

Design of Mica Effect Pigments for Long Term Durability in Powder Coatings

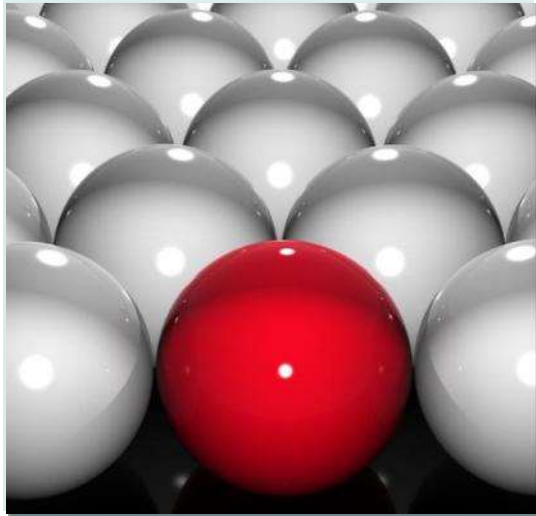
Bonnie Piro

Technical Marketing Manager

SUDARSHAN

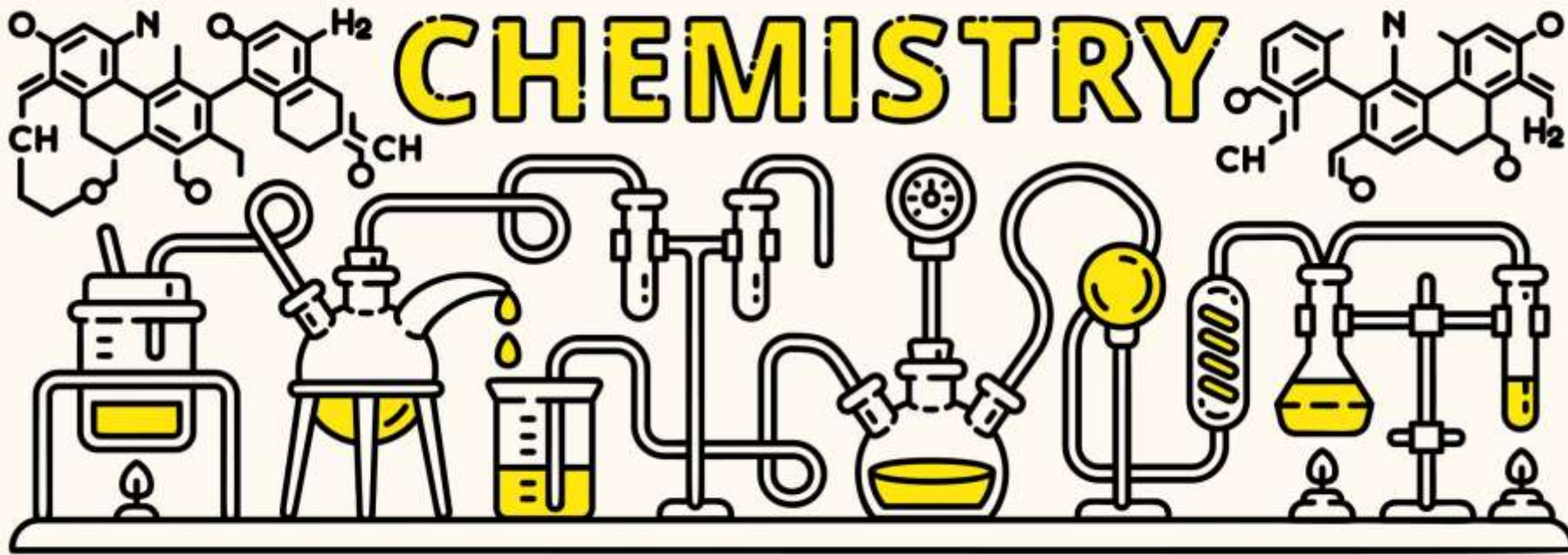


Why Use Effect Pigments?



- ❖ Effect pigments let manufacturers develop their own distinctive color effects.
- ❖ Colors support the balancing act between function and aesthetics, technology and art.
- ❖ Customers buy not only for purely rational reasons but also with their heart.
- ❖ Around 70% of buyers opt for an effect color regardless of the color they choose.





It is more than just chemistry...

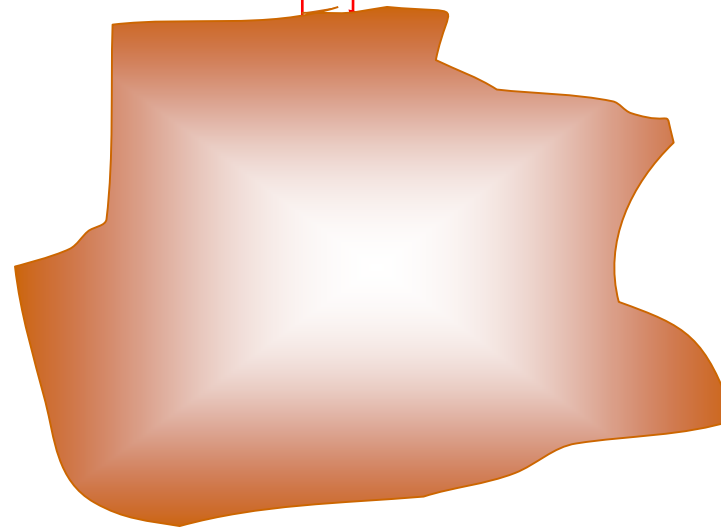
How is pearl effect is created?

MICA PLATELET

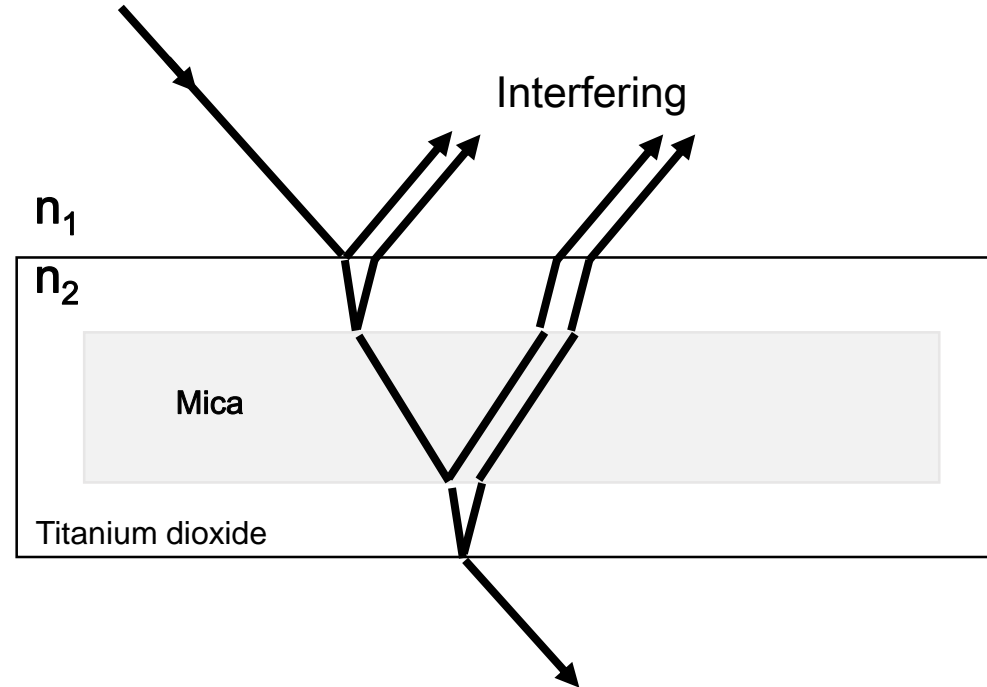
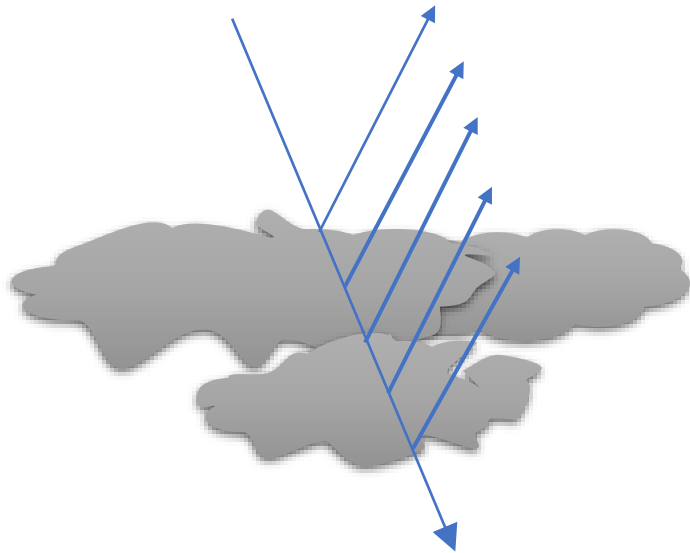
**REFRACTIVE INDEX 1.4
TO 1.5**

METAL OXIDE

**REFRACTIVE INDEX
2.7 TO 3.2**

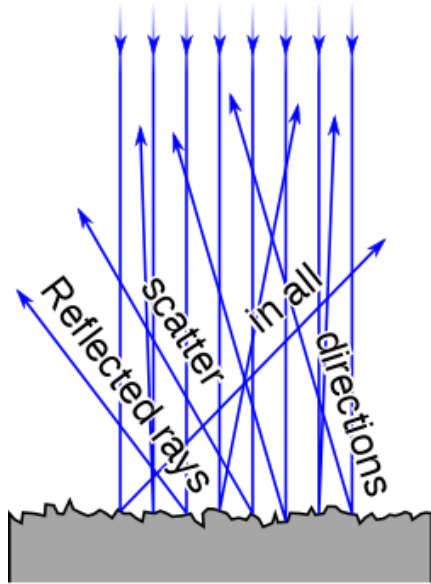


How is pearl effect is created?



