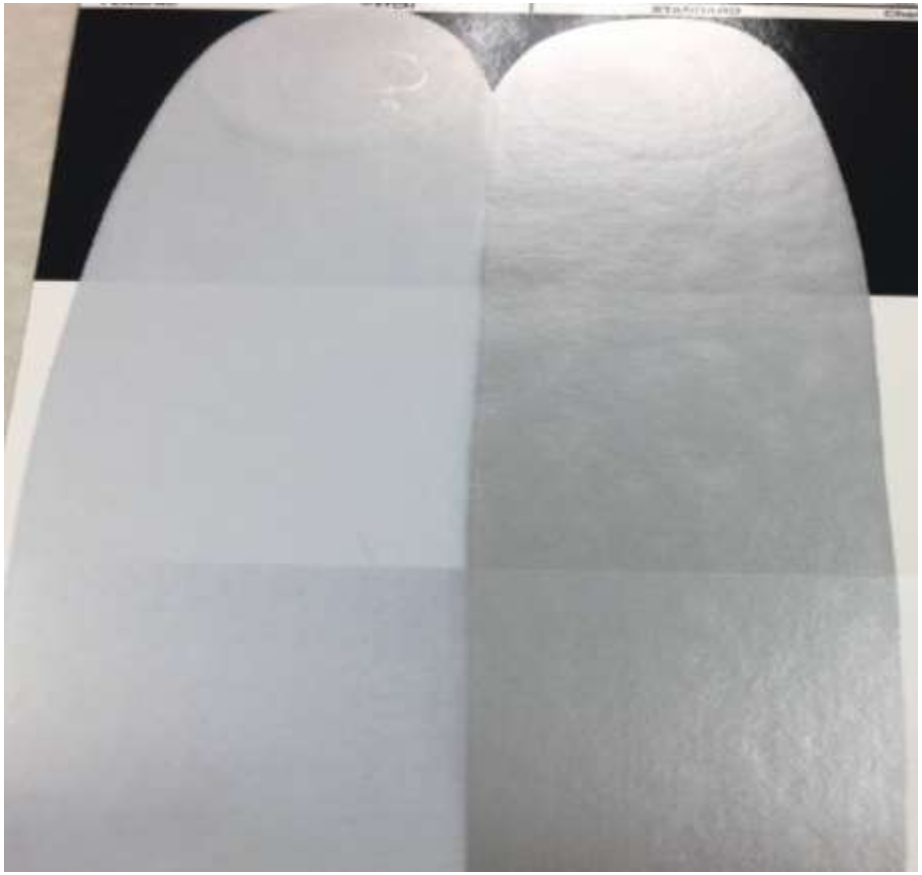
- Spray applied to steel panels
- DFT ~ 3 mils
- Tested on QUV vs WB paste

168 Hrs

336 Hrs

Performance Evaluations

Solvent solubility



Mineral Spirits N-Butyl Acetate

19 micron non-leafing Granule

Mineral Spirits N-Butyl Acetate

20 micron leafing Granule

Washed-out look in MS indicates resin on flake more compatible in polar solvents

Summary

Granulated Pellets

- Dispersion time in water or solvent is approximately 3 - 5 min
- Dispersion time: 10 - 15 min for finished paint systems, depending on wetting properties, viscosity, and batch size
- Draw down on lanetta chart or mylar film to confirm adequate dispersion.
- Draw down should be free of seeds / grit / clumps, etc.

Acknowledgements

- Sean Brown
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Thank you for your attention

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