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July 2026

NAPIM Summer Course

Pigments for Ink Application

Mike V. Oberski

Technical Sales Representative; XA Solutions

Agenda

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What is printing?

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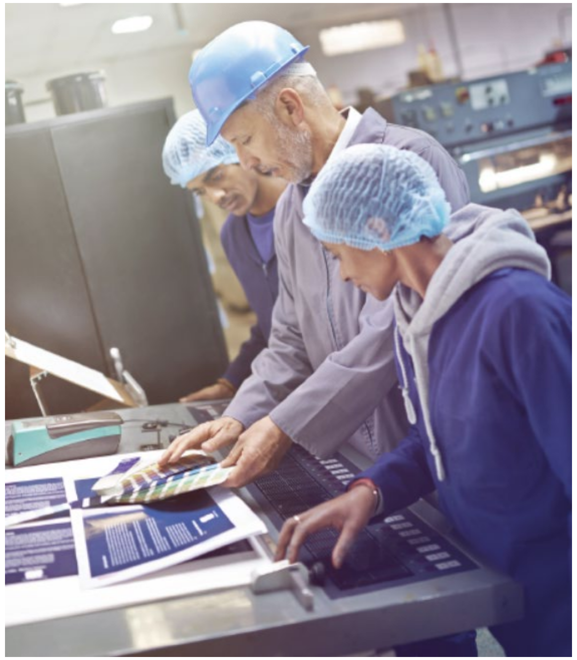

Line work

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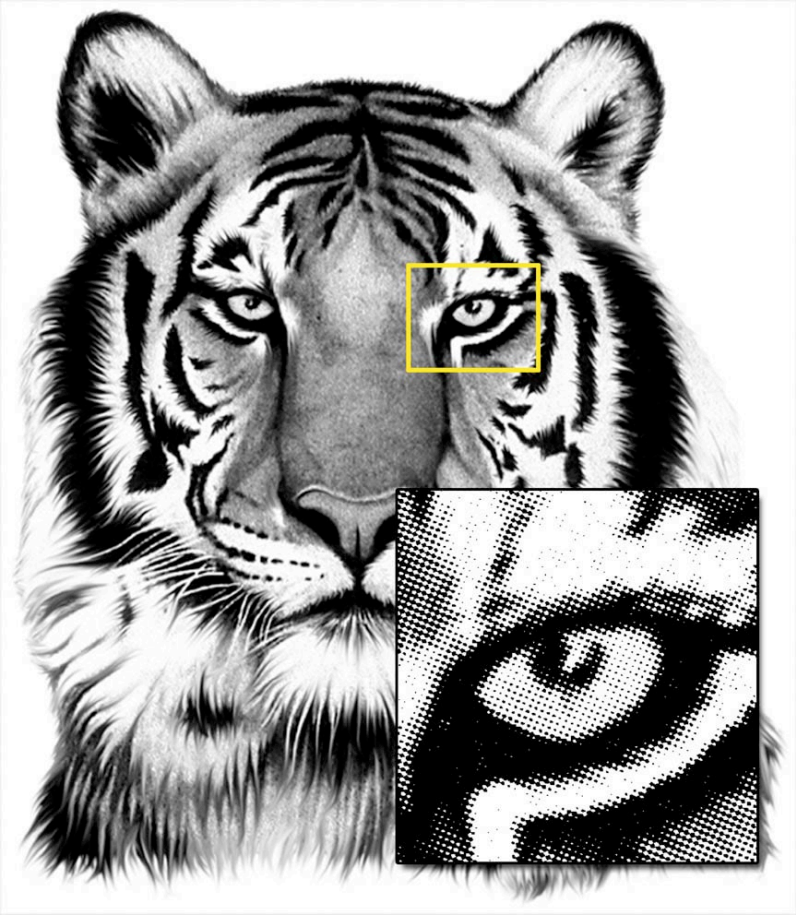
Image taken from www.greenlinepaper.com

Halftone dots



Process color

Some Common Printing Processes

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Screen Printing

Screen printing – process

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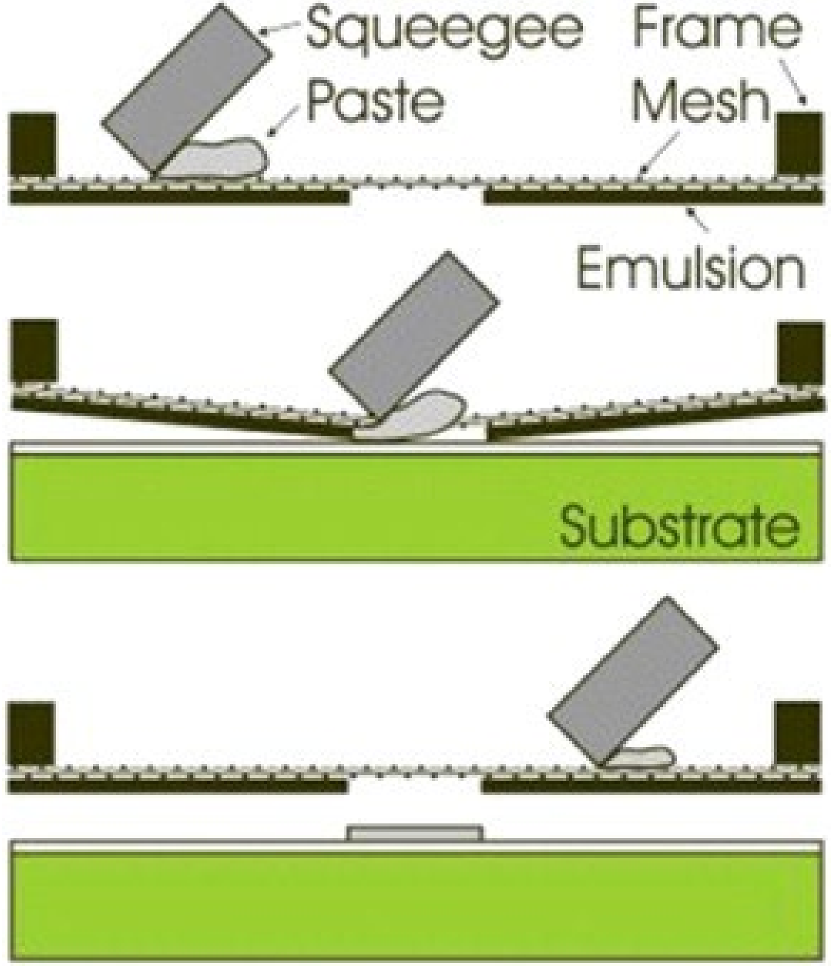

Screen printing – inks

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Lithography

Lithography – process

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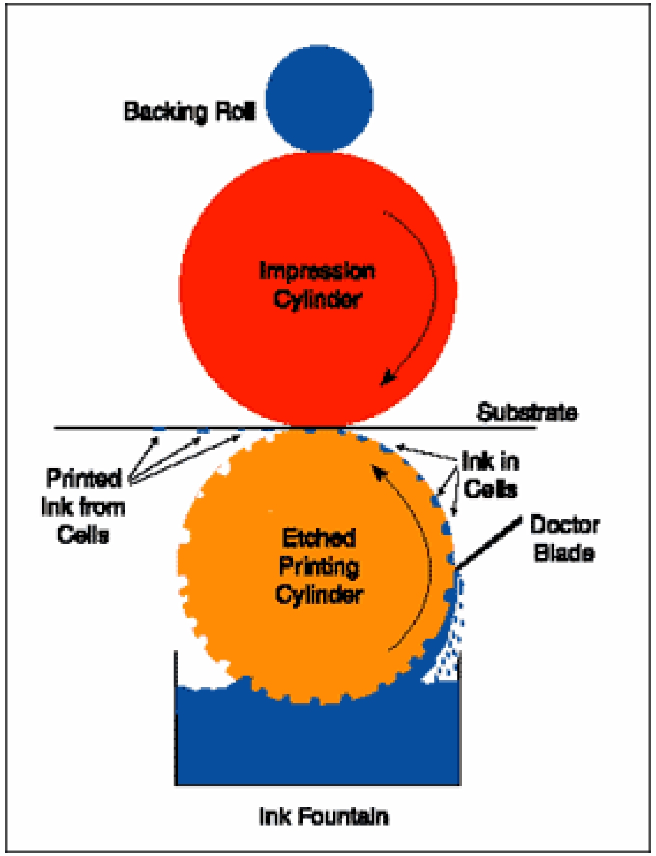
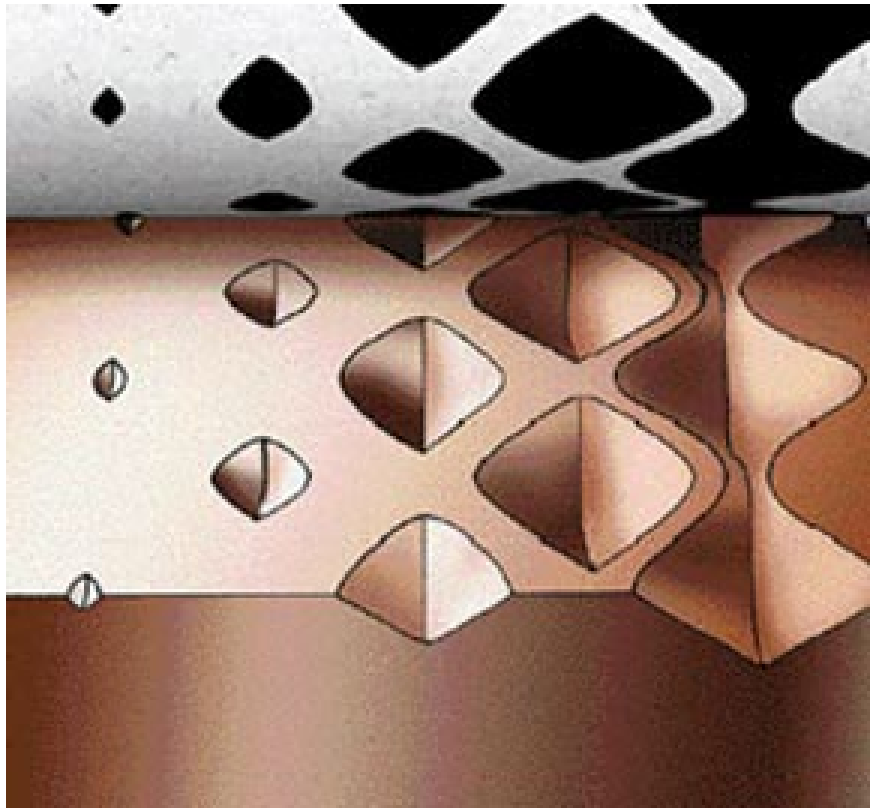
Lithography – ink properties

Gravure

Gravure – process



Gravure – engraved roll



Gravure – ink properties

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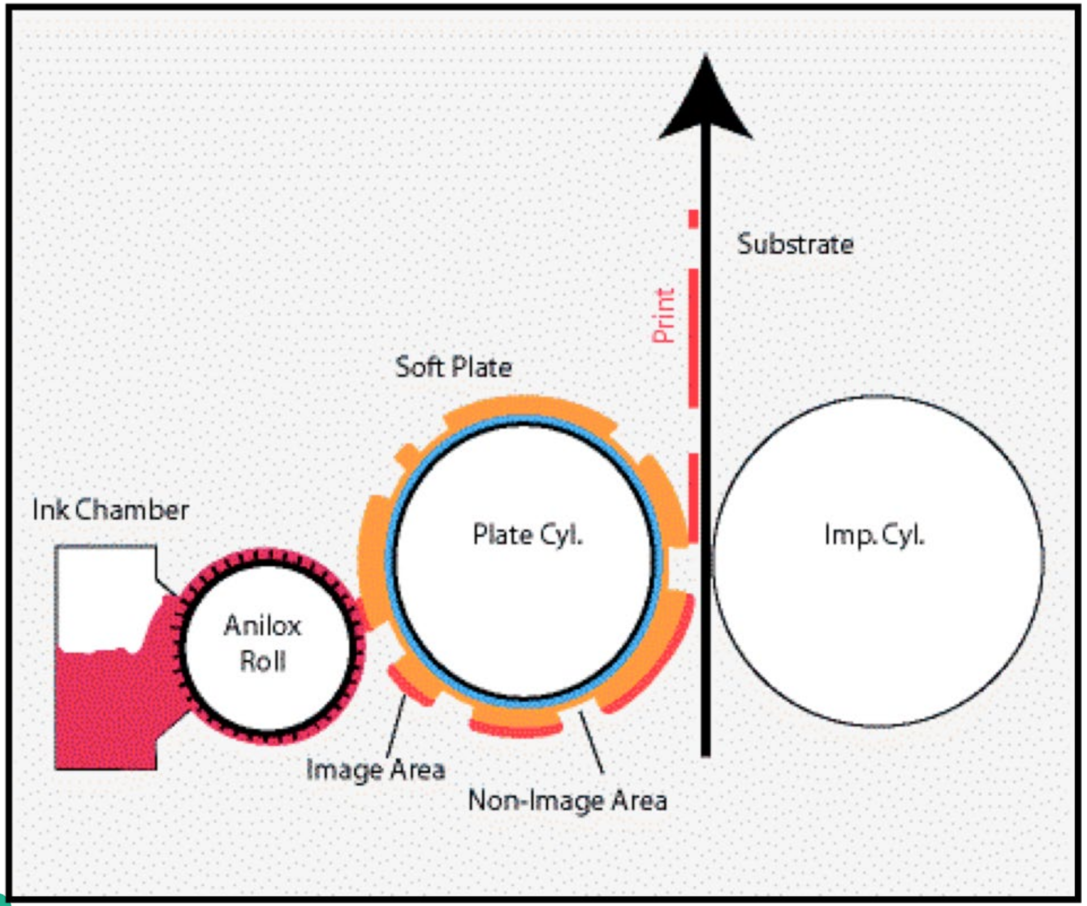
Flexography