- Thin and translucent platelets (mica) of high refractive index
- Ability to partly reflect & transmit incident light
- Multiple parallel reflections over oriented particles

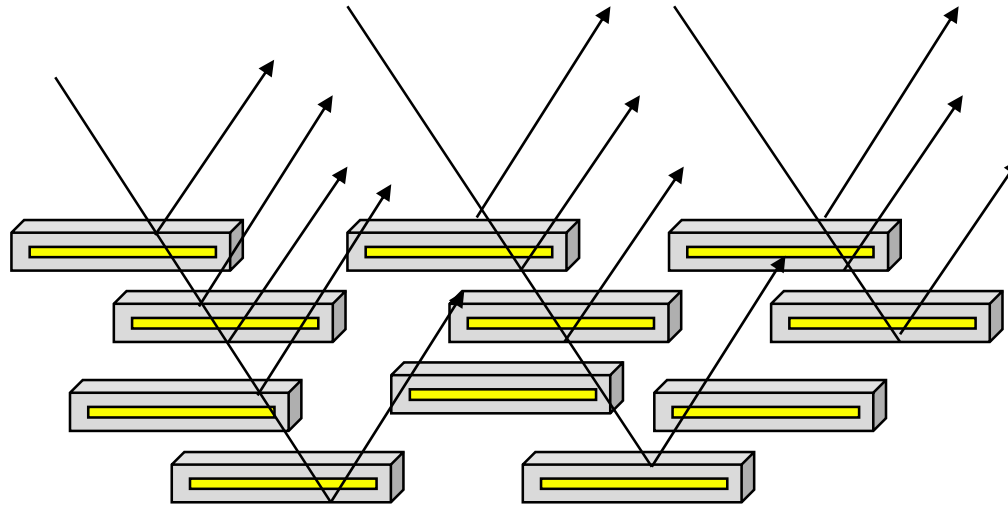
light rays shining on a surface



Each particle

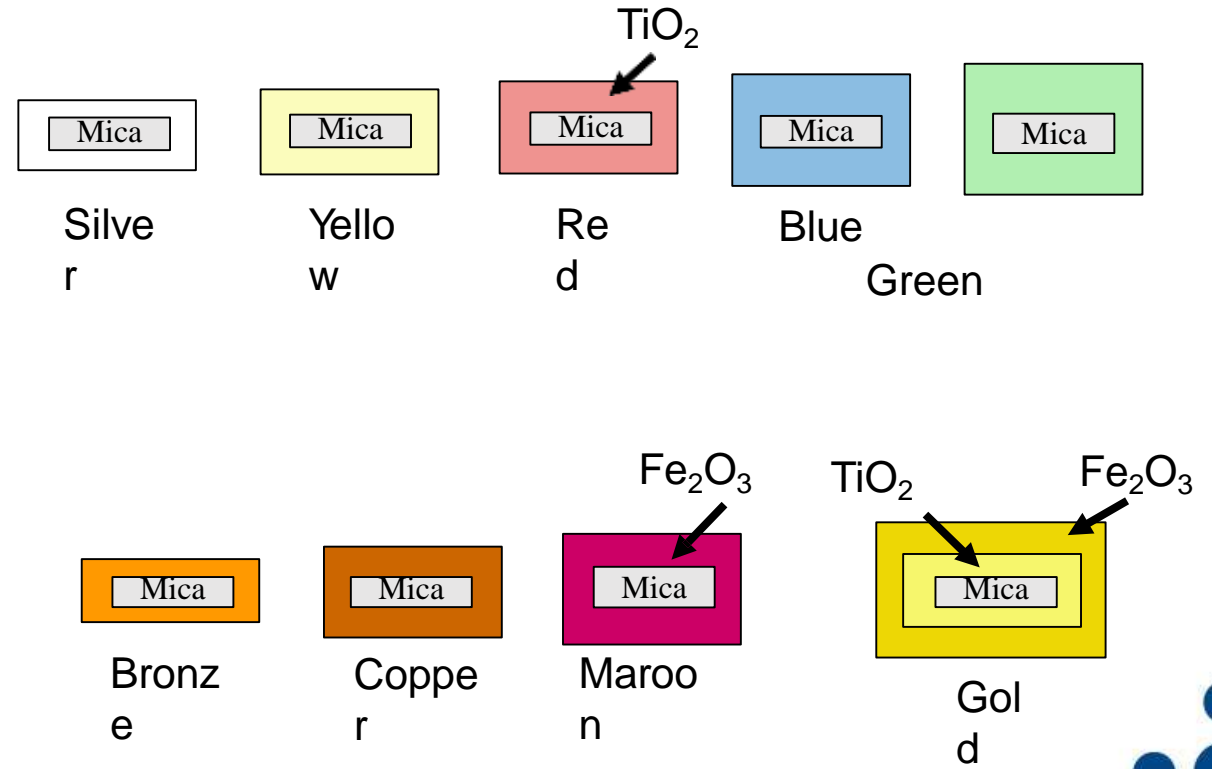
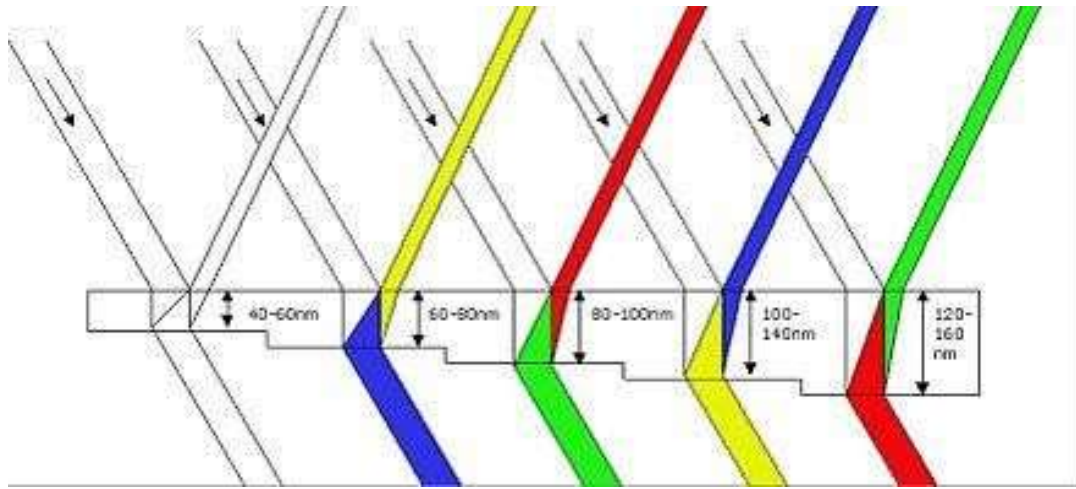


film with particles



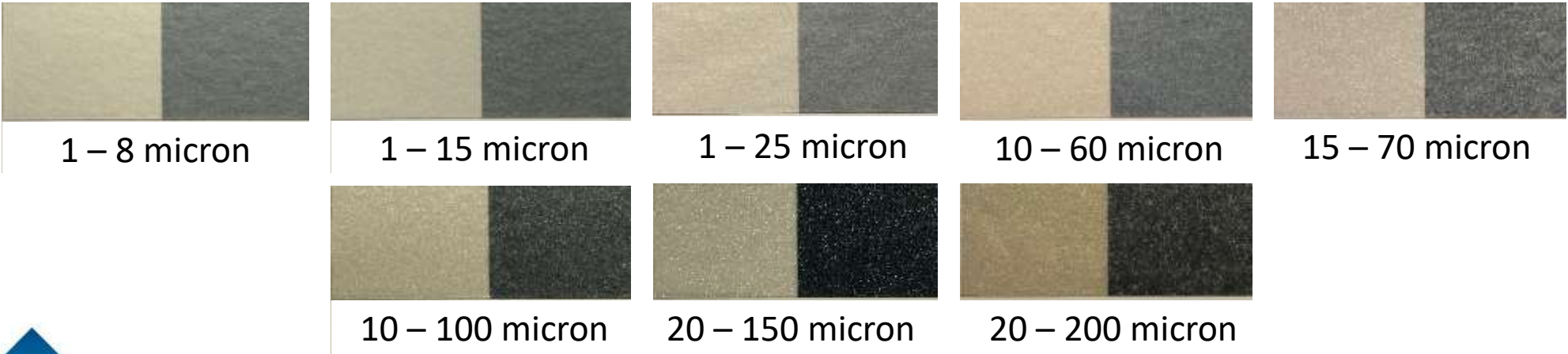
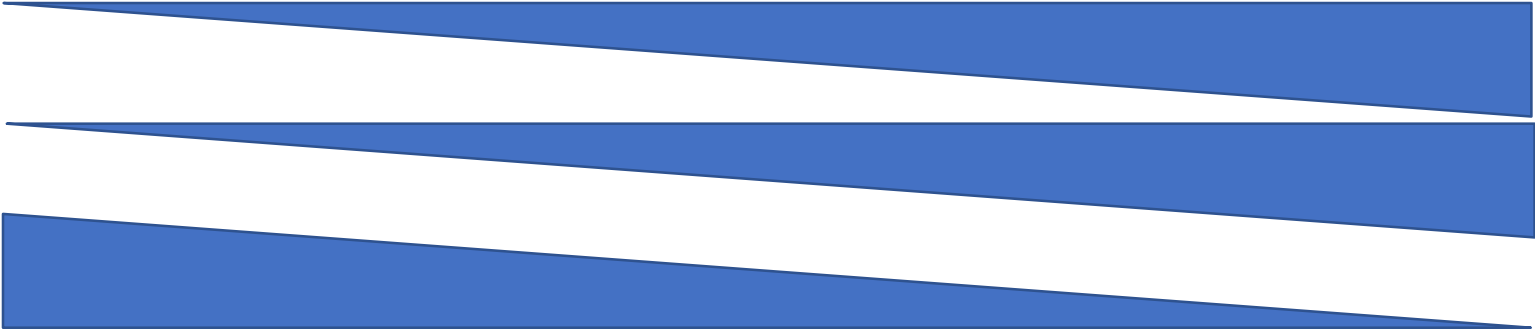
COLOR
&
EFFECT

