Measuring and Controlling Wet Hiding of Architectural Coatings

Shan Jiang, David Fasano, David G. Kelly, Linda Adamson
Dow Coating Materials
Fundamentals of Hiding

Hiding (Opacity)
The ability of a paint to obscure the surface upon which it is applied

Interaction with Light
Scattering is the key in improving paint hiding performance

- Reflection
- Transmission
- Absorption
- Scattering
What Determines Scattering Power

Path length
- Thicker film: more than one coat

Concentration of scattering particles
- Higher TiO₂ formulation (higher cost)

Contrast in refractive index
- 250 nm TiO₂
- Opaque polymer
- Other extenders

Distribution of scattering particles
- Extender package
- Pre-composite polymer technology
**What Is Wet Hiding**

**Definition**
The hiding of the paint when it is first applied to the substrate, usually for white and pastel paints.

**Observation**
Wet hiding does not correlate to the final dry hiding.

**Significance**
Consumers (DIY) - First impression: good wet hiding = high quality
Contractors – Calibration: amount of paint applied is affected by wet hiding.
How to Measure on Wet Paint

Measure reflection in-situ when the paint dries

✓ Contrast Ratio
✓ Tint Strength (Y Reflectance)
✓ Scattering Coefficient (S/mil)

![Diagram showing how to measure on wet paint]

![Graph showing typical hiding changes during drying]

- Paint with TiO₂
- Paint with TiO₂ and Opaque Polymer
- Paint with reduced TiO₂ and Opaque Polymer
Comparison of 3 Hiding Technologies

Pre-composite Polymer

Opaque Polymers

Extender Calcined Clay

High Throughput Measurement Using Mixed Design of Experiment

<table>
<thead>
<tr>
<th>Pigmentation Factor</th>
<th>PVC %</th>
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<tbody>
<tr>
<td></td>
<td>Lower Limit</td>
</tr>
<tr>
<td>TiO₂</td>
<td>5</td>
</tr>
<tr>
<td>Opaque Polymer</td>
<td>0</td>
</tr>
<tr>
<td>Calcium Carbonate (12 µm)</td>
<td>20</td>
</tr>
<tr>
<td>Calcined Clay (1.5 µm)</td>
<td>10</td>
</tr>
<tr>
<td>Total PVC</td>
<td>45</td>
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</tbody>
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1. Pre-Composite Polymer

**TiO$_2$ adsorption polymer**
Latex binder designed to adsorb onto TiO$_2$ to improve hiding

**Composite Ratio**
Sufficient pre-composite polymer to cover surface

**Improved TiO$_2$ distribution**
- Less crowding
- Greater scattering efficiency
- Micrographs show the improved distribution
Mixture Design: Hiding vs. TiO$_2$ level

- Wet scattering is driven by TiO$_2$ level
- Use of pre-composite polymers allows for improved wet scattering
2. Opaque Polymer

- Opaque Polymer helps save TiO$_2$
- With reduced TiO$_2$ formulation, wet scattering is usually lower
Opaque Polymer

TiO$_2$ PVC is set at 5%

☑️ Opaque Polymer does not change wet scattering
3. Calcined Clay

Calcined Clay slightly improves wet scattering when used at very high levels.

TiO₂ PVC is set at 5%
✓ Only TiO$_2$ and pre-composite polymer have a significant effect on wet scattering
Case Study in a Satin Formulation

Quality Acrylic Satin Formulation
40 PVC; 36 VS; Rheology Modifier: HEUR

Reduce $\text{TiO}_2$ Level using 3 strategies
✓ Pre-composite polymer
✓ Opaque polymer
✓ Calcined clay

Maintain PVC, VS and Dry Tint Strength
✓ Similar gloss; some extender changes; not exact match

Measure Wet Contrast Ratio and Tint Strength
Dry Tint Strength of TiO$_2$ Reduction Strategies

- **15% TiO$_2$ Reduction**
- **Equal Dry Tint Strength**

3 strategies can help reduce 15% TiO$_2$ while maintaining the dry hiding.
Wet Tint Strength of TiO₂ Reduction Strategies

✓ Pre-composite polymer allows for a minimal loss of Wet Tint Strength at 15% TiO₂ Reduction

✓ Greater loss for calcined clay and opaque polymer, proportional to TiO₂ reduction
Wet Hiding of TiO₂ Reduction Strategies

- 24% TiO₂ Reduction
- Equal Dry Tint Strength

✓ Combination of strategies can help further reduce 24% TiO₂ while maintaining the dry hiding
Wet Tint Strength of TiO₂ Reduction Strategies

- Pre-composite polymer with opaque polymer allows for large TiO₂ reduction with a moderate loss of Wet Tint Strength.
- Greater loss for higher level of opaque polymer alone, proportional to TiO₂ reduction.
Summary

 ✓ Developed a method to measure wet hiding

 ✓ Evaluated how pre-composite polymer technology, opaque polymer and calcined clay affect wet hiding.

 ✓ When reducing TiO₂ while maintaining dry hiding:

   Opaque polymer and calcined clay reduce wet hiding proportional to TiO₂ reduction

   Pre-composite polymer allows for minimal loss of wet hiding at reduced TiO₂ levels

   The combination of pre-composite and opaque polymers offers the greatest formulation latitude for dry and wet hiding
Acknowledgement

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