COLORANTS FOR AUTOMOTIVE COATINGS

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Asian PPG Industries
Coating Process of Car Body
Global Automotive Paint
Driving Forces

- Higher Quality
  Appearance, Durability, Color
- Lower Cost
  Process Consolidation
- Environmental Compliance
- Shorter Development Times
- Product Differentiation by Vehicle Models, Colors
Automotive Paint Constituents

- **Resin**: Key ingredient for performance, adhesion, and film formation.
- **Paint Additives**: Surface wetting/levelling, defoaming, rheology control, solvency & dilution.
- **Solvent**: Drying behaviour, rheology control.
- **Additive**: Surface wetting/levelling, defoaming, rheology control, UV protection.
- **pigment**: Decoration, color, surface protection, special function.
What is Color?

- Matter of perception
- Subjective interpretation
- A color expression often means ten different colors to ten different people
- Color is defined by different theoretical & practical models
Light and Observer

- Type and Intensity of light shining on an object has an effect on our perception of color of that object
- Many factors affect how individuals perceive color
- We are all different and can perceive the same color differently
Why do we see an object colored?
Color Attributes

- Hue
- Chroma
- Value
Dimensions of Visual Color

Hue: The attribute whereby Red is distinguished from Green, Blue from Yellow, etc.

Value: The lightness (or darkness) of a color.

Chroma: The Saturation, Intensity or distance from gray
Colorants

- Pigments: Insoluble in Solvent & Necessary to disperse.

- Dyes: Soluble in Solvents & Necessary to Dissolve [Automotive Sector stopped using dyes in the formulations due to Fading problems]
Colorants

Organic Pigments
- Based on Carbon, Hydrogen, Nitrogen, Oxygen…
- Color by Chemical Bonding
- Complex synthetic organic chemicals.

Inorganic Pigments
- Based on Iron, Lead, Cadmium, chrome, Titanium…
- Color by oxidised metal
- Synthetic or naturally occuring minerals that are micronised and processed in to the correct particle size.

Special Effect Pigments
- Aluminium flakes for metallic finishes
- Mica based pigments for pearlescent finishes
- Speciality pigments for use in Harlequin colours
Pigments Chemistry

Chemical Structure

Physical Properties
- Particle Size
- Particle Shape
- Crystal Modification
- Particle Surface

Basic Color Shade

Coloristic
- Color shade
- Brilliance
- Color strength

Application
- Dispersibility
- Mill base viscosity
Pigment Dispersion
Pigment Dispersion

Wetting

Dispersing

Stabilization

Agglomerate Flocculate

Primary Particle (Ideal Dispersion)

Flocculated

Dispersion

Flocculation

Deflocculated
## Pigments in OE Industry

<table>
<thead>
<tr>
<th>Pigments</th>
<th>C.I.Number</th>
<th>Chemical Class</th>
</tr>
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<tbody>
<tr>
<td>White TiO2</td>
<td>Pigment White 6</td>
<td>TiO2</td>
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<tr>
<td>Black FW 200</td>
<td>Pigment Black 7</td>
<td>Carbon</td>
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<td>Irg. Red DPPBO</td>
<td>Pigment Red 254</td>
<td>Aminoketone</td>
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<td>Sicotr. Red L 2817</td>
<td>Pigment Red 101</td>
<td>Ferric Oxide</td>
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<td>Novap. Red F2RK</td>
<td>Pigment Red 170</td>
<td>Monoazo</td>
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<td>Host. Yellow H3G</td>
<td>Pigment Yell. 154</td>
<td>Monoazo</td>
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<tr>
<td>Monstr. Grn. 6YC</td>
<td>Pigment green 36</td>
<td>Pthalocyanin grn</td>
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<tr>
<td>Halio. Blu L 6700</td>
<td>Pig. Blue 15.6</td>
<td>Pthalocyanin blu</td>
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<tr>
<td>Chromp. Blu A3R</td>
<td>Pigment Blu 60</td>
<td>Indathrone</td>
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### Pigment Properties

<table>
<thead>
<tr>
<th>Property</th>
<th>Inorganic</th>
<th>Organic</th>
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<tbody>
<tr>
<td>Solubility</td>
<td>none</td>
<td>partly</td>
</tr>
<tr>
<td>Particle size</td>
<td>med.-coarse</td>
<td>small</td>
</tr>
<tr>
<td>Spec. surface</td>
<td>small</td>
<td>large</td>
</tr>
<tr>
<td>Brilliance</td>
<td>fair</td>
<td>high</td>
</tr>
<tr>
<td>Transparency</td>
<td>poor-good</td>
<td>exc.- good</td>
</tr>
<tr>
<td>Opacity</td>
<td>excellent</td>
<td>poor-good</td>
</tr>
<tr>
<td>Color strength</td>
<td>poor</td>
<td>excellent</td>
</tr>
<tr>
<td>Solvent stability</td>
<td>excellent</td>
<td>good-fair</td>
</tr>
<tr>
<td>Heat stability</td>
<td>excellent</td>
<td>poor-good</td>
</tr>
<tr>
<td>Weather fast</td>
<td>good-exc.</td>
<td>poor-good</td>
</tr>
<tr>
<td>Overspray fast</td>
<td>excellent</td>
<td>poor-good</td>
</tr>
<tr>
<td>Dispersibility</td>
<td>poor-good</td>
<td>poor-good</td>
</tr>
</tbody>
</table>
Pigment Properties

