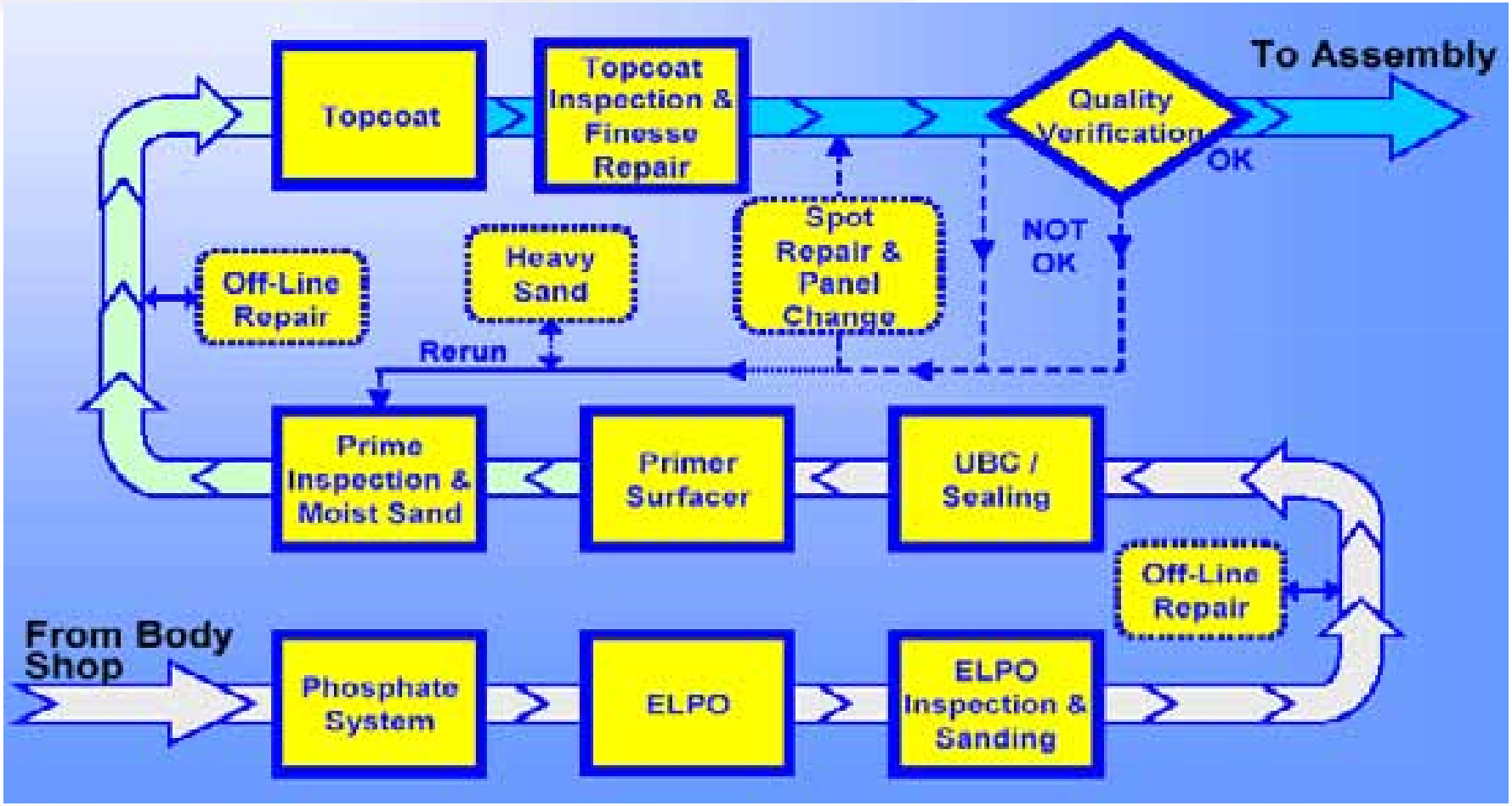
COLORANTS FOR AUTOMOTIVE COATINGS

Narendra Upadhyay
Asian PPG Industries

Coating Process of Car Body



Global Automotive Paint Driving Forces

Higher Quality

Appearance, Durability, Color

Lower Cost

Process Consolidation