Flexography – process



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Flexography – ink properties

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Resolubility – why it matters

Dry Offset

Dry Offset

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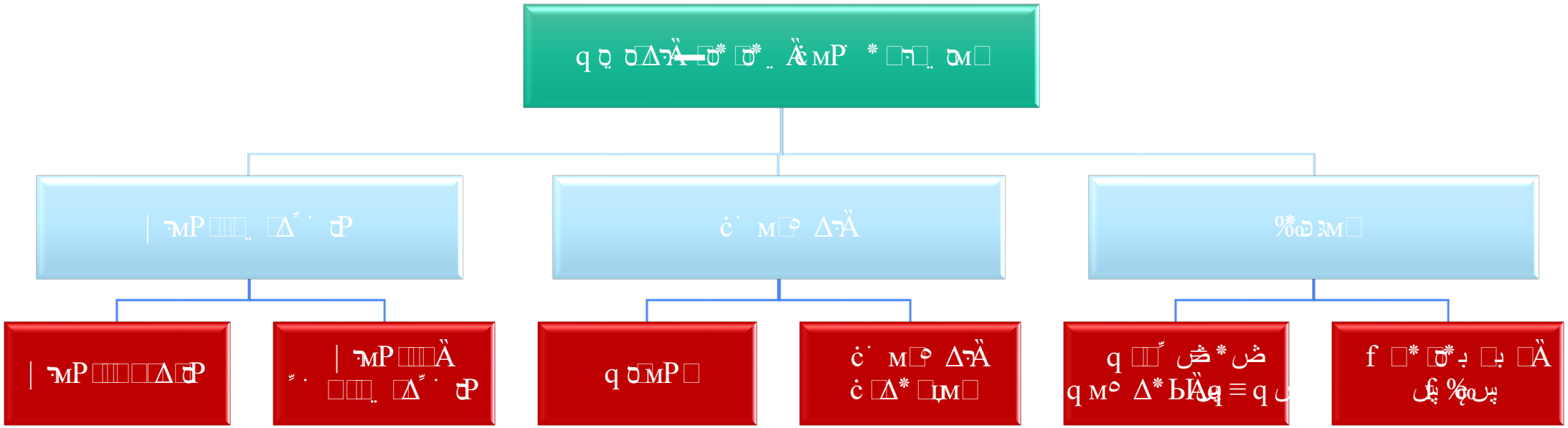
Digital

Digital Printing Types: Overview



Drop-on-Demand Inkjet: Formulation Challenges

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Printing Overview

	Gravure	Flexo	Lithography	Screen	Digital
Typical Print Speeds	**Up to 600 m/min**	**~ 450 m/min**	**600-700 (heatset) 15000-18000 iph (SF)**	**100 m/min (rotary)**	**30-100 m/min (state of art)**
Typical Ink Viscosities	**20-25 secs Zahn 2 0.05 – 0.2 Pa.s**	**20-25 secs Zahn 2 0.05 – 0.5 Pa.s**	**40-100 Pa.s**	**1 – 5 Pa.s (flatbed) Lower for rotary**	**6-15 mPa.s solvent/UV 2-5 mPa.s aqueous**
Typical Wet Film Thickness (µm)	**7 – 15**	**3 – 7**	**0.5 – 2**	**8 – 30**	**6 – 12 (multiple passes)**
Typical Particle Size	**< 8µm**	**< 4µm**	**< 4µm**	**-**	**Mean of 0.05 – 0.2µm Max. of 0.5 – 1.0µm**
Main Binders	**Nitrocellulose, Cellulose Acetate Proprionate, Polyvinyl butyral, Polyamide, Polyurethane, Polyvinyl,** Acrylics, Acrylated Oligomers	**Nitrocellulose, Cellulose Acetate Proprionate, Polyvinyl butyral, Polyamide, Polyurethane, polyvinyl,** Acrylics, Acrylated Oligomers	**Modified rosin esters (phenolic), Hydrocarbons, Drying oils (linseed oil, alkyds)** Acylated Oligomers	**Polyvinyls, Plastisol,** Acrylated Oligomers	**Polyvinyl, nitrocellulose,** Acrylated Oligomers
Main Solvents	**Alcohols (ethanol, n-propanol), Esters (ethyl acetate, n-propyl acetate), glycol retarders (ethoxy propanol),** Water **Ketones,** Acrylated Monomers	**Alcohols (ethanol, n-propanol), Esters (ethyl acetate, n-propyl acetate), glycol retarders (ethoxy propanol),** Water **Ketones,** Acrylated Monomers	**Petroleum distillates (heatset inks, 260-290°C), Mineral oils, Vegetable Oils (linsed, soya, rapeseed etc)** Acrylated Monomers	**Glycols,** Acrylated Monomers	**Water, Glycols, esters, ketones,** Acrylated Monomers

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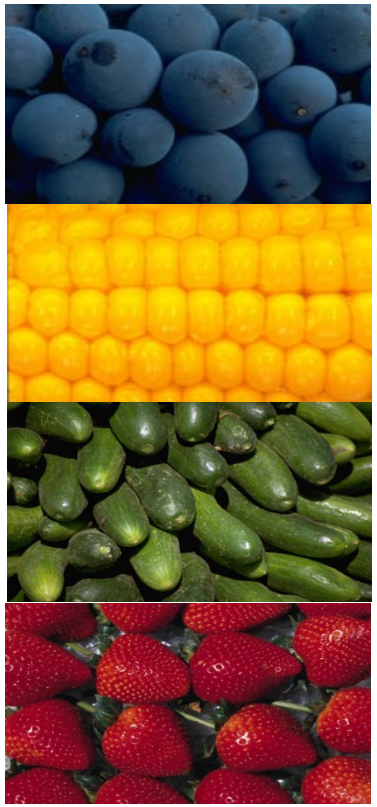
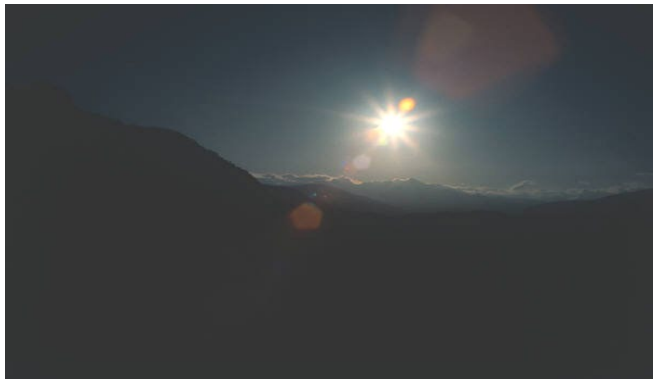
What is Color?

What is Color?





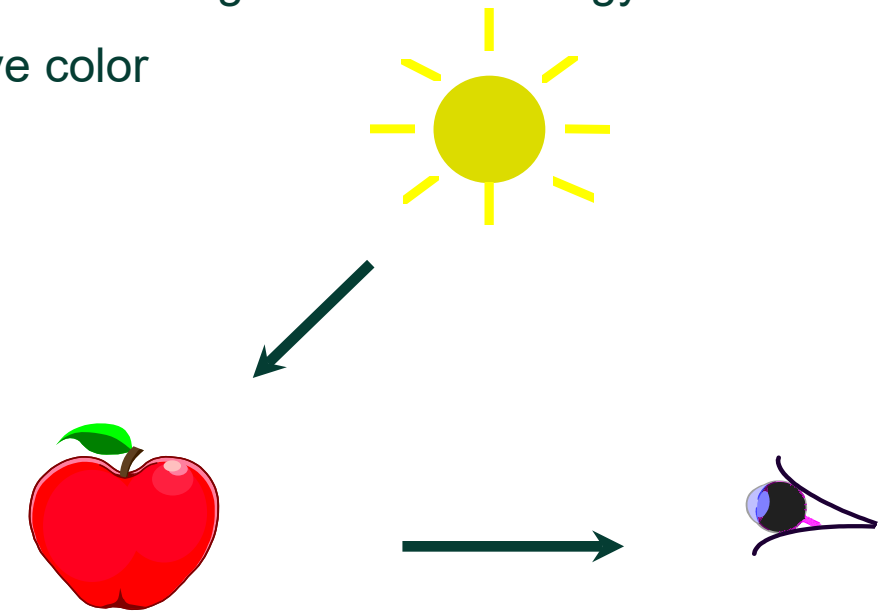
Color is the physiological perception of an object exposed to light

What does that mean?

No light —–> no color

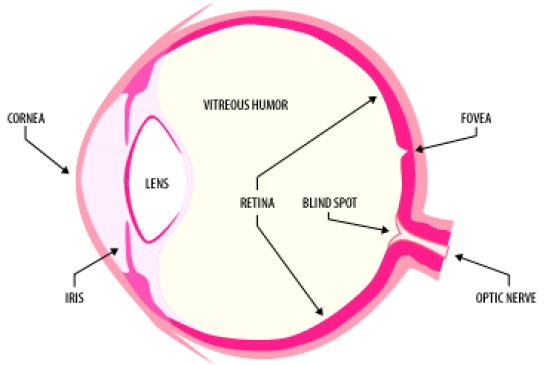
Three elements are necessary for perception of color:

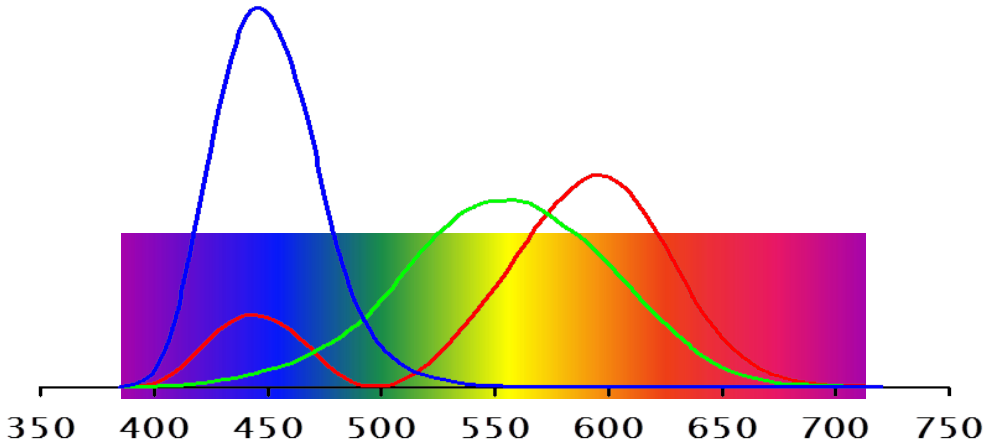
1. **Light:** emitting energy
2. **Object:** absorbs a part of energy and re-emitting the rest as energy
3. **Receptor:** vision allows us to perceive color