Coating Thickness Defines Color



Mica Size Defines Sparkle, Brightness and Coverage

Fine  Coarse



1-8 μm 1-15 μm 5-25 μm 10-50 μm 15-70 μm 20-150 μm

Visual effects depending on particle size 



Substrate Type Defines Chroma, Sparkle and Cost

Natural  Synthetic

Chrom
a

Sparkle

Cost



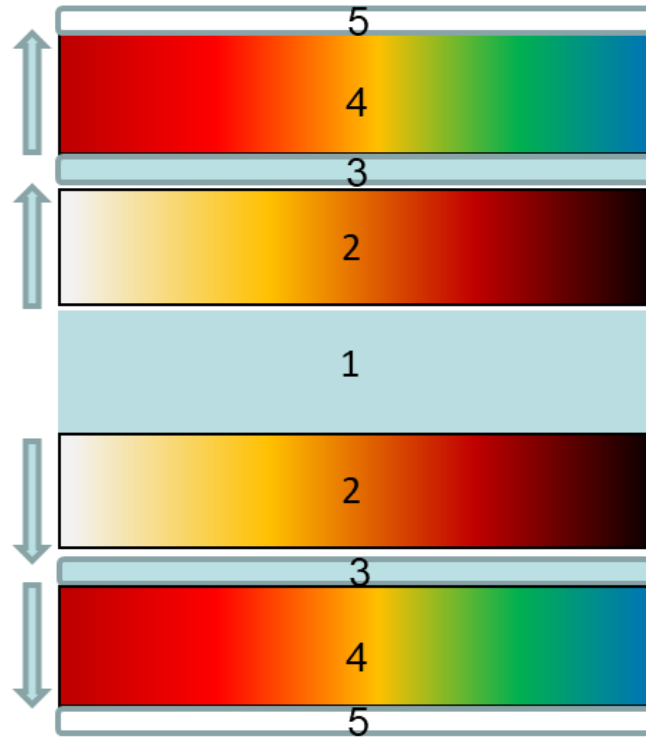
New Effect Color Development

Layer 1: Substrate

- Natural mica
- Synthetic mica
- Thickness
- Particle size & distribution

Layer 2: Metal Oxide, Organic

- TiO_2
- $\text{Fe}_2\text{O}_3 / \text{Fe}_3\text{O}_4$
 - Gold
 - Red
 - Black
- CICP
- Organic
- Thickness
- Multiple layers



Layer 3: Bonding Agent

- Pigment chemistry

Layer 4: Pigment

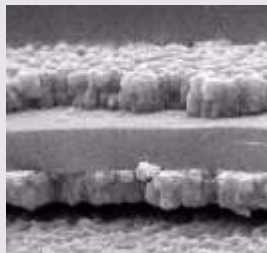
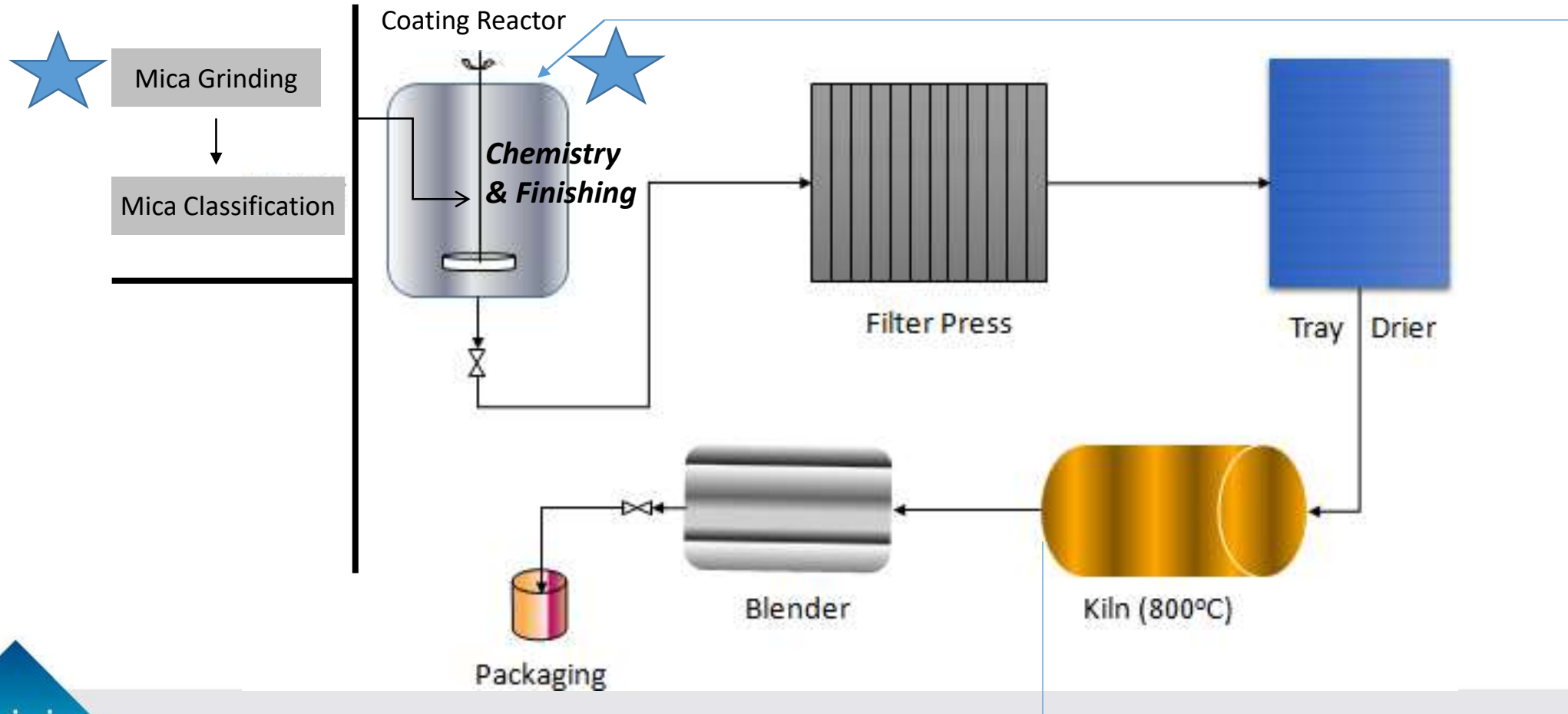
- Organic
- Inorganic
- Thickness of layer
- More than one layer

Layer 5: Weather Treatment

- Chemistry
- Thickness (by weight or surface area)
- Multiple layers

Many color options

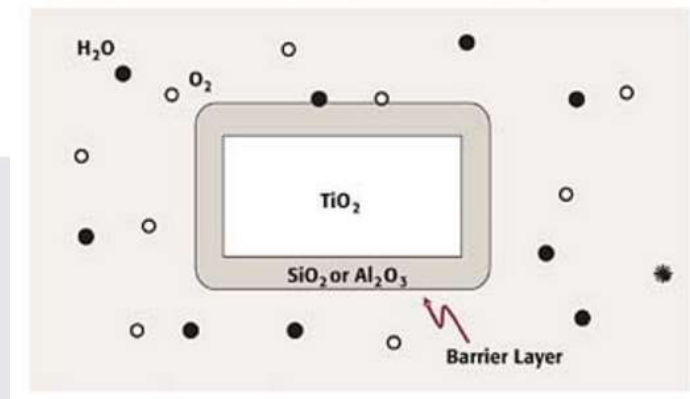
Effect Pigment Manufacturing



Example of substrate coated with metal oxide

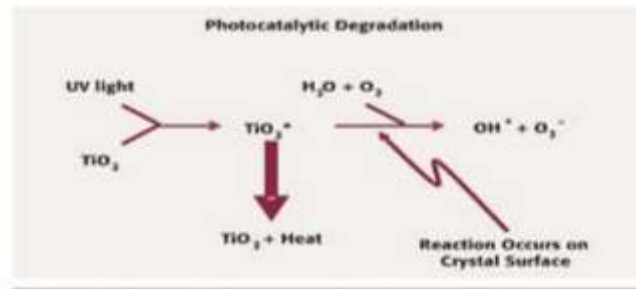
Surface Treatments

- What is the difference between a surface treatment and encapsulation?
 - Encapsulation completely covers the surface of what is being encapsulated.
 - A surface treatment only modifies the surface that is being treated. The surface that is being treated may still have exposed areas.
 - When selecting a treatment to correct a physical failure of a pigment or particle, the mechanism of the failure must be identified and known.