Environmental Compliance

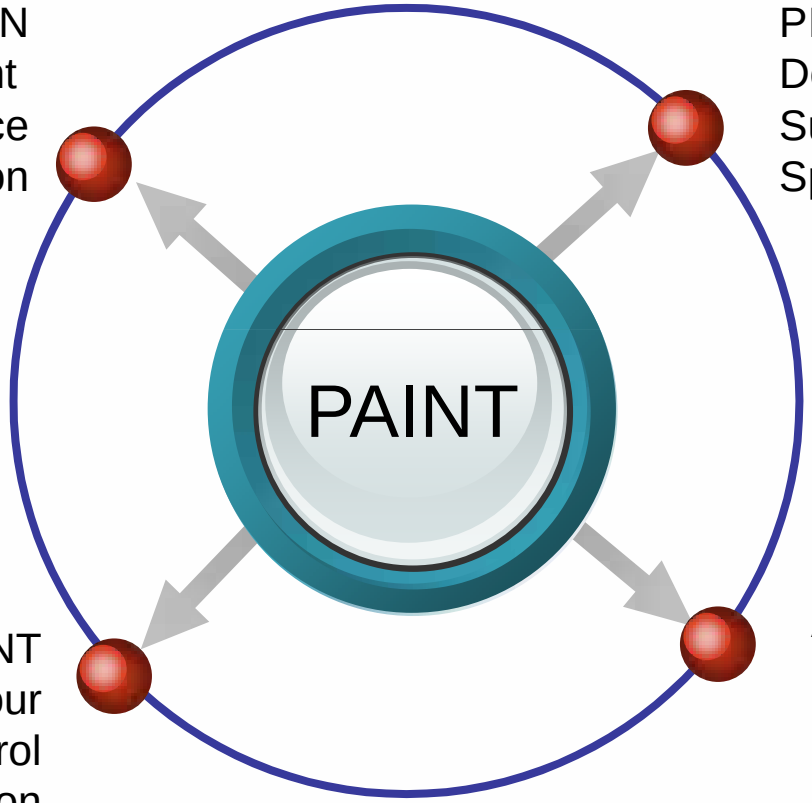
Shorter Development Times

Product Differentiation by Vehicle Models, Colors

Automotive Paint Constituents

RESIN
Key Ingredient
for performance
Adhesion & Film Formation

PIGMENT