Perceiving Color – Color Vision

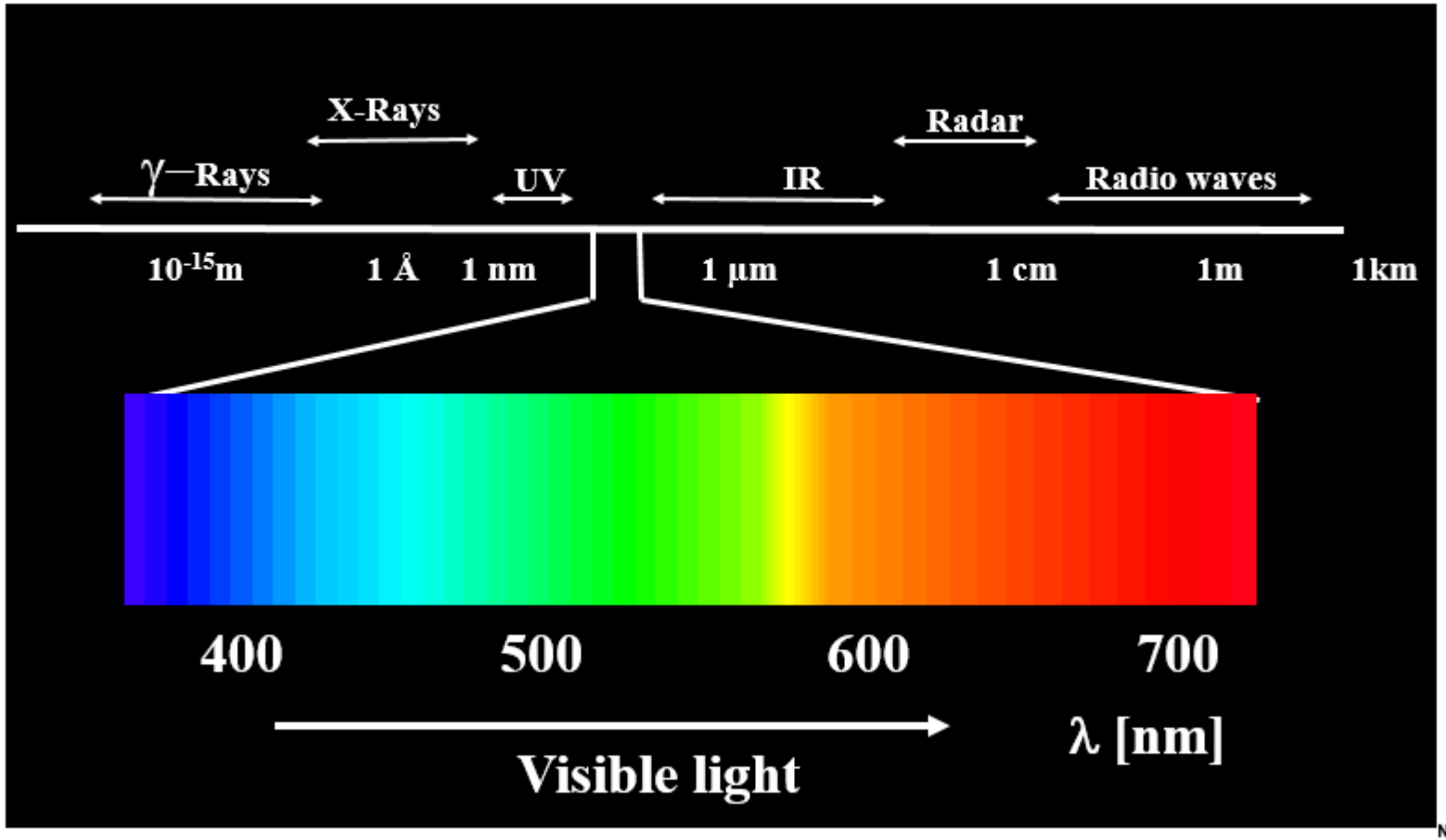
- Light enters the eye through the cornea, iris and lens and is imaged onto the retina.





- Light receptors, cones and rods, absorb some of the light and generate a signal that is interpreted by the brain.
- Cones are the receptors that are responsible for color.

Electromagnetic Spectrum

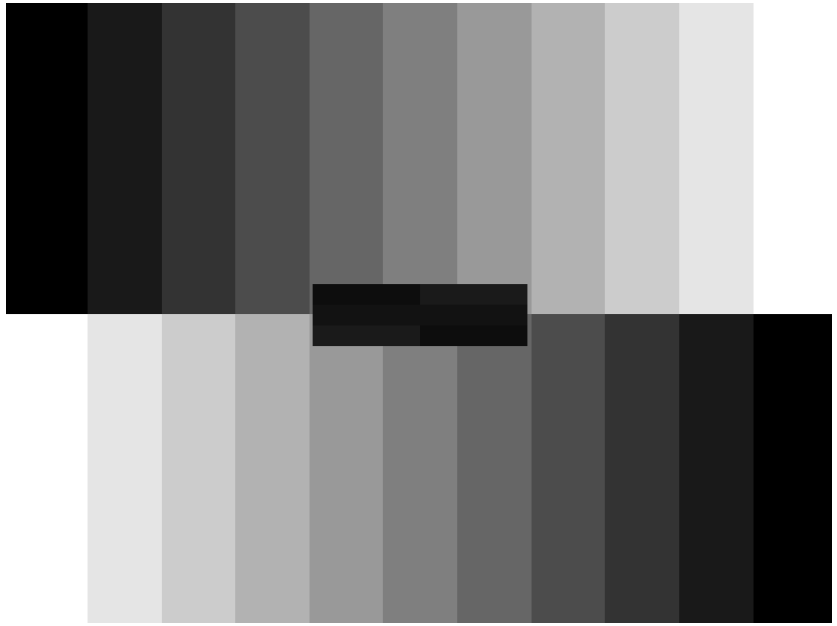


NRD/PG 2011

Describing Color

Lightness:

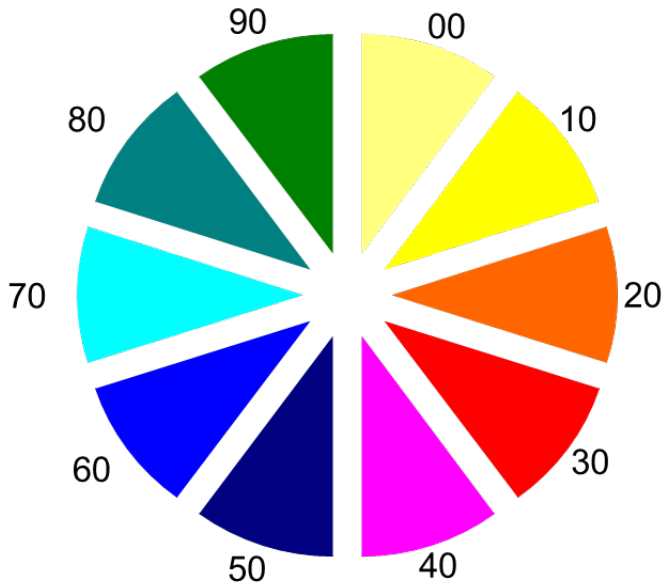
"Attribute by which a perceived color is judged to be equivalent to one of a series of grays ranging from black to white." (ASTM E 284)



Describing Color

Hue:

"Attribute of a visual perception according to which an area appears to be similar to one of the colors, red, yellow, green, and blue, or to a combination of adjacent pairs of these colors considered in a closed ring." (CIE 17.4)



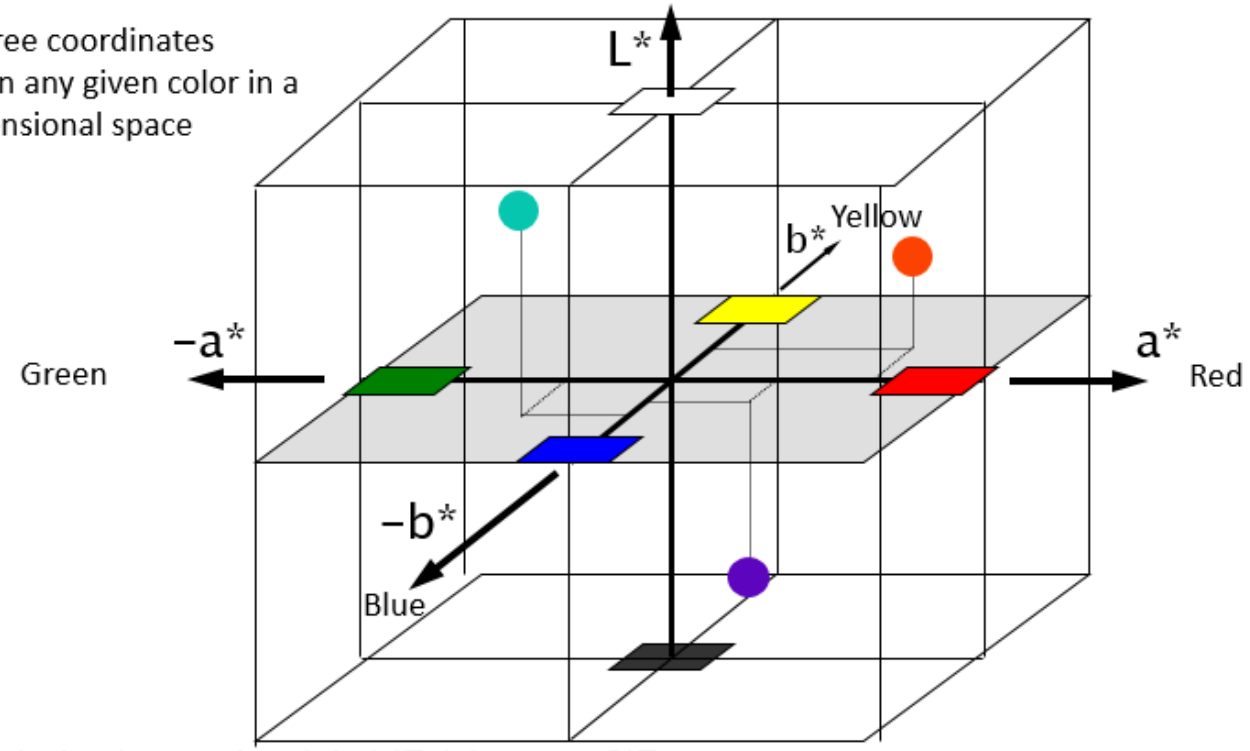
Describing Color

Chroma / Saturation:

"Attribute of color used to indicate the degree of departure of the color from a gray of the same lightness." (ASTM E 284)