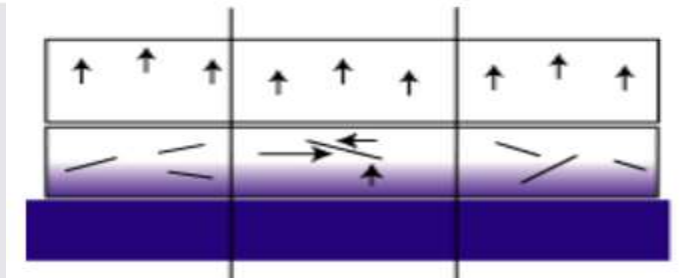


Mica Surface Treatment

- *Why use a surface treatment?*
 - Primary coatings for mica's are titanium dioxide and iron oxide.
 - *Iron oxide is stable when exposed to UV radiation, however titanium dioxide may undergo photocatalytic degradation*



- Substrates for mica pigments have high aspect ratio and are hydrophilic in nature
 - *Mica pigments may provide a wicking action for moisture entry into a film. Also due to the large platelet structure stresses within the film may results in delamination*



Surface Treatments for Pearlescent Pigments

- *Why use a surface treatment or encapsulation?*
 - ✓ To slow or prevent an undesirable reaction from occurring
 - Photo degradation
 - Humidity effects
 - ✓ To change the rheology of the system
 - Improve dispersion
 - Compatibility with the system
 - ✓ To improve overall performance
 - Durability
 - Adhesion



Mica Surface Treatment Investigation

Objectives

1. Surface treatment **chemistry and amount** on weatherability of mica in a powder coating formula
2. Impact of **particle size** on weatherability of mica in a powder coating formula
3. Impact of **metal oxide type and thickness** on weatherability of mica in a powder coating formula

Formulation

- Fluoropolymer thermoset gray powder coating (master batch)
 - AAMA 2605-17 spec
 - 2% mica loading added to master batch

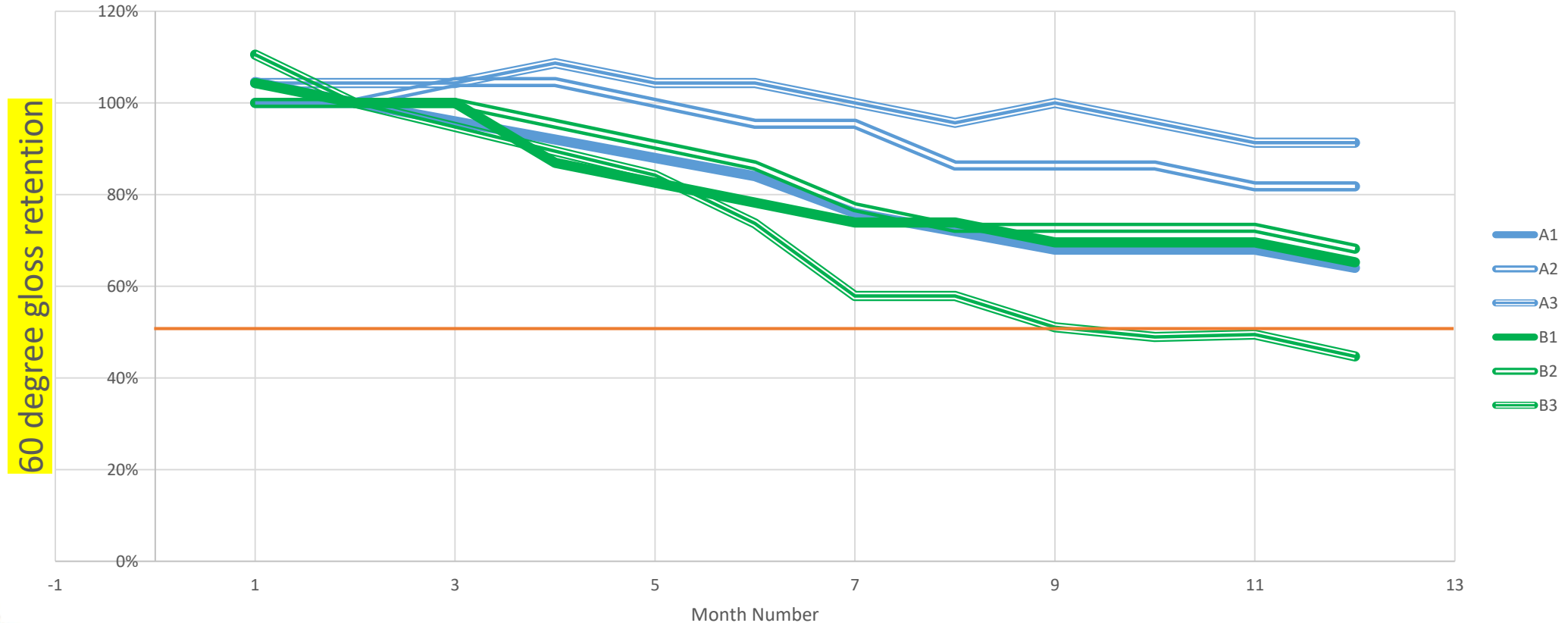
Testing

- Ultra Accelerated EMMAQUA, 1 cycle (12 months)
- Florida (out to 5 years; 2 years complete)
- Xenon (out to 3000 hours)

Surface Treatments for Pearlescent Pigments

Objective 1

ST Chemistry and Amount Impact (UA)



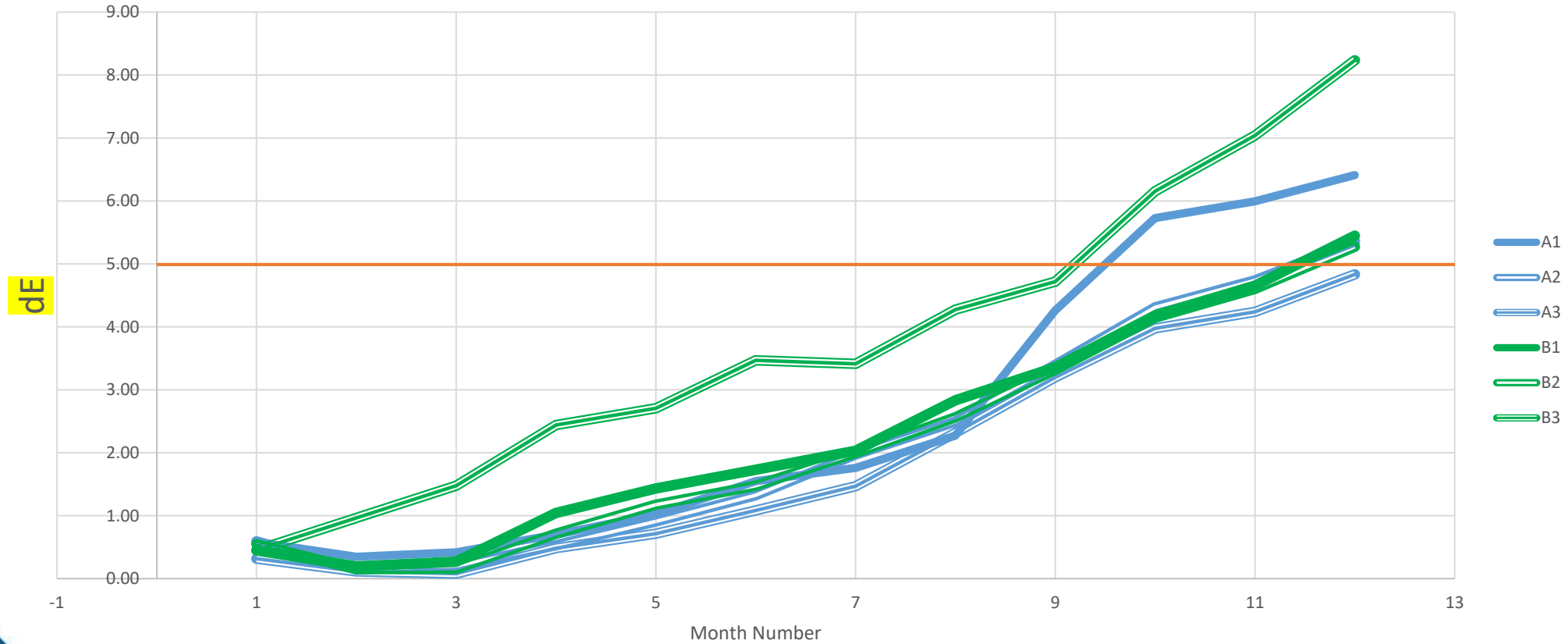
Silver Mica, 1 – 15 micron

A – Chrome-Containing Surface Treatment
B – Chrome-Free Surface Treatment

Surface Treatments for Pearlescent Pigments

Objective 1

ST Chemistry and Amount Impact (UA)