Decoration & Color
Surface Protection
Special Function



SOLVENT
Drying Behaviour
Rheology Control
Solvency & Dilution

ADDITIVE
Surface wetting/ levelling
Defoaming
Rheology Control
UV Protection

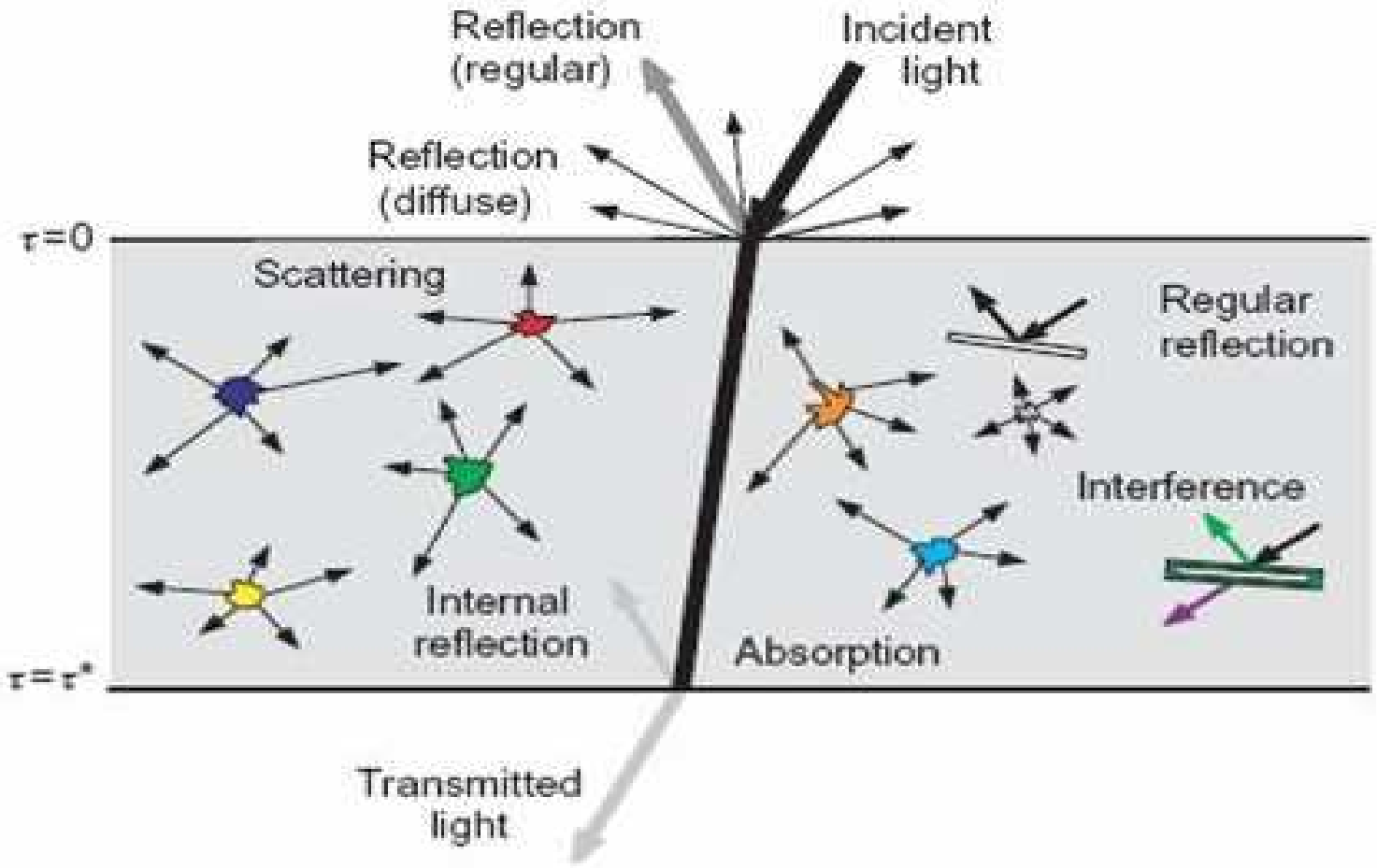
What is Color ?