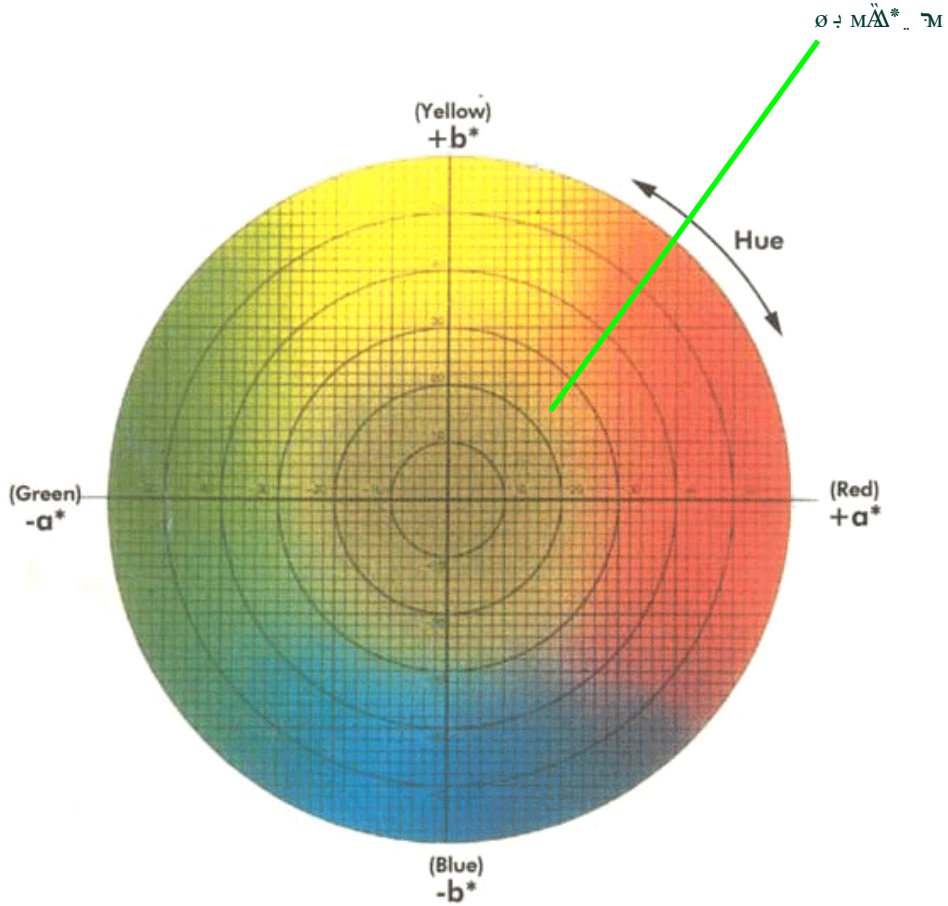
(CIELAB) L*a*b* Color Space

The three coordinates position any given color in a 3-dimensional space



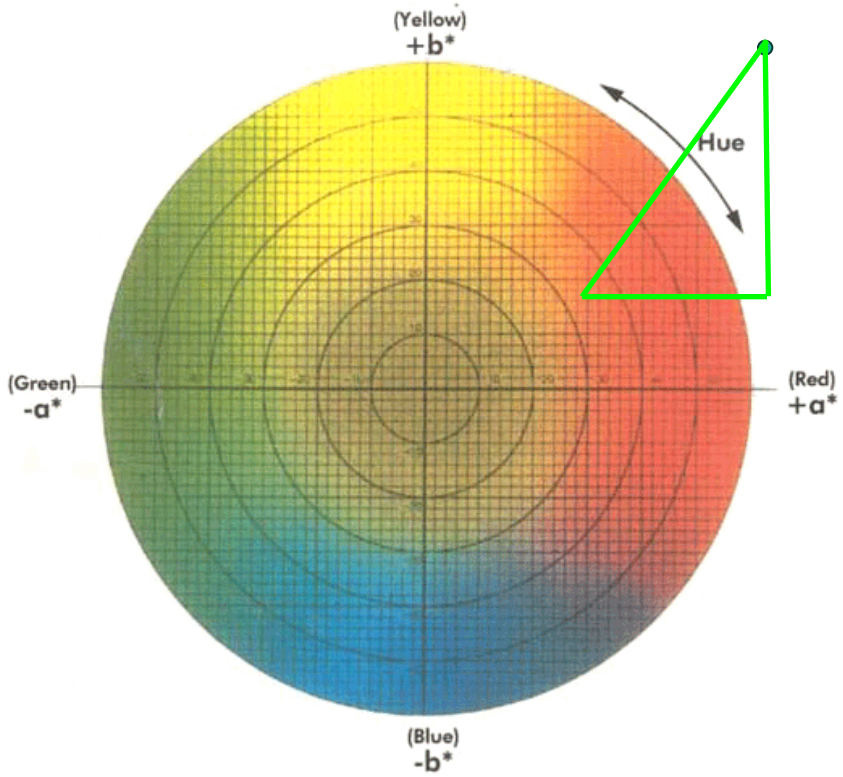
Commission International de L´Eclairrage = CIE

CIELAB Color Space



- Two additional coordinates, C* and h, are calculated from L*, a* and b*
- Hue, h, is a polar coordinate defining a color's position relative to the +a* axis (assigned 0°)
- Chroma, C*, represents a color's distance from the neutral center
- C* is the hypotenuse of the right triangle formed by a* and b*
- The hue angle can be determined through trigonometry

L*a*b* vs. L*C*h



- L*, a* & b* and L*, C* & h are simply two ways of describing the position of the same point
- L* = 61.15, a* = 30, b* = 40
- L* = 61.15, C* = 50, h = 53.13°

- Most of the US tends to prefer using the L*a*b* coordinates

Pigment Properties

As a powder:

Particle size
Specific surface
Oil Absorption
Density
Bulk density
Dry content
pH
Conductivity
Toxicity
Safety properties
Heat stability
Inherent Compatibility

In a medium:

Hue
Chroma
ΔE*
ΔH*
Color strength
Transparency
Hiding power
Flow properties
Dispersibility
Stability to flocculation
Heat stability
Fastness to overcoating
Weather resistance
Gloss

Opacity/Transparency

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What is Metamerism?

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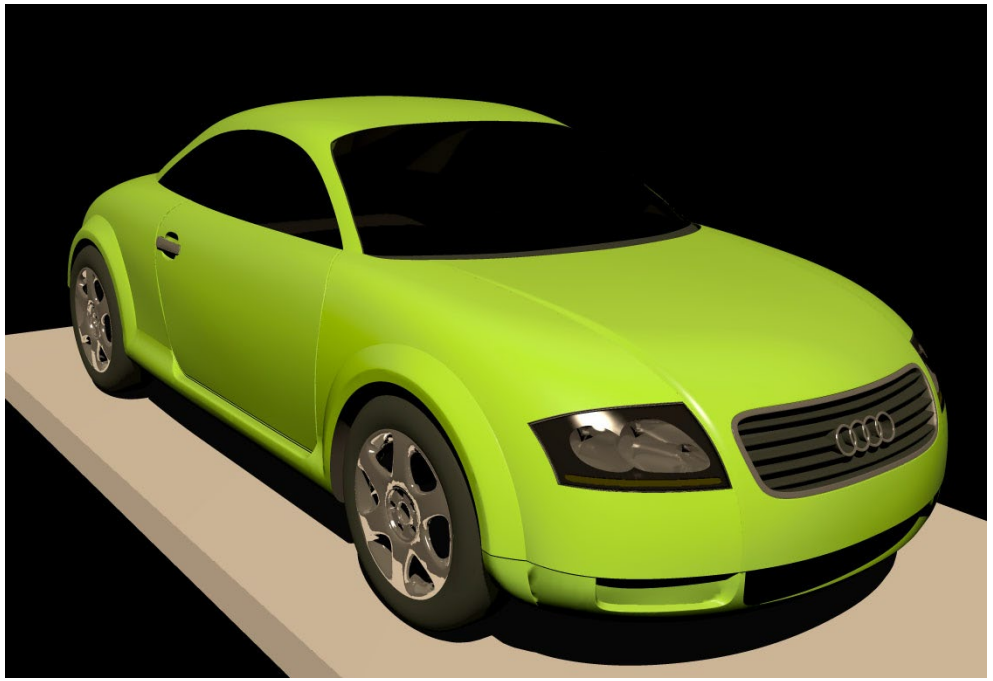
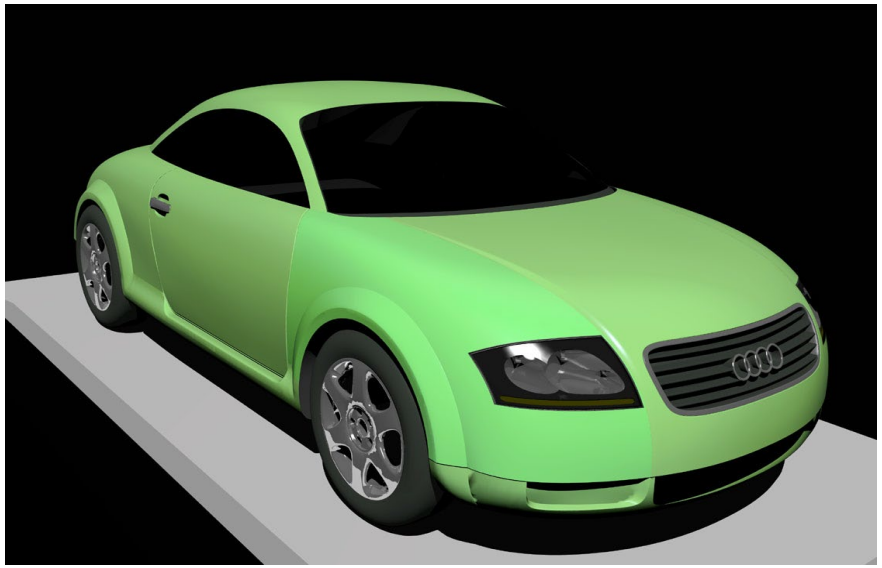
Metamerism is the phenomena in which two objects seem to have the same color under one light source, but different colors under another light source

Metamerism is caused by using different pigment chemistry or materials in the paint formulation



Illuminant F11 (TL84)