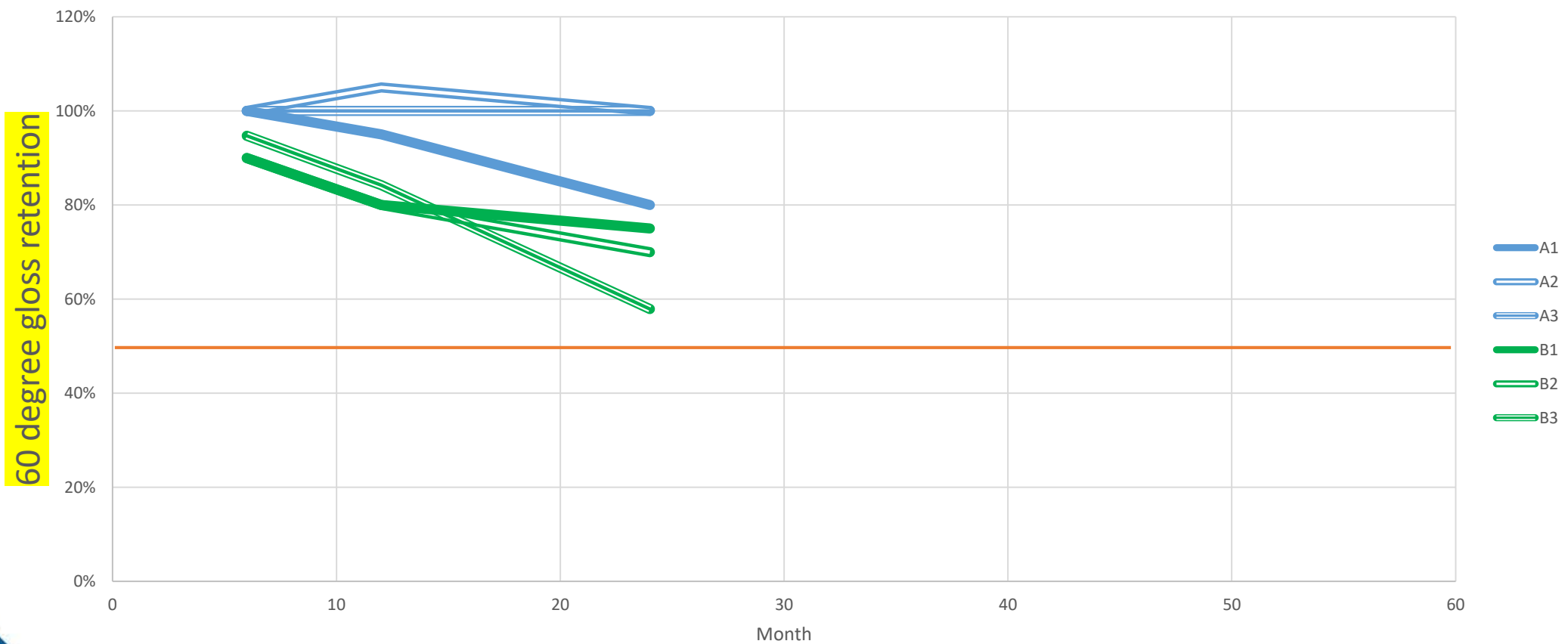


Silver Mica, 1 – 15 micron

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B – Chrome-Free Surface Treatment

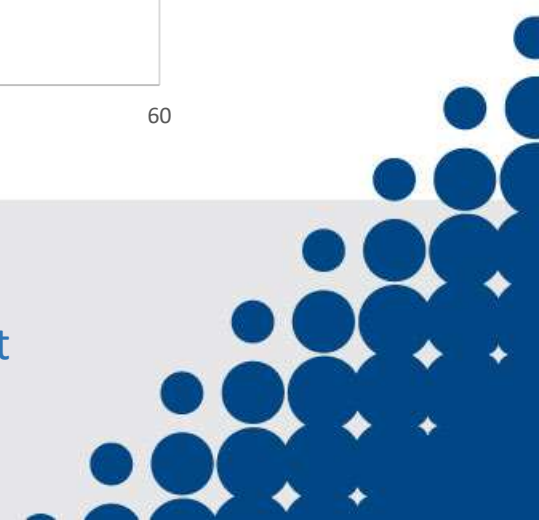
Surface Treatments for Pearlescent Pigments

ST Chemistry and Amount Impact (Fla)



Silver Mica, 1 – 15 micron

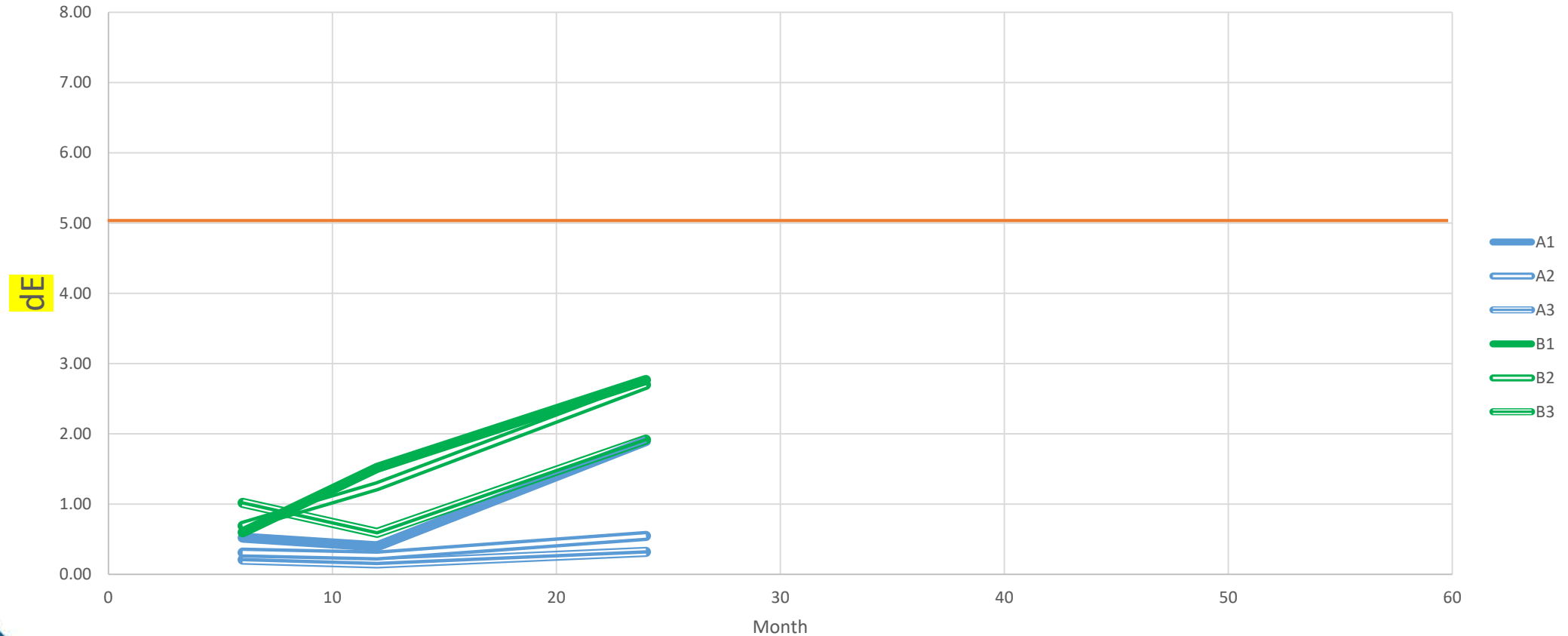
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Surface Treatments for Pearlescent Pigments

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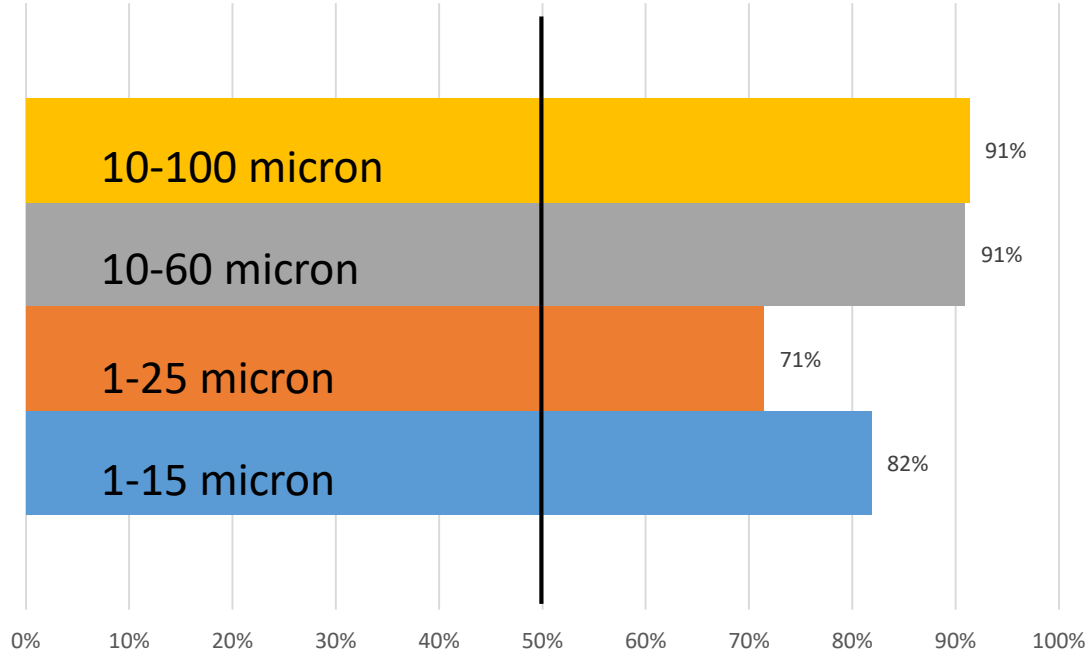