- 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

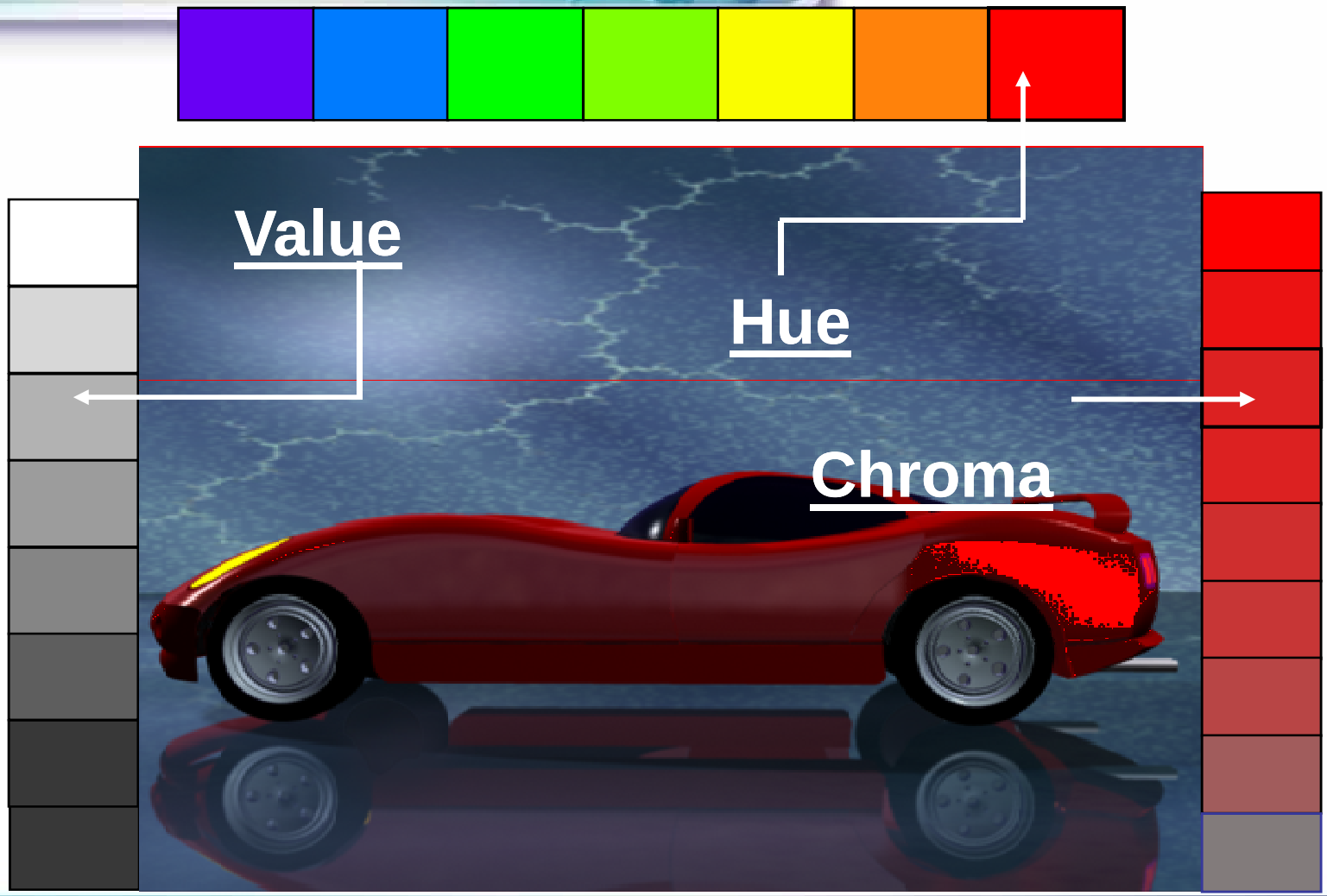
Light and Observer

- 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

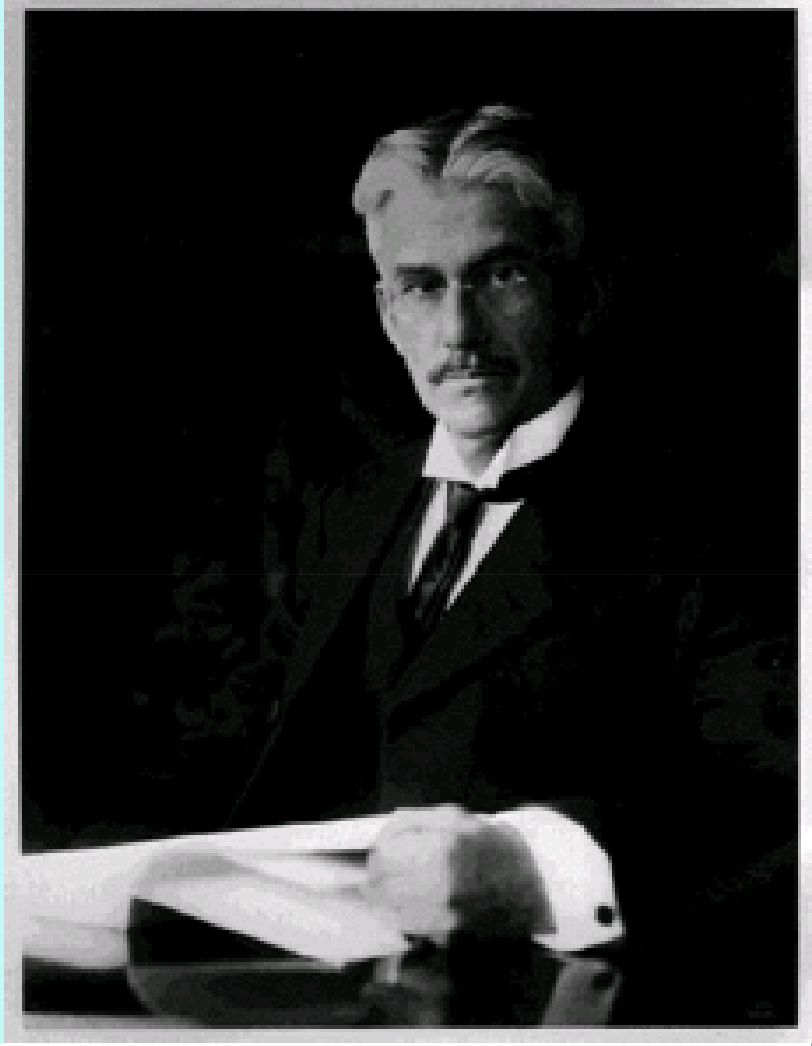


Dimensions of Visual Color