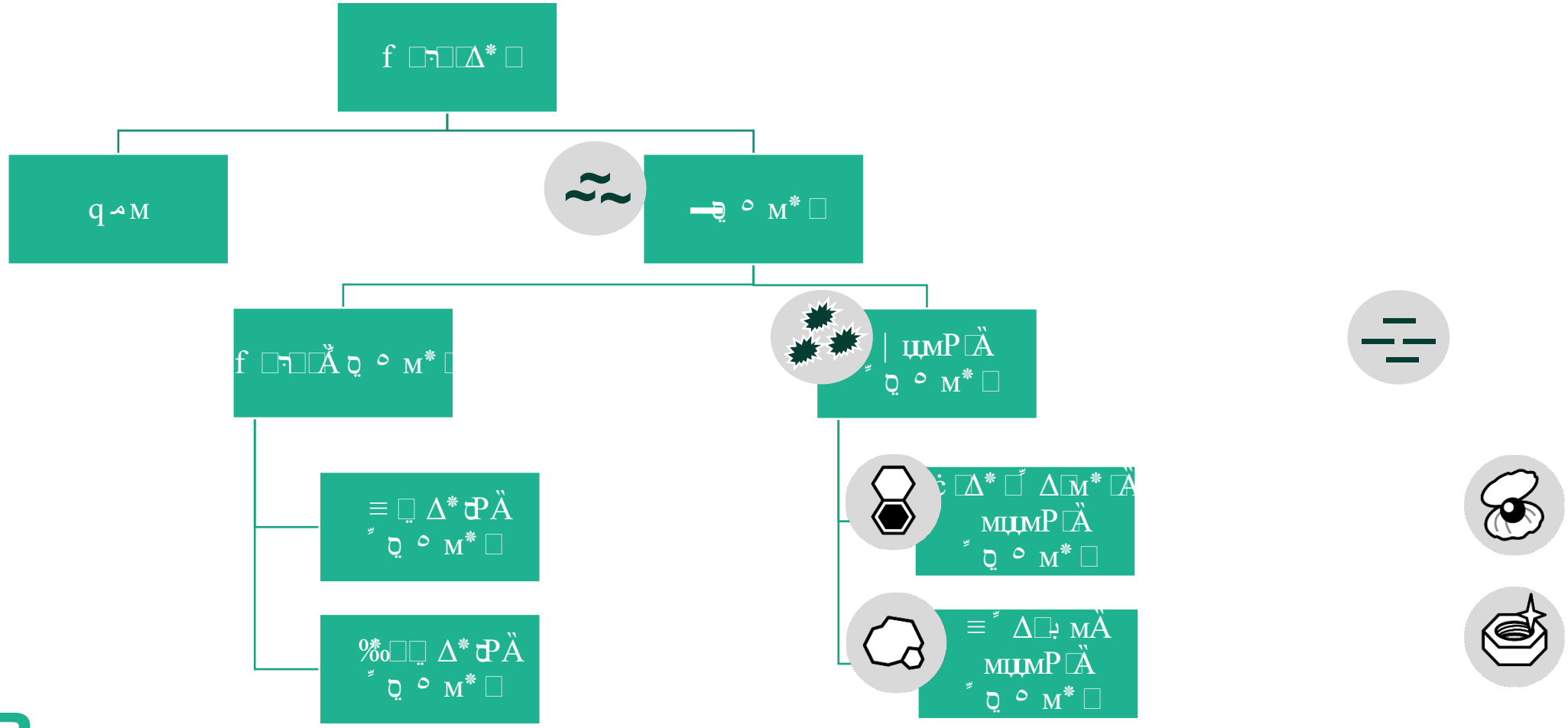


Illuminant D65

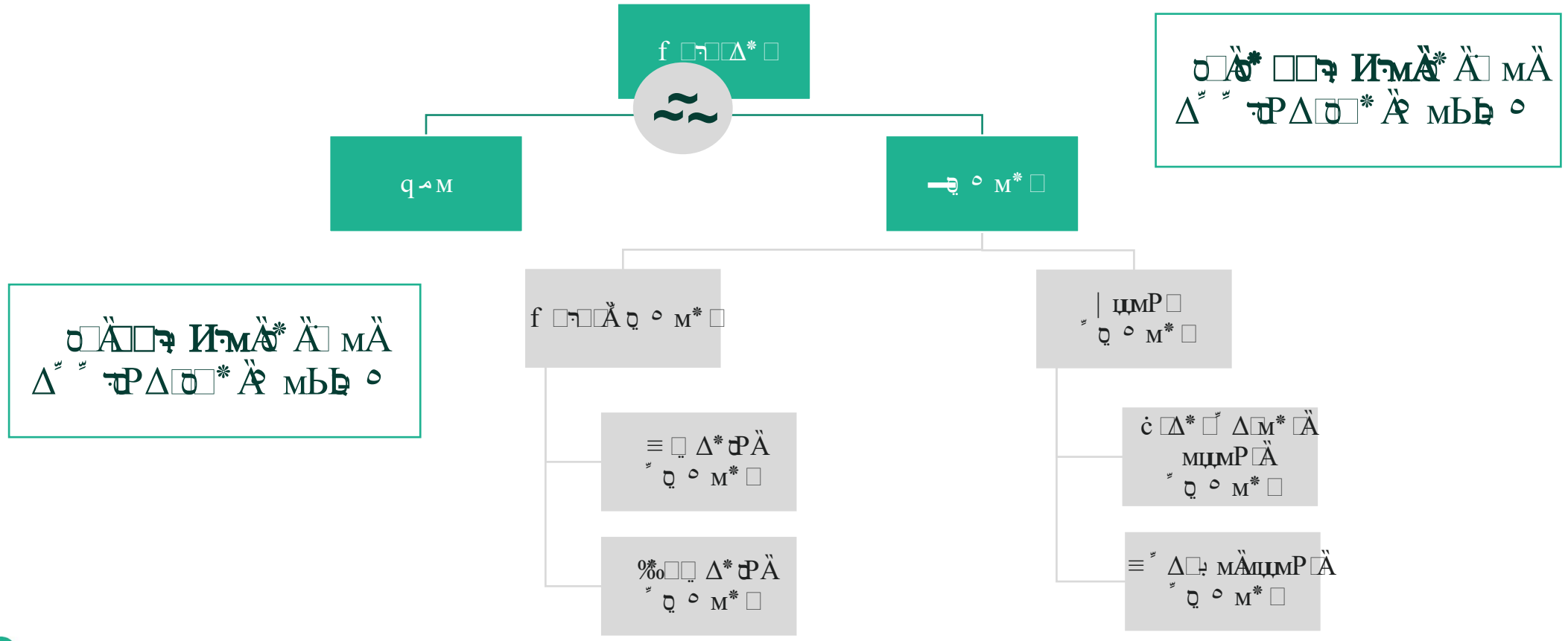
BRANDTtechnologies, LLC
a Xenon arc company

Colorants for Inks

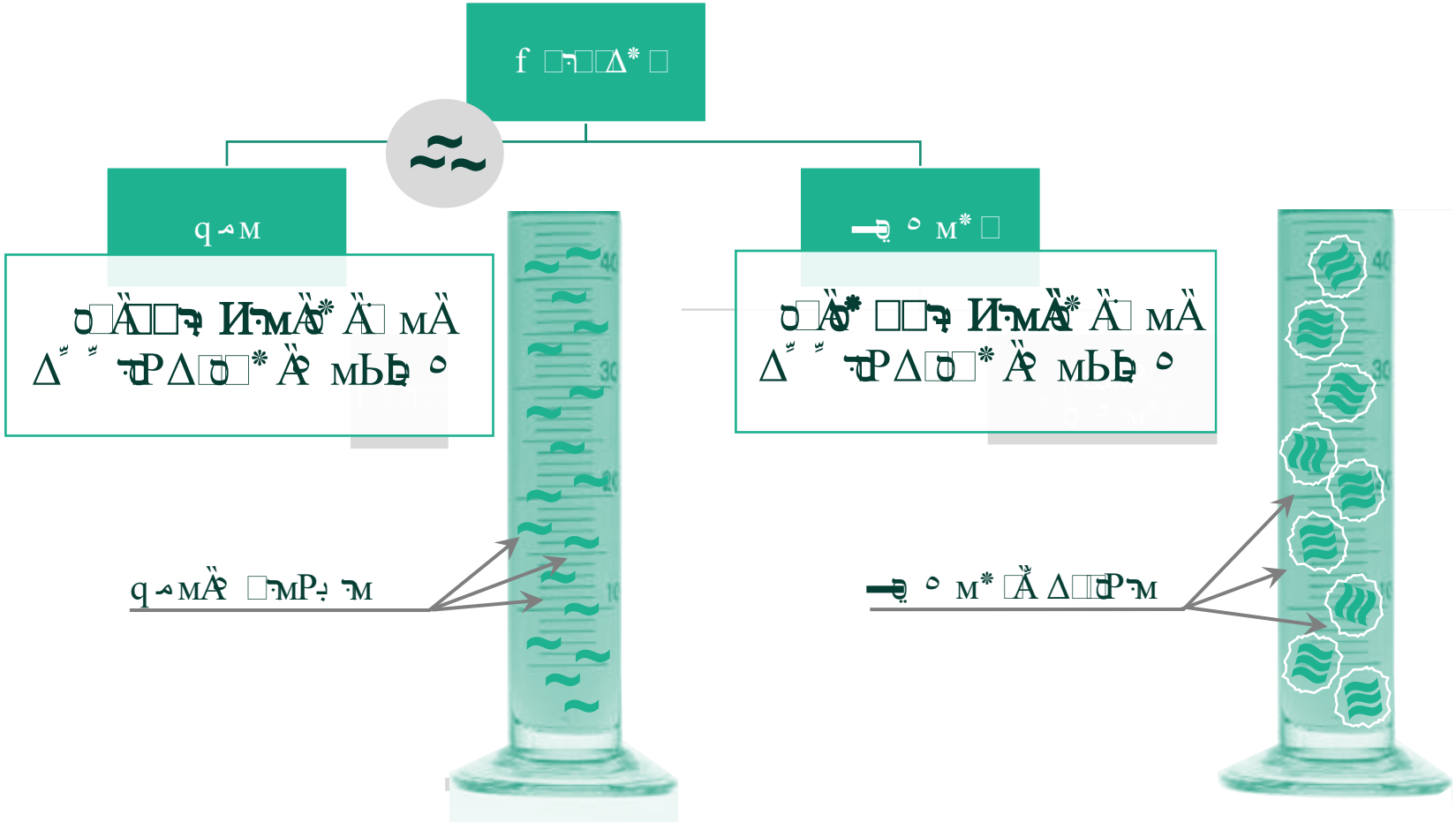
Types of colorants



What is a dye?
What is a pigment?

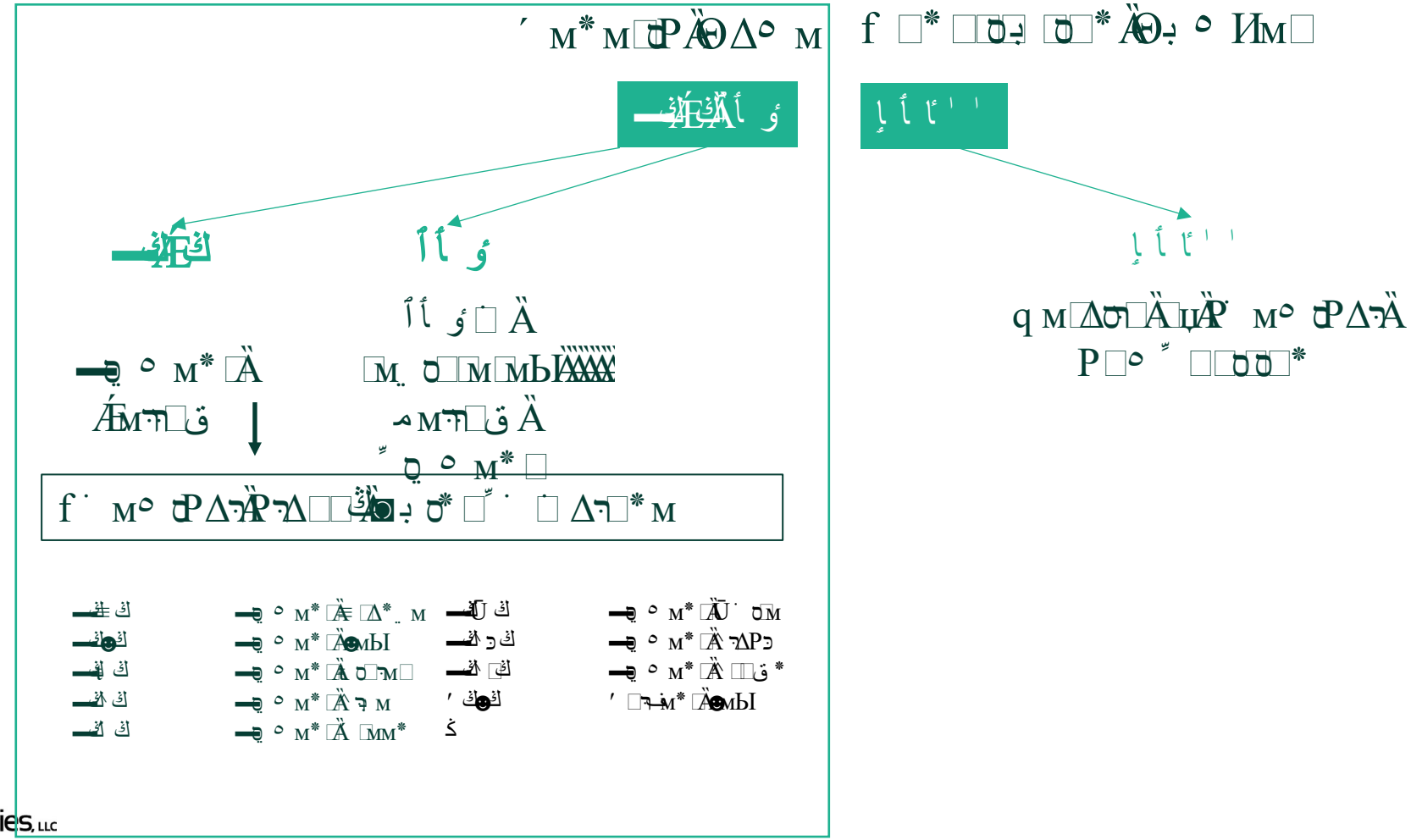


What is a dye?
What is a pigment?



What is a dye?
What is a pigment?

What is Color Index?



Color Index (CI)

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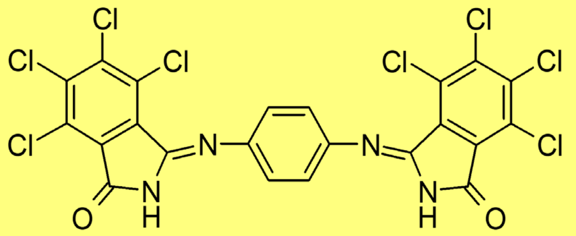

Isoindolinone
C. I. Pigment Yellow 110

Diketopyrrolopyrrole – DPP
C. I. Pigment Red 255

C.I.Pigment Violet 19

Cinquasia®
Red
L 4100 HD

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Cinquasia
Violet
L 5120

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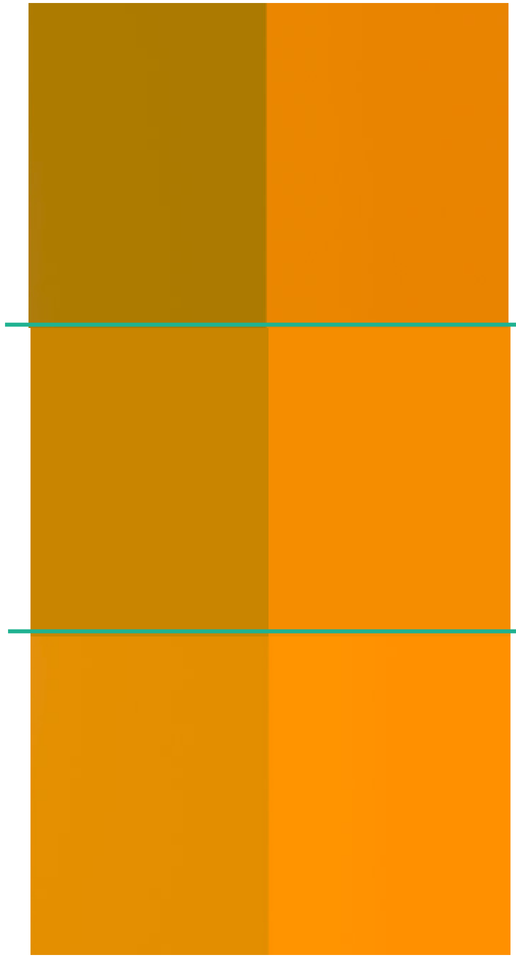
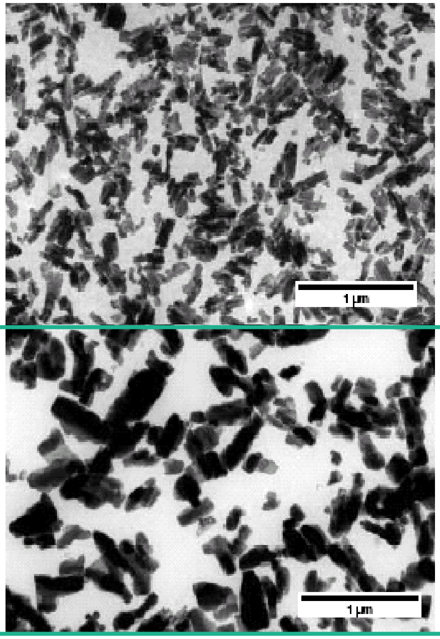
Mass Tone