Silver Mica, 1 – 15 micron

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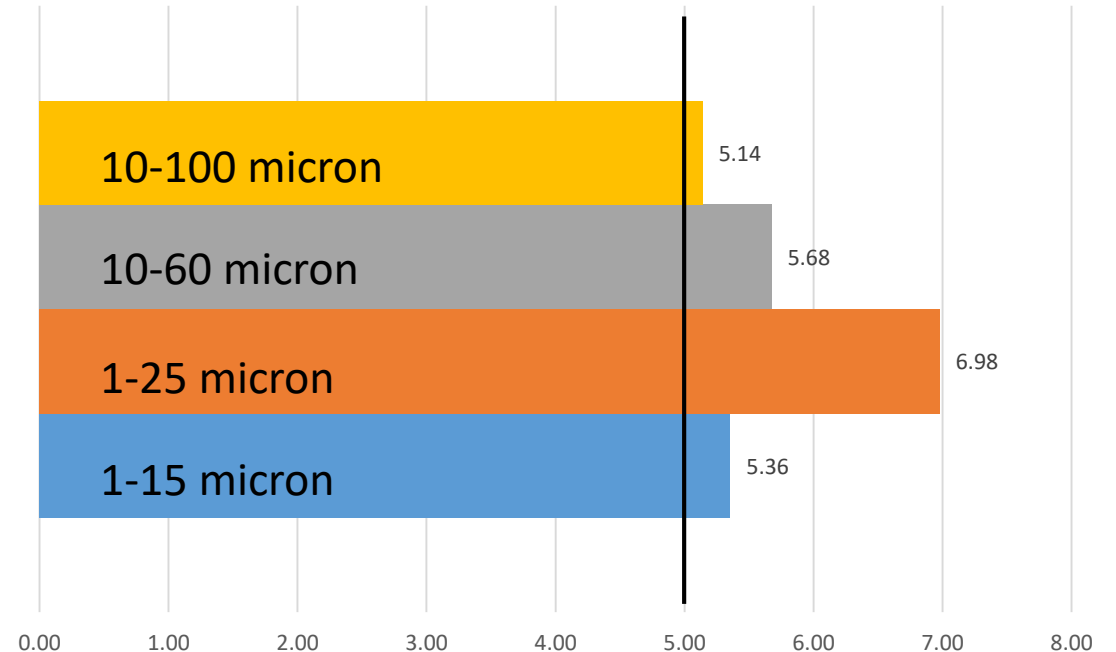
Surface Treatments for Pearlescent Pigments

Particle Size Impact (UA)



60 degree gloss retention

Particle Size Impact (UA)



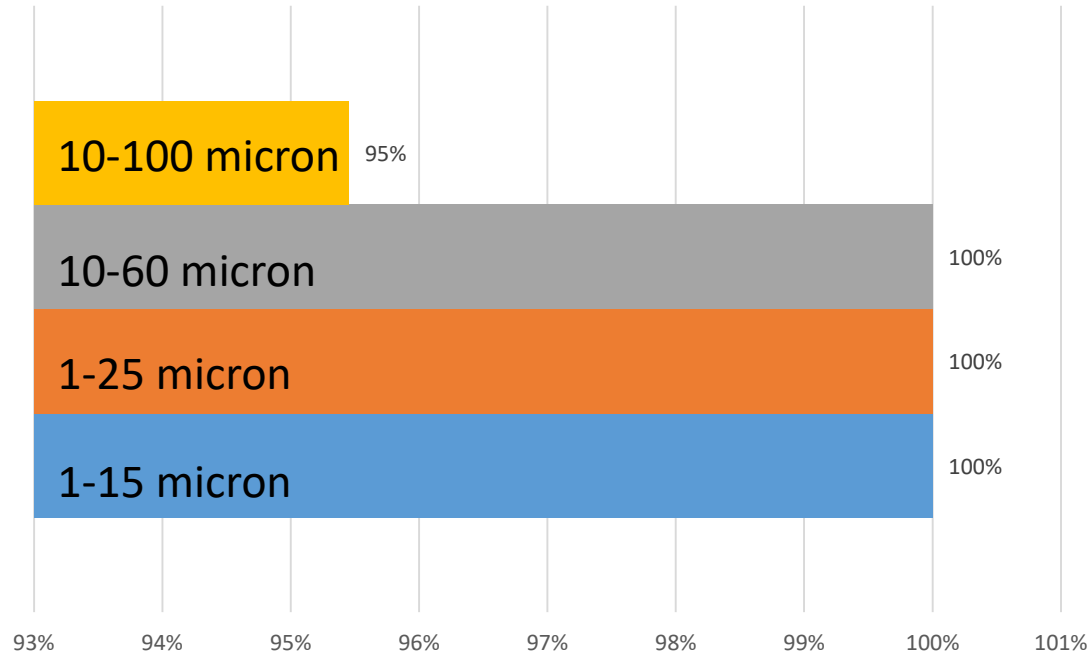
dE



All silver micas with the same surface treatment chemistry and amount
12 months exposure

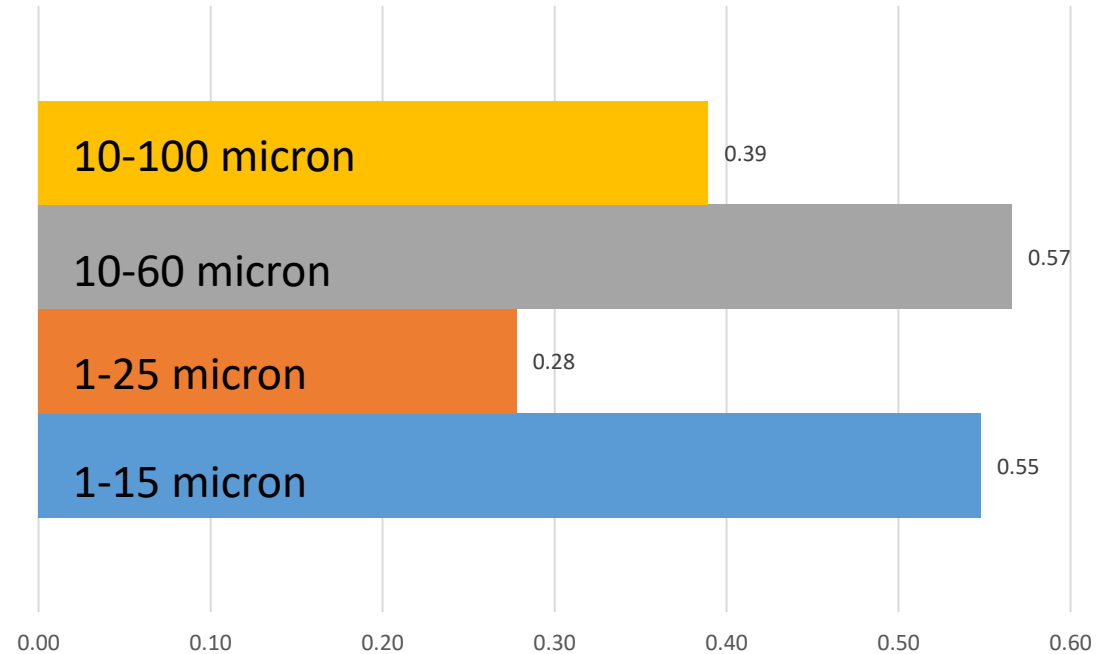
Surface Treatments for Pearlescent Pigments

Particle Size Impact (Fla)



60 degree gloss retention

Particle Size Impact (Fla)



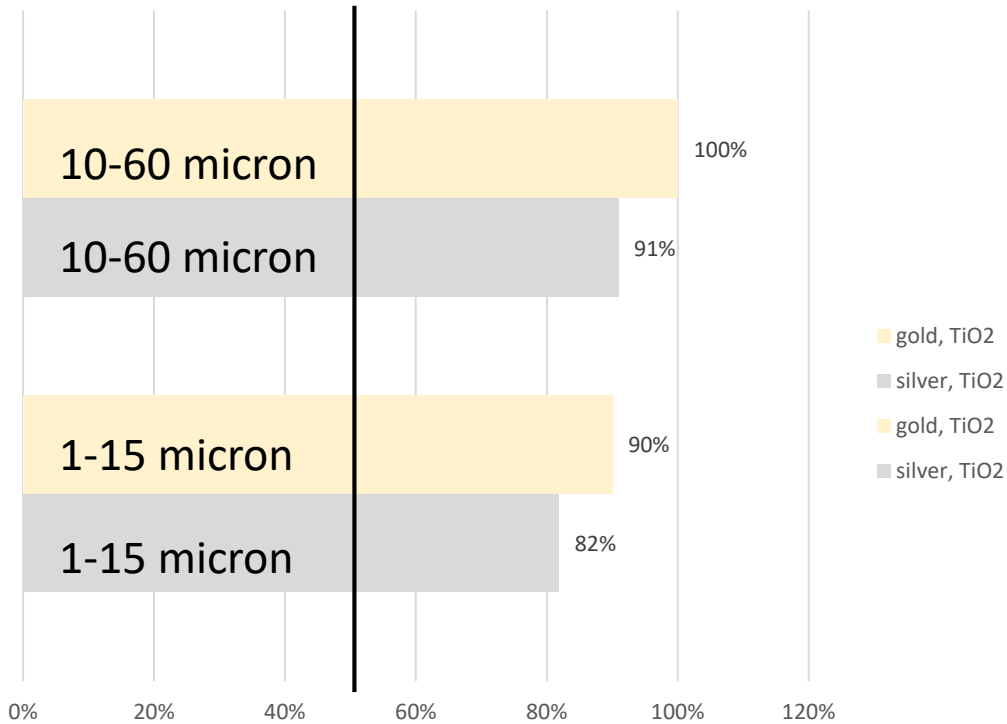
dE



All silver micas with the same surface treatment chemistry and amount
2 year exposure