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



Albert Munsell

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

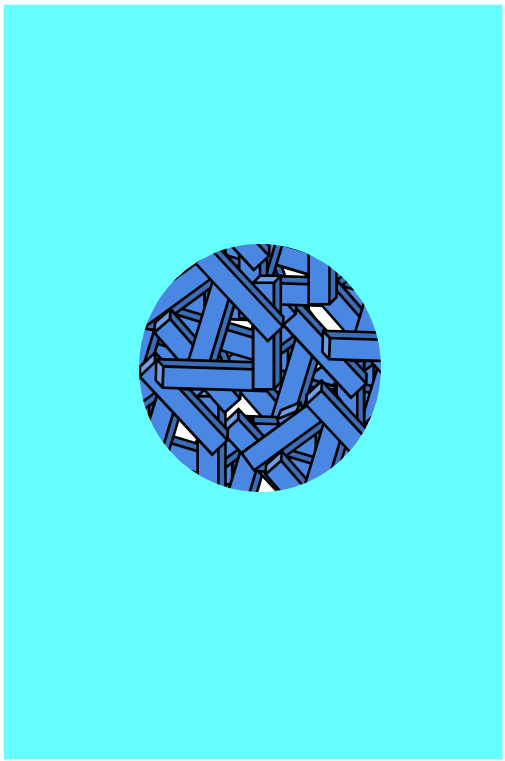
- **Particle Size**
- **Particle Shape**
- **Crystal Modification**
- **Particle Surface**