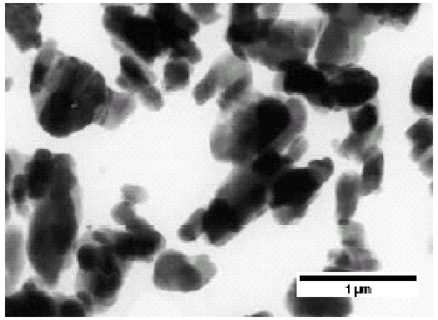
PY 139 Examples





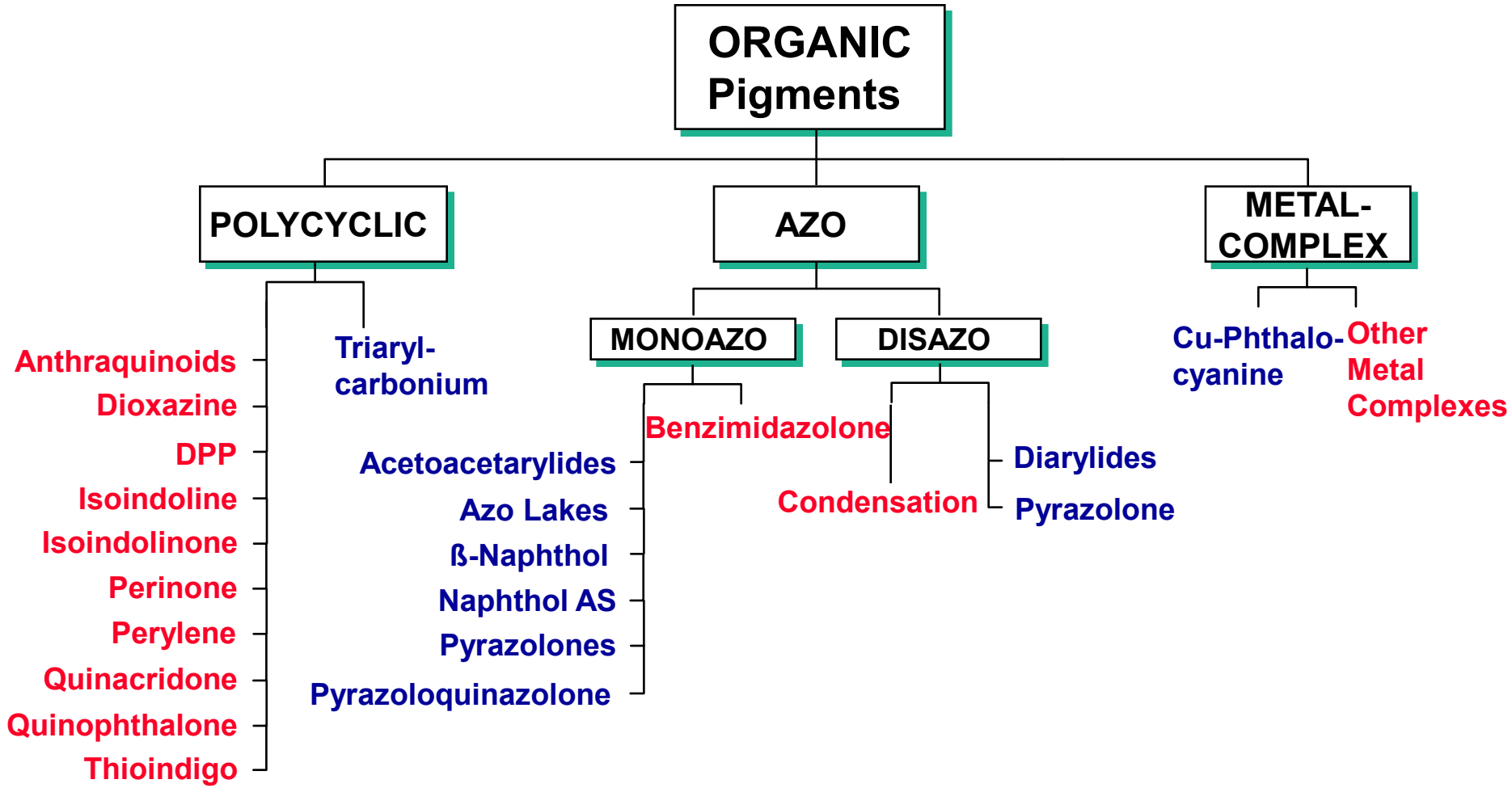
~130 nm

~200 nm

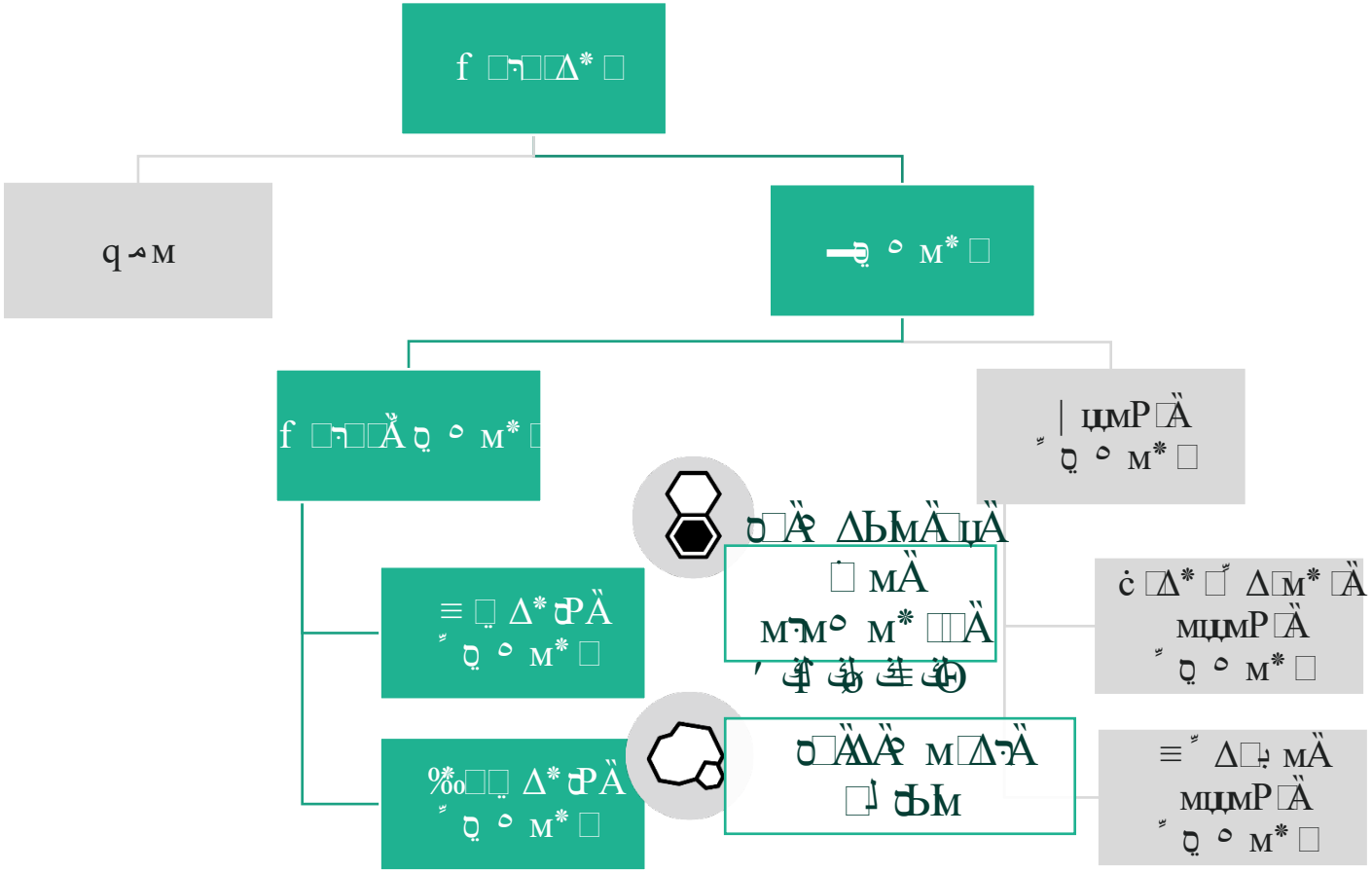


~300 nm

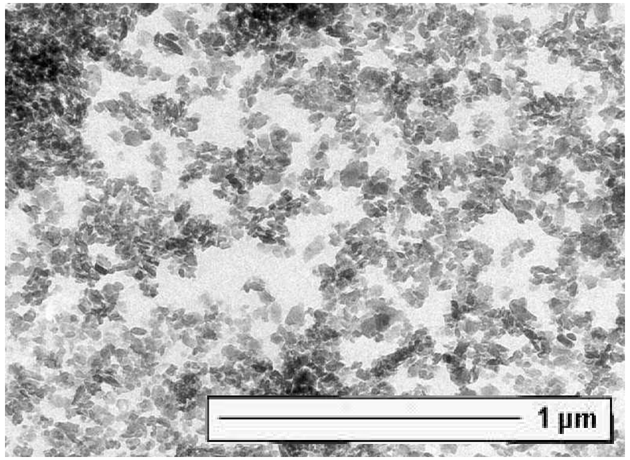
Organic Pigments

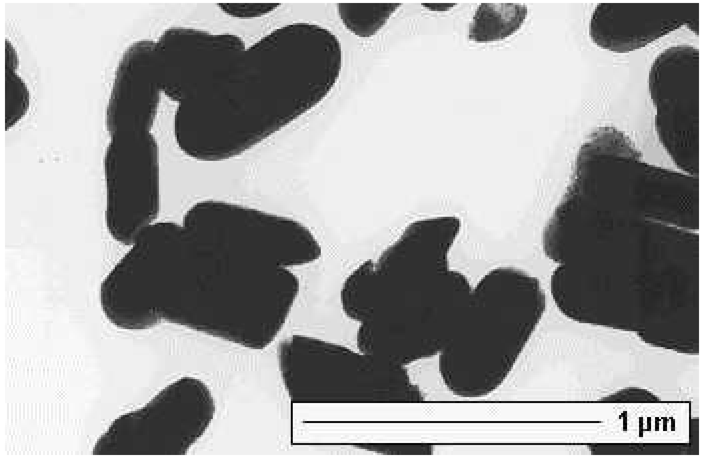


What is the difference between organic and inorganic pigments?