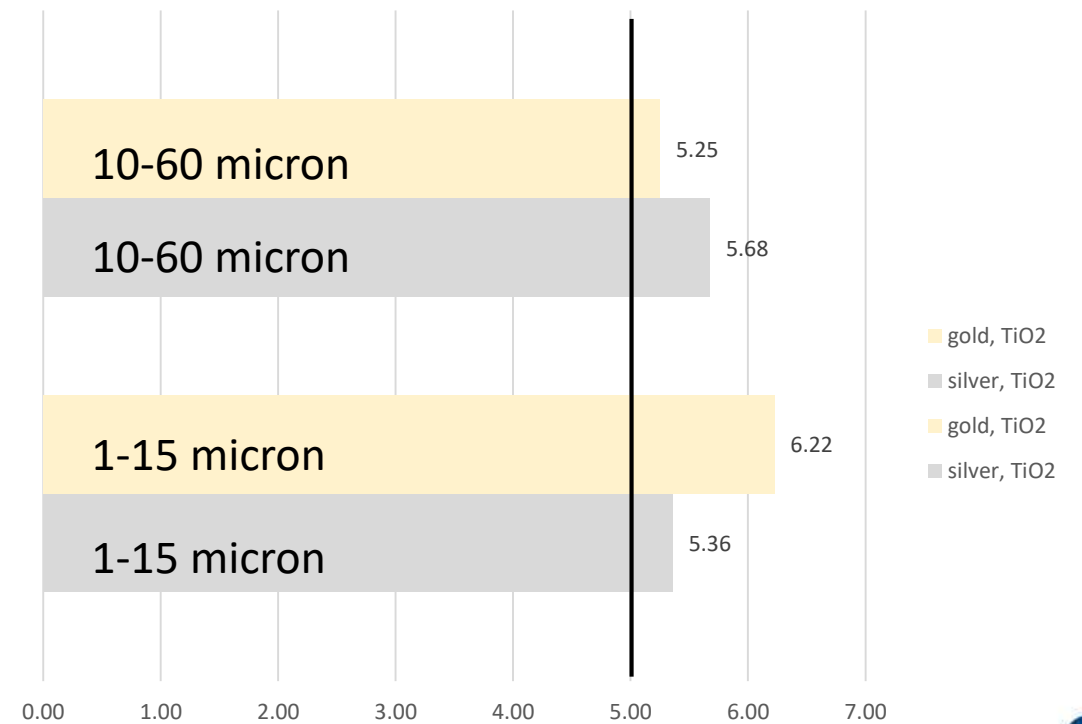
Surface Treatments for Pearlescent Pigments

Base Metal Oxide Thickness Impact (UA)



60 degree gloss retention

Base Metal Oxide Thickness Impact (UA)



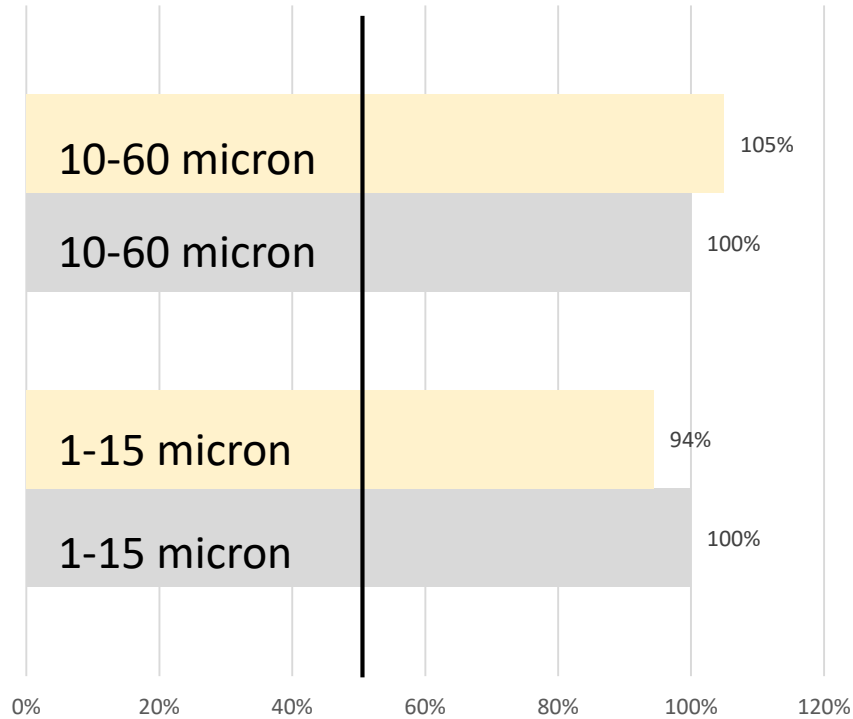
dE



All micas have the same surface treatment chemistry and amount
12 month exposure

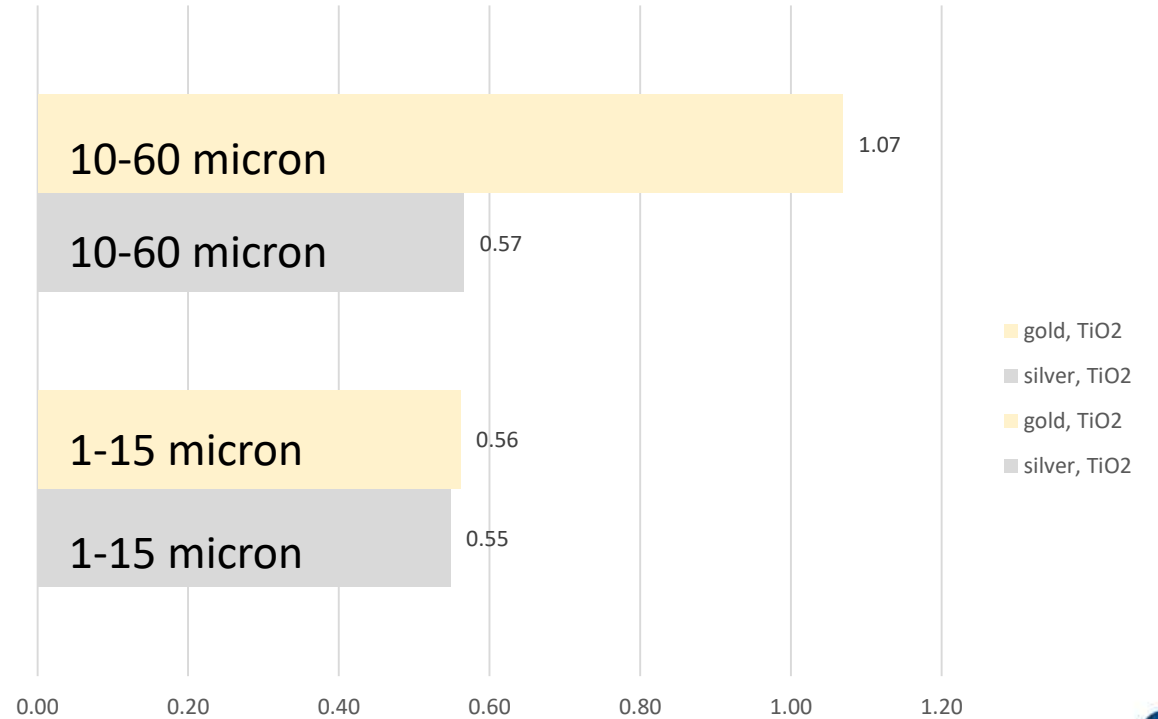
Surface Treatments for Pearlescent Pigments

Base Metal Oxide Thickness (Fla)



60 degree gloss retention

Base Metal Oxide Thickness (Fla)