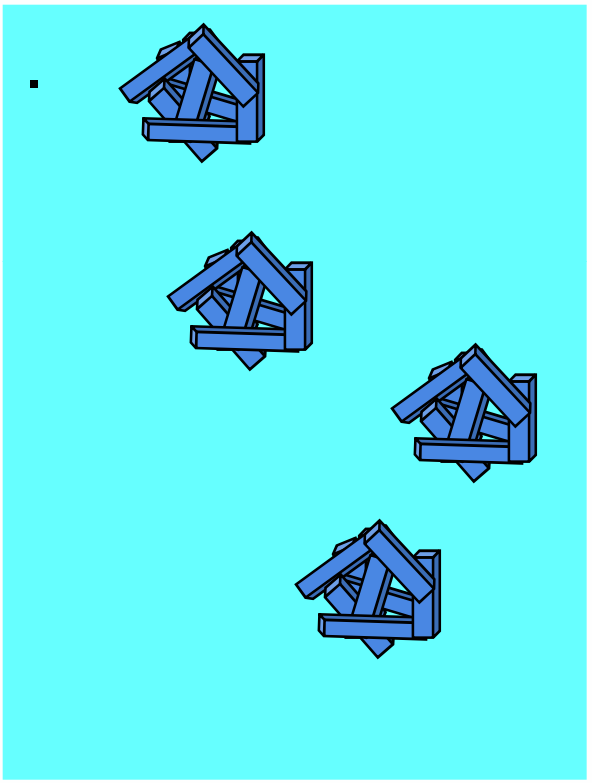
Basic Color Shade

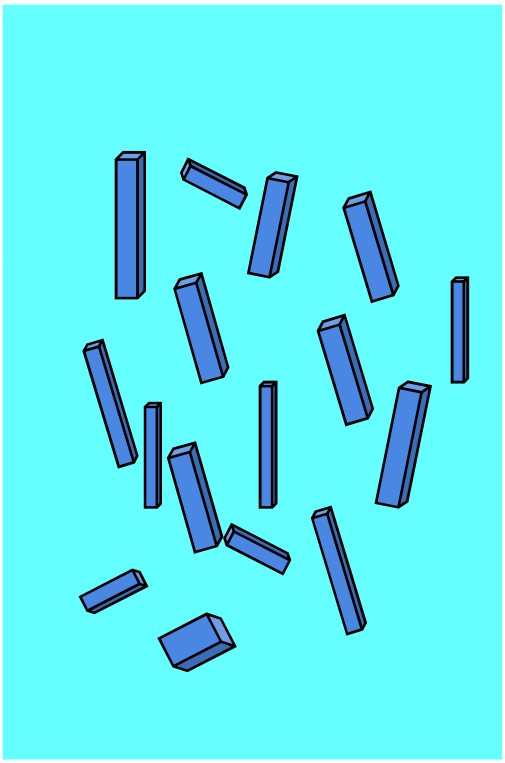
Coloristic
- Color shade
- Brilliance
- Color strength

Application
- Dispersibility
- Mill base viscosity

Pigment Dispersion

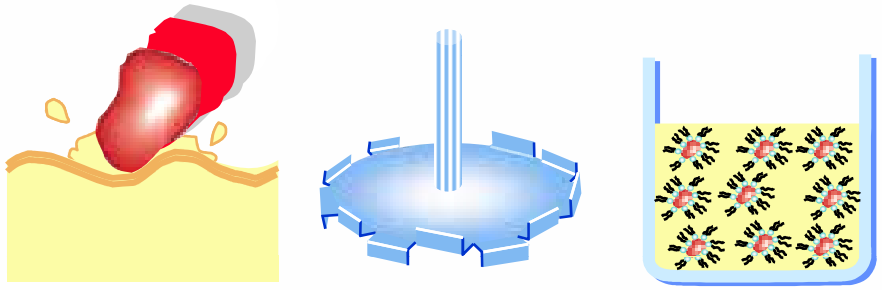






Pigment Dispersion

Wetting **Dispersing** **Stabilization**

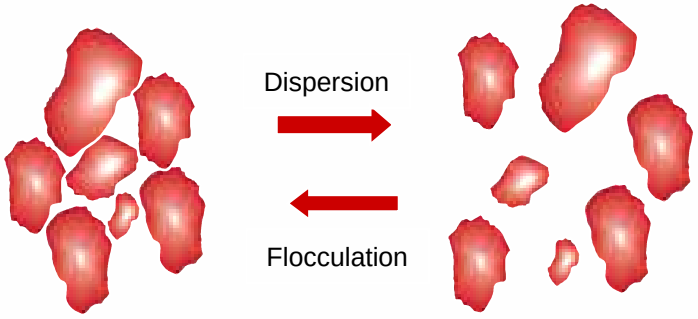


Agglomerate

Flocculate

Primary Particle

(Ideal Dispersion)



Flocculated **Deflocculated**

Pigments in OE Industry

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

Pigment Properties

Property	Inorganic	Organic
Solubility	none	partly
Particle size	med.-coarse	small
Spec. surface	small	large
Brilliancy	fair	high
Transparency	poor-good	exc.- good
Opacity	excellent	poor-good
Color strength	poor	excellent
Solvent stability	excellent	good-fair
Heat stability	excellent	poor-good
Weather fast	good-exc.	poor-good
Overspray fast	excellent	poor-good
Dispersibility	poor-good	poor-good

