Breaking the Pigment-to-Binder Ratio Paradigm of Metallic Pigments: Concomitantly Promoting Pigment-Binder Bonding and Metallic Pigment Orientation

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Introduction

- Metallic PVD pigments: highly reflective, mirror-like effects achievable
- Typically optimize for *either* optical or mechanical performance:
  - Increased binder loading produces better adhesion, with reduced gloss
  - Increased pigment loading produces higher gloss, with reduced adhesion

High Binder (left) vs High Pigment (right)

Introduction

- <u>High optical performance</u> ***and*** <u>adhesive integrity</u> may be achieved if pigments are tailored to binder system classes (acrylic, NC, PVB, etc.)
- Accomplished via:
  - Optimization of pigment-to-binder ratio
  - Chemical modification of the pigment

Experimental Procedure

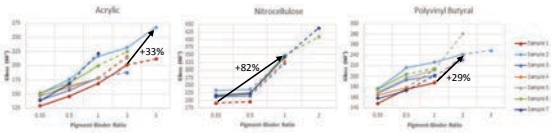
- 7 metallic pigment dispersions were evaluated across multiple binder systems at varying pigment-to-binder ratios
  - Acrylic, nitrocellulose, and polyvinyl butyral (PVB)
  - Target ratios from 0.33 (binder heavy) to 3.00 (pigment heavy)

Sample	Sample Description	Trade Name
1	Standard Grade Control	Q310105AE
2	Next-Generation	C21010AE
3	Experimental	N/A
4	Experimental	N/A
5	Experimental	N/A
6	Experimental	N/A
7	Experimental	N/A

Experimental Procedure

- Samples were applied via automatic drawdown onto Leneta opacity charts and evaluated for gloss (60°) and adhesion (tape test)
- Two methods for manipulating pigment-binder ratios were evaluated:
  - Method 1: Increase pigment dispersion/decrease binder in each sample
  - Method 2: Dilute binder while holding pigment dispersion constant
- Experimental constants:
  - Flake optical density 1.9 (± 0.1)
  - Dispersion d50 particle size 10.0 µm (± 0.5)
  - Dispersion NVM 10% (± 0.1)
  - All dispersions wet in ethyl acetate solvent

Gloss vs Pigment:Binder + Adhesion (Method 1)

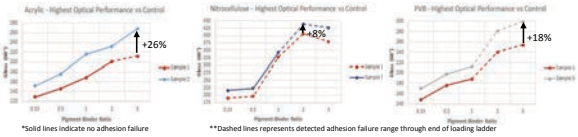


*Solid lines indicate no adhesion failure **Dashed lines represent the range at which adhesion failure occurred

- Improvement in optical performance with increased pigment-binder ratio across all systems while maintaining mechanical performance
  - Maximum adhesion at pigment-binder ratios between 1.00 and 3.00

Gloss Ignoring Adhesion Failure

- Highest optically performing samples relative to control for visual clarity



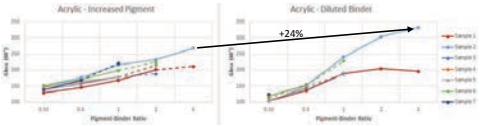
*Solid lines indicate no adhesion failure **Dashed lines represents detected adhesion failure range through end of loading ladder

- Top performing materials remained the same in acrylic and nitrocellulose binders
- Sample 5 exhibited best overall gloss in the PVB system, in contrast to the previous data set

Formulation Comparison (Method 1 vs 2)

Method 1: Increase Pigment/Decreased Binder

Method 2: Diluted Binder/Constant Pigment



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- Similar optical trends across formulation methods
- Substantial optical improvement while maintaining adhesion through alteration in formulation technique

Impact of Chemical Modification

Sample 1 (Control) Sample 7 (Experimental)

Pass Fail Pass Pass

*Both samples prepared in nitrocellulose binder system

Conclusions

- Gloss performance was improved while maintaining adhesive integrity across all samples and systems
  - 29-82% gloss improvement up to point of adhesion failure relative to control
- Gloss performance continued to improve post-adhesion failure
  - 8-26% overall gloss improvement through end of loading ladder over control
- Top performing samples varied between binder systems, based on the unique chemical modifications of each pigment dispersion
  - Can be tailored to desired binder, target performance properties, etc.
- Eckart is currently working to expand these concepts into additional applications and binder systems