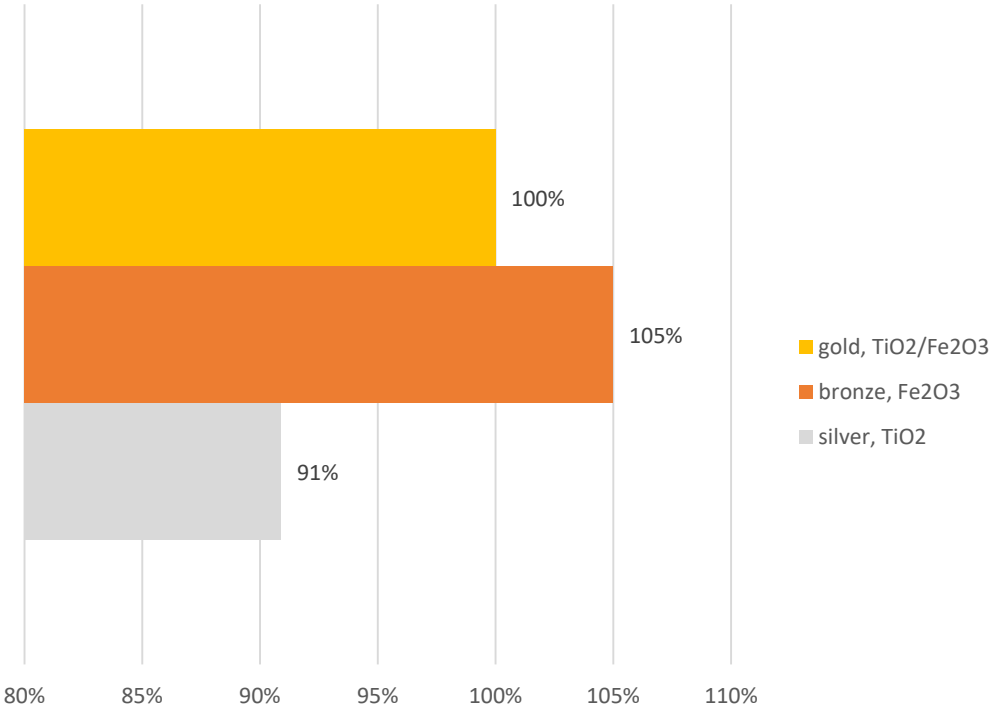


dE

All micas have the same surface treatment chemistry and amount
2 year exposure

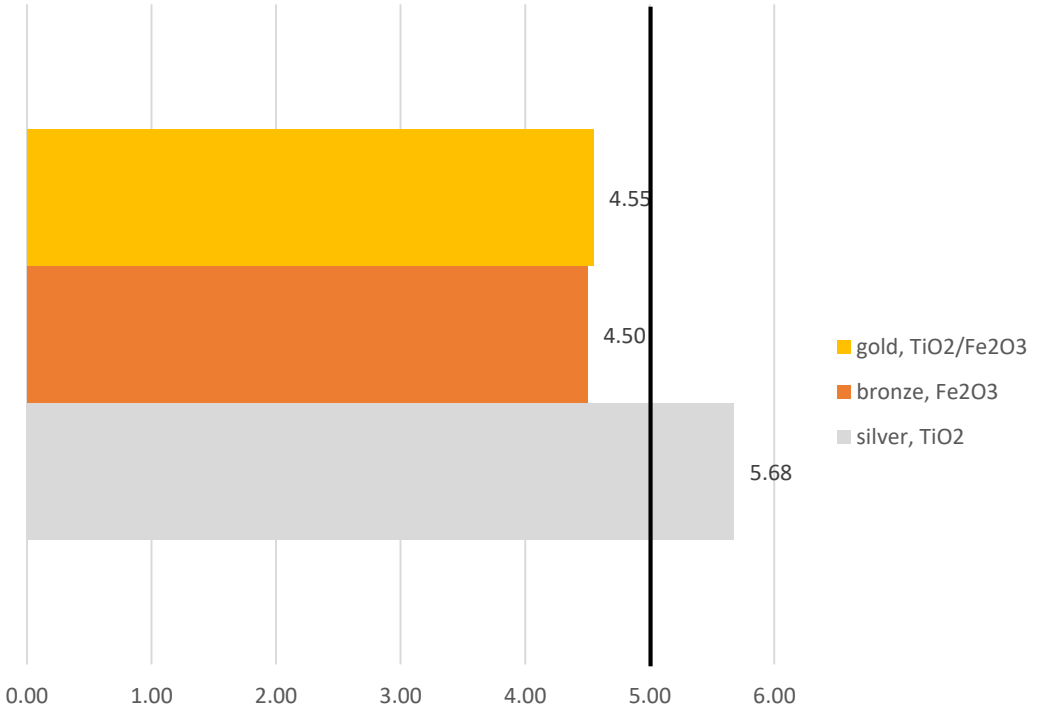
Surface Treatments for Pearlescent Pigments

Metal Oxide Type Impact (UA)



60 degree gloss retention

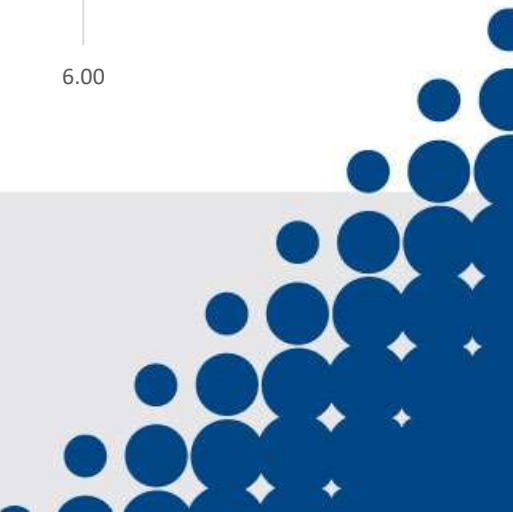
Metal Oxide Type Impact (UA)



dE

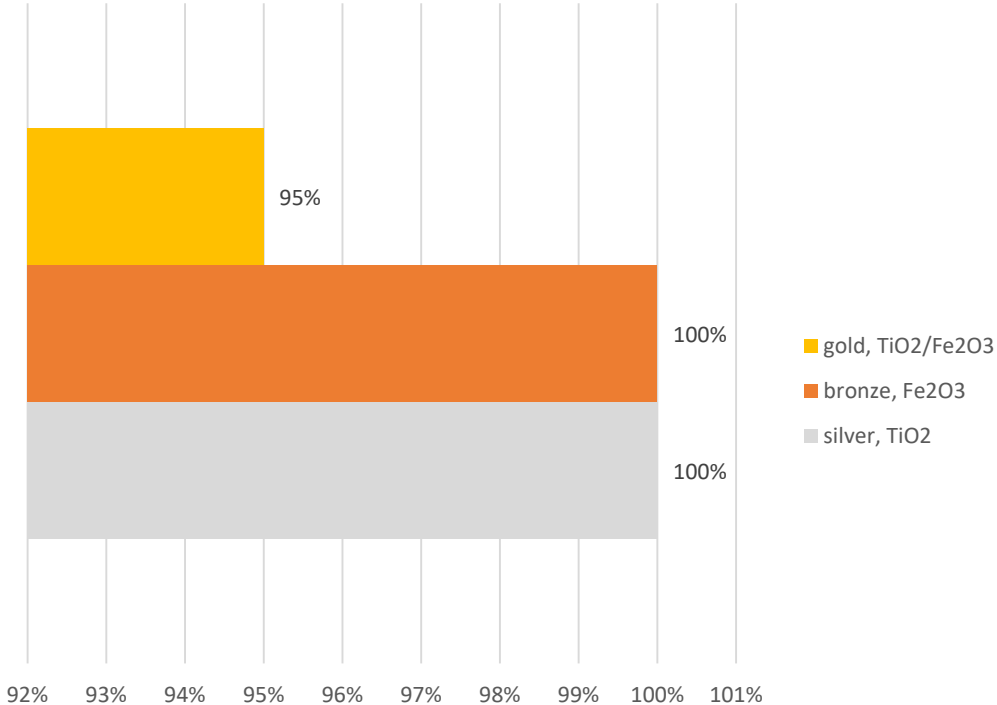


All 10 – 60 micron and same treatment chemistry and amount
12 month exposure



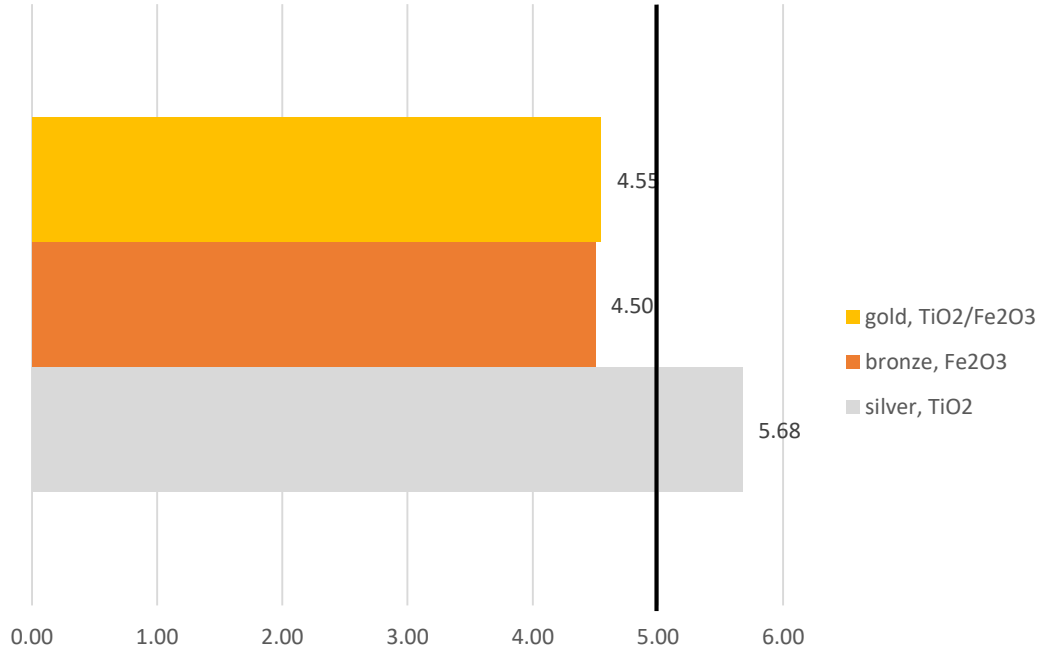
Surface Treatments for Pearlescent Pigments

Metal Oxide Type Impact (Fla)



60 degree gloss retention

Base Metal Type Impact (2 year Florida)



dE



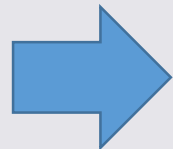
All 10 – 60 micron and same treatment chemistry and amount
2 year exposure

Surface Treatments-Summary

- ❖ Pearlescent pigments provide unique aesthetics but may have undesirable effects on performance in a particular application.
- ❖ There is no universal treatment for all applications.
- ❖ Surface treatment or encapsulation of mica is designed based on the failure mode of the application.
 - Once the failure mode and mechanism is understood, a surface treatment may be engineered to “fix” the failure.
- ❖ Custom solutions will provide an ultimate performance advantage over the one size fits all compromise.

Surface Treatments-Conclusions

- ❖ Smaller particle size mica (soft luster and high opacity) require a higher amount of surface treatment.
- ❖ Selection of surface treatment chemistry is critical to performance.
- ❖ Micas with TiO₂ undergo photocatalytic degradation; thinner layers of TiO₂ (silver) are more susceptible.
- ❖ Micas with TiO₂ as a first layer do not exhibit photocatalytic degradation.
- ❖ Ultra-Accelerated vs Florida?



Match surface treatment to color/effect
and performance requirements!



Questions?



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SUDARSHAN