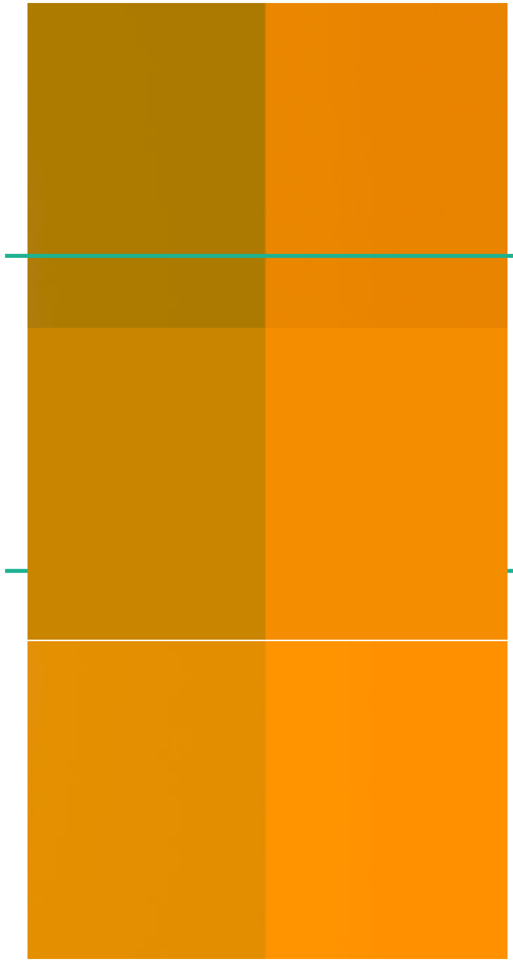


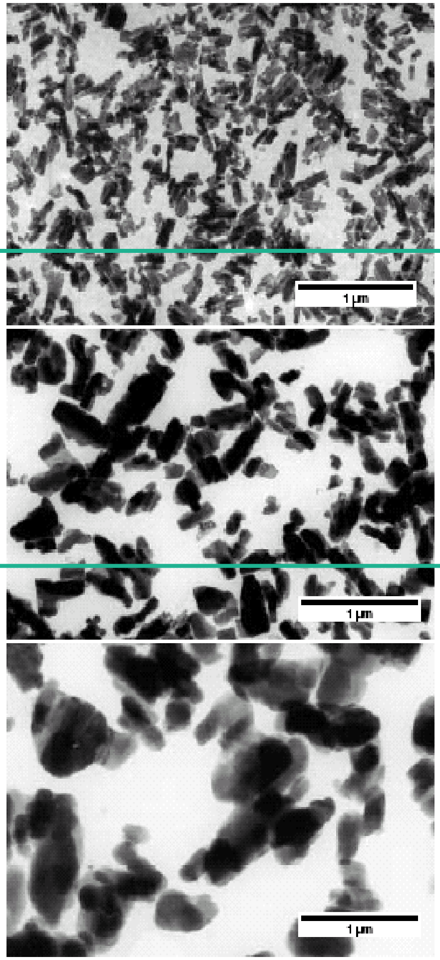
What do they look like under a microscope?



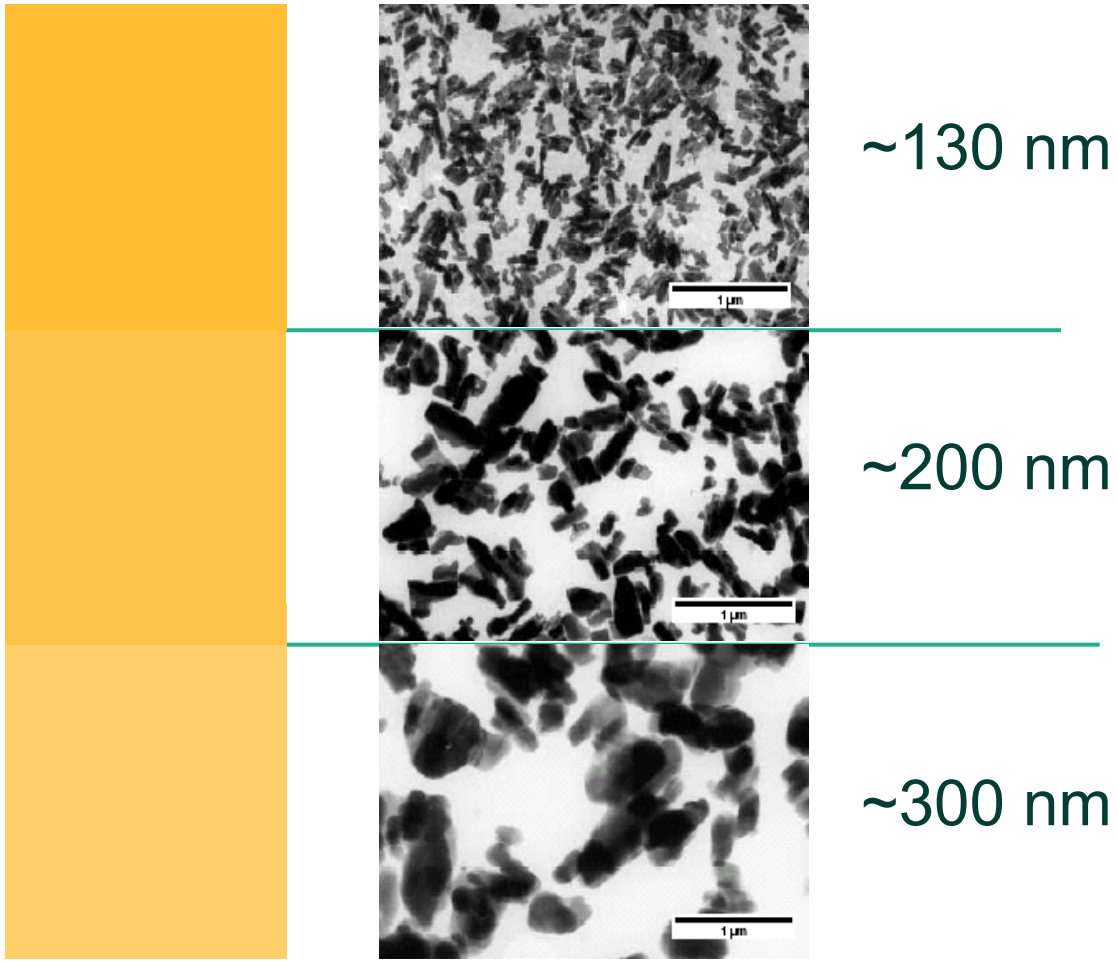


Influence of particle size on transparency and opacity





Influence of particle size on color strength

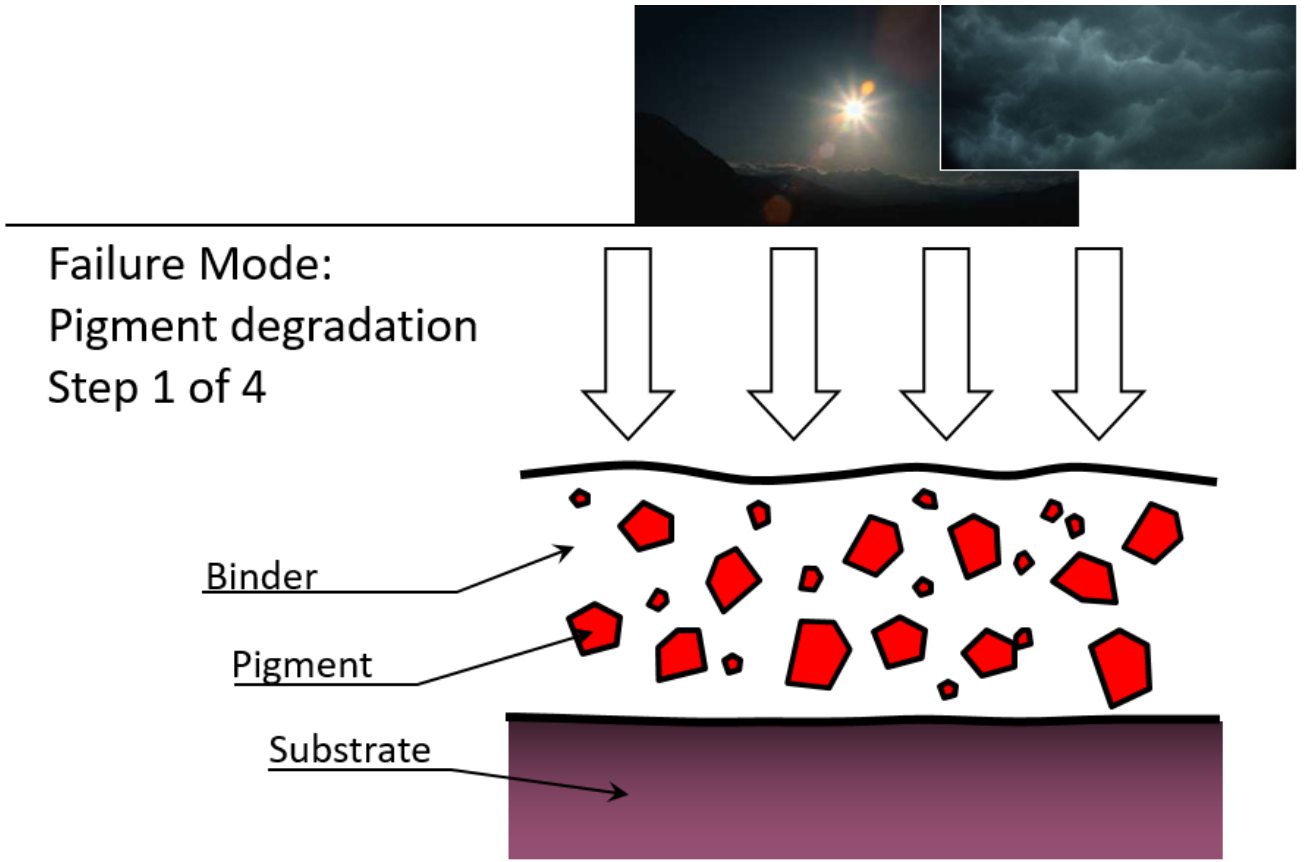


BRANDTtechnologies, LLC
a Xenon arc company

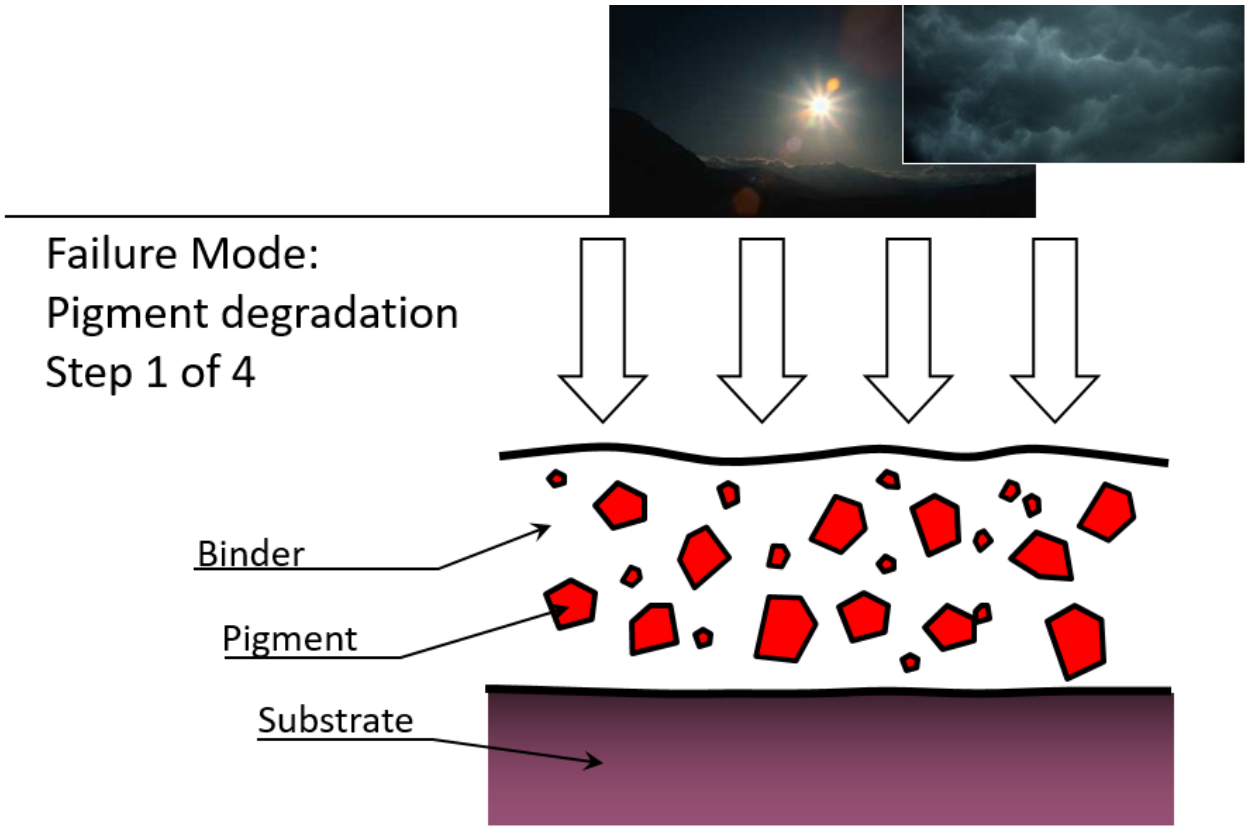
How do properties of organic and inorganic pigments relate to particle size?