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

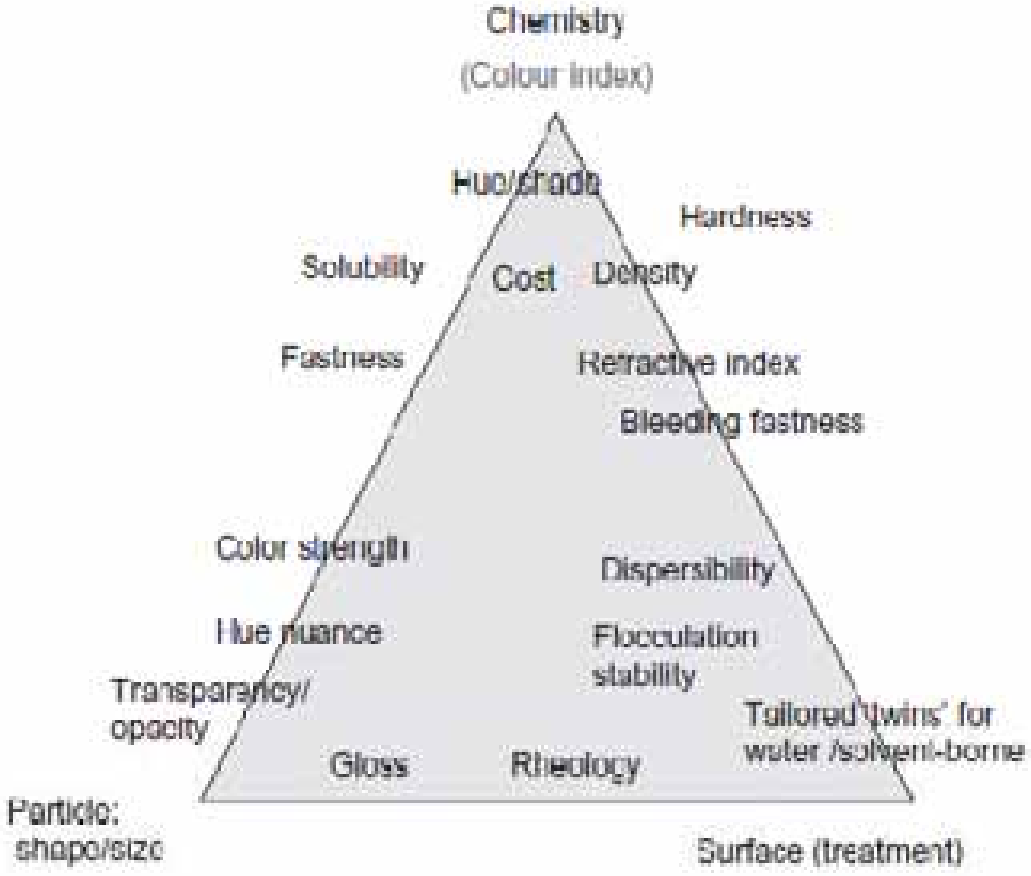
Difference between extender and binder refractive index
The higher the ratio between the refractive index of the pigment and that of the binder matrix, the more significant is the pigment property in terms of hiding.

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

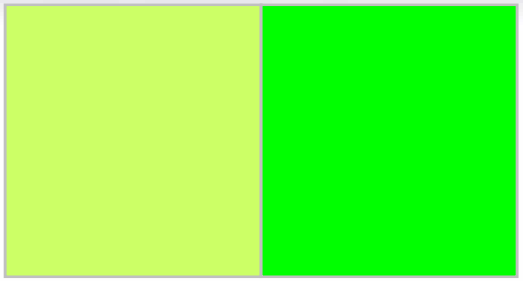
- *In Liquid Paint*
  - dispersibility
  - rheology
  - flocculation, sedimentation
  - storage behavior
- *In Final Coatings Film*
  - light fastness
  - weather fastness
  - solvent resistance
  - chemical resistance
  - heat resistance
  - bleeding resistance



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



Standard **Batch**

Environment

- Light Source
- Background

Samples

- Size
- Material
- Texture
- Gloss

Observer

- Experience
- Duration of Observation
- Viewing Geometry
- Observer Differences

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 as Flip/Flop behavior.