- Pigment
  - Type
  - Quality
  - Quantity
  - Colour
  - Refractive Index
  - Hardness
  - Particle Size
  - Climatic Resistance

- Extender
  - Support Mechanical Performance
  - No Hiding Power
Pigment Properties

Pigment Refractive Index

Difference between extender and binder refractive index
The higher the ratio between the refractive index of the pigment and that of the binder matrix, the more significant is the pigment property in terms of hiding.

Pigment Particle Size

The smaller the pigment, the higher the specific surface; and more binder, resin, and additives are needed for proper wetting.
Pigment Properties

- **In Liquid Paint**
  - dispersibility
  - rheology
  - flocculation, sedimentation
  - storage behavior

- **In Final Coatings Film**
  - light fastness
  - weather fastness
  - solvent resistance
  - chemical resistance
  - heat resistance
  - bleeding resistance
Pigment Properties

- **Opacity / transparency** are depending on the ability of pigments to absorb and scatter light and therefore the light transmission through the coating.
- In practice, paints are applied over a white and black chart, resulting in a color difference (DE contrast) given for the two backgrounds.
- Concept of Colour Key primer to improve the process hiding of poor opacity pigments Viz Yellow & Red.
- Opaque pigments are used in solid shades.
- Transparent pigments are used in effect shades and as shading partner.
Factors that affect Color

<table>
<thead>
<tr>
<th>Standard</th>
<th>Batch</th>
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</thead>
<tbody>
<tr>
<td>Environment</td>
<td>Samples</td>
</tr>
<tr>
<td>• Light Source</td>
<td>• Size</td>
</tr>
<tr>
<td>• Background</td>
<td>• Material</td>
</tr>
<tr>
<td></td>
<td>• Texture</td>
</tr>
<tr>
<td></td>
<td>• Gloss</td>
</tr>
</tbody>
</table>
Factors that affect Color

- Film Builds – Hiding Capability
- Film Splits - 1st Pass and 2nd Pass Ratios
- Foil Solids – Wet / Dry Application
- Metallic Flake Orientation - Travel
Factors that affect Color

- Paint applied over white substrate appearing brighter than over black substrate, this is referred to as contrast.
- The look on a metallic shade from different angles results in a brighter or darker color appearance, this is referred to as Flip/Flop behavior.
Pigment Orientation

- Orientation of Effect Pigments is Critical

- **Solid Colors** - Have no Orientation Issues - Particle Size

- **Aluminum & Mica Flakes** - Have Maximum Effect - Parallel to Surface
  - Aligned these flakes correctly Maximizes “Face & Flop” Color Travel
  - Misaligned Reduces “Metallic Effect & Color Travel”
Pigment Metamerism

- Metamerism is the phenomena that two objects seem to have the same color under a certain light source, but having a different color under a second light source.
- Metamerism is caused by using different pigment chemistries or materials in the paint formulation.
Pigment Durability

- **Florida Exposure**: 2 Years at 5 Deg Angle facing south; Gloss Retention Min 90%, No Chalking, cracking or any other defect.
- **UV Transmissivity**: UV Transmittance less than 0.2% at 400 – 470nm
- **UV Resistance**: 0.6 Irradiance, 4 Hrs UV & 4 Hrs Condensation – Min 1500 Hrs
Extenders

Used for filling, sanding, adhesion and corrosion resistant properties

Extenders are translucent and therefore have poor opacity
Aluminium Pigments
## Pigment Market

### Dye & Organic Pigment Demand

- **Asia/Pacific**: 35% (US$10.6 billion, 2008)
- **North America**: 34%
- **Western Europe**: 20%
- **Other Regions**: 11%

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2/6/2009
Recent Regulations

Dichlorobenzidine (DCB) / Diarylide Pigments
- Disazo Yellow: PY13, PY17, PY83
- Pyrazolone: PO13, PO34, PR38

Mechanism:
- Diarylide $\rightarrow$ monoazo compound $\rightarrow$ DCB

Lead pigments
- Lead Chrome Yellow: PY34 (PbCrO4)
- Molybdate Orange: PR104 (PbCrO4, PbMoO4, PbSO4)

Azo colorants ban in Germany
- Release of aromatic amines from colorants

2/6/2009
Major Trends

- Increasing demand for heat resistance pigments
- Universally high performance pigments, which are compatible in broad applications
- Improved properties of Light Fastness, weathering, heat resistance & IR reflection
- Preference for COB System over Monocoats for improved appearance and durability
Major Challenges

- Slumping Global economy
- Increased RM cost
- Demand for improved properties with no cost increase
Thank you