Property	Organic	Inorganic
Particle size		
Transparency	☺	☹
Opacity	☹	☺
Color strength	☺	☹
Chroma	☺	☹

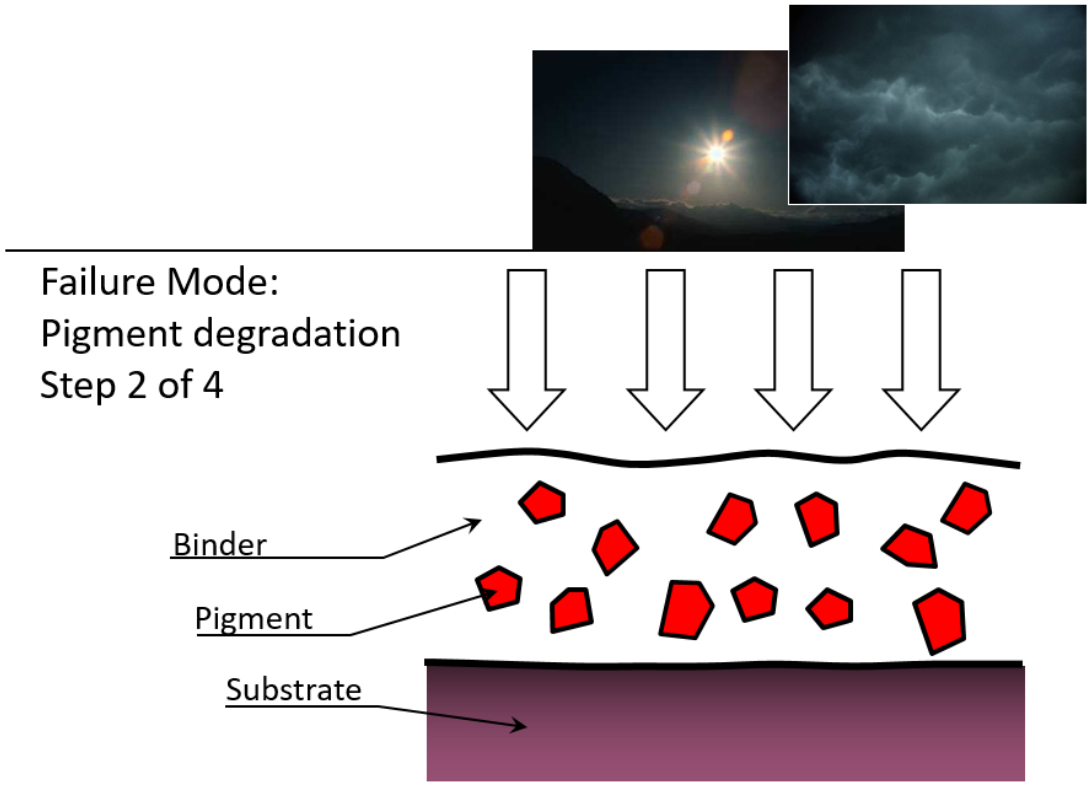
Fastness Properties



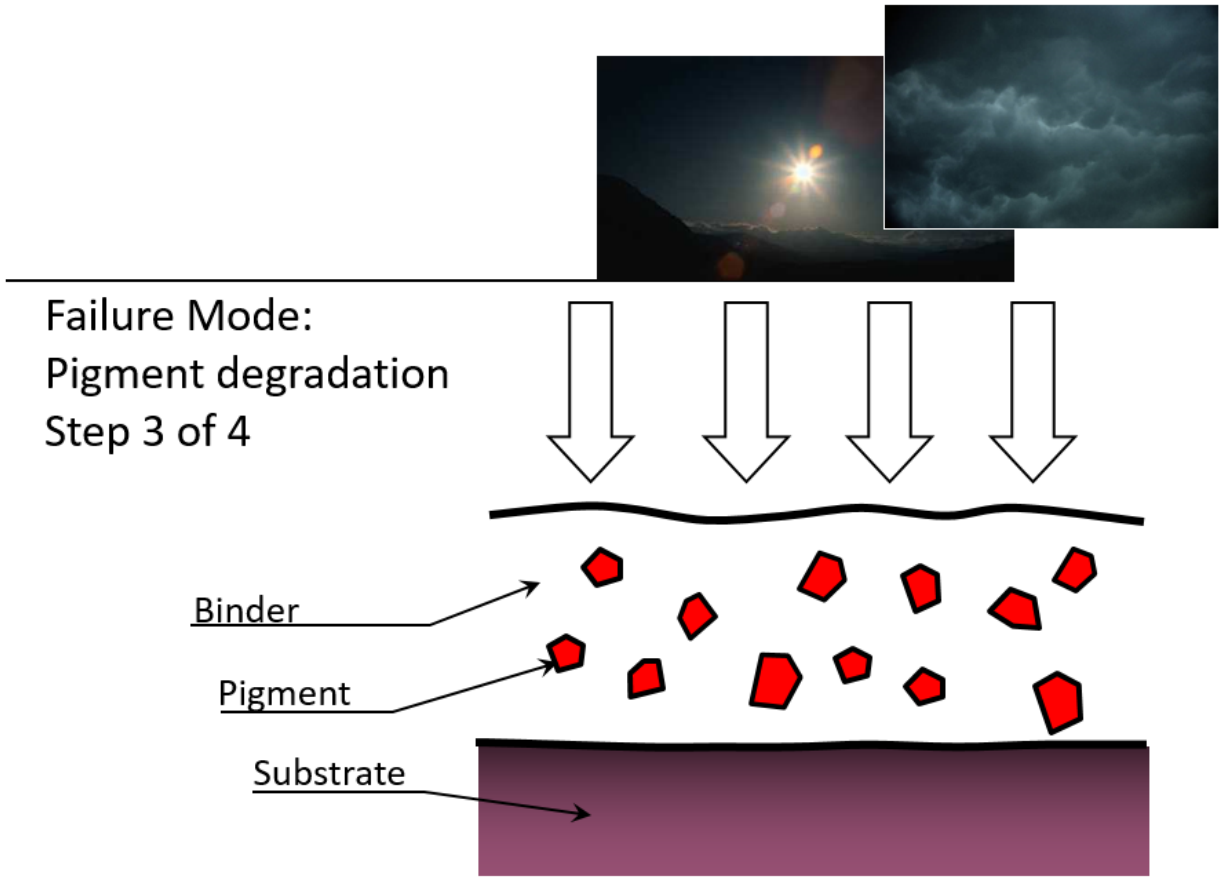
Fastness properties
e.g. weatherfastness



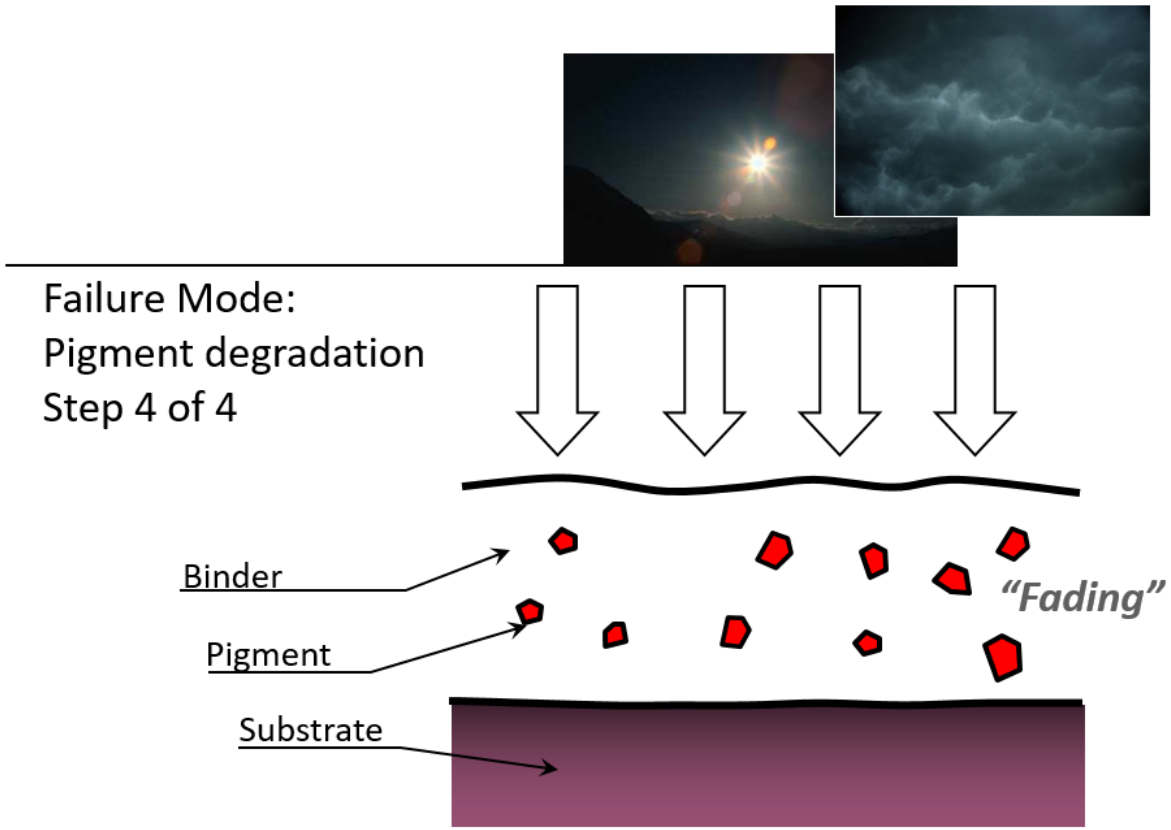
Fastness properties
e.g. weatherfastness



Fastness properties
e.g. weatherfastness



Fastness properties
e.g. weatherfastness



How do properties of organic and inorganic pigments relate to particle size?

Property	Organic	Inorganic
Particle size		
Transparency	☺	☹
Opacity	☹	☺
Color strength	☺	☹
Chroma	☺	☹
Fastness properties	😐	☺

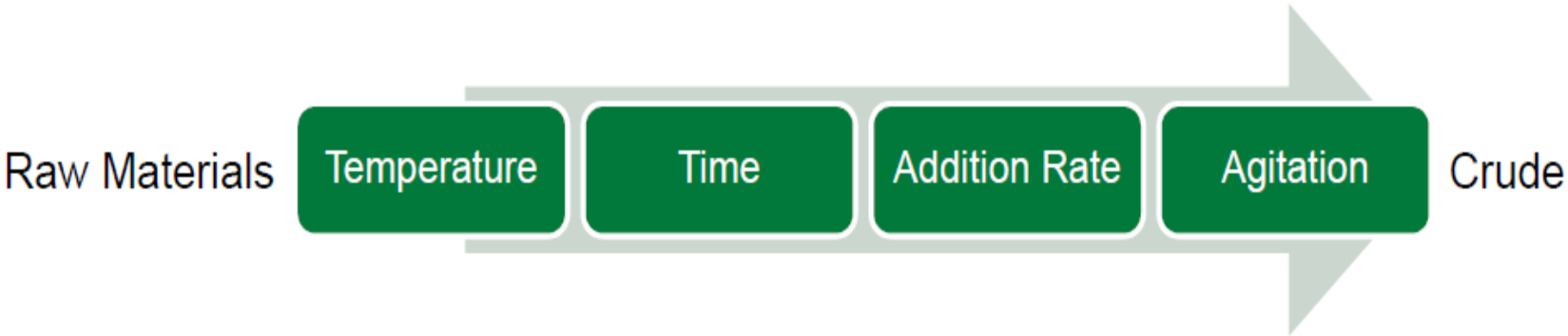
Pigments and Performance - Overview

Pigment Properties	Inorganic	Organic Classical	Organic High Performance
Color, Purity	Often Dull	Usually Bright	+/- High
Opacity	High	+/- transparent	+/-transparent
Color Strength	Middle to Low	Normally High	Usually Bright
Lightfastness (Blue Wool Scale)	Good to High (7-8)	Low to Middle (<7)	Good to High (7-8)
Weather Resistance	Varies/Chemistry	Insufficient	Middle to High
Heat Resistance	> 500°C	150°C to220°C	200°C to 300°C
Solvent Fastness	High	Middle to Good	Good to High
Chemical Resistance	Varies/Chemistry	High except salts	High
Product cost	Low to Middle	Middle	High