Pigment Orientation

- **Orientation of Effect Pigments is Critical**
  - **<u>Solid Colors</u>** - Have no Orientation Issues - Particle Size
  - **<u>Aluminum & Mica Flakes</u> -** 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 & $ Hrs Condensation – Min 1500 Hrs

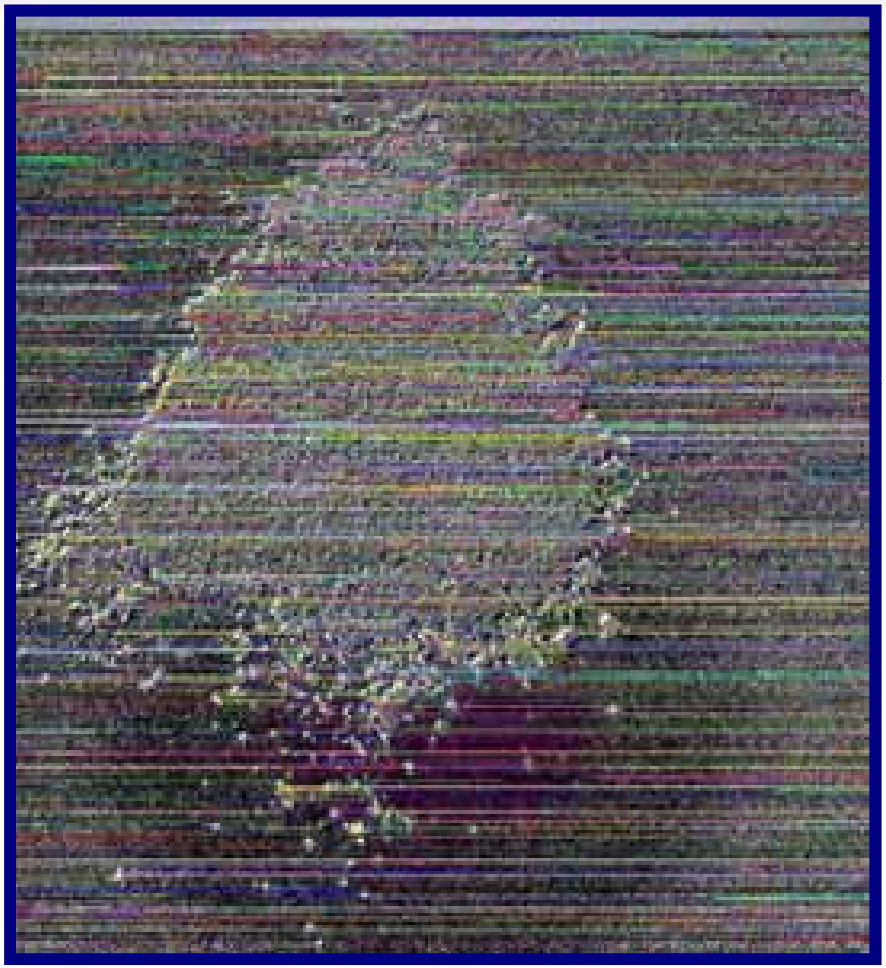
Extenders

Used for filling, sanding, adhesion and corrosion resistant properties

Extenders are translucent and therefore have poor opacity

Aluminium Pigments

Pearls & Mica Pigments



Pigment Market

Recent Regulations

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

Lead pigments
- Lead Chrome Yellow: PY34 ($PbCrO_4$)
- Molybdate Orange: PR104 ($PbCrO_4$, $PbMoO_4$, $PbSO_4$)

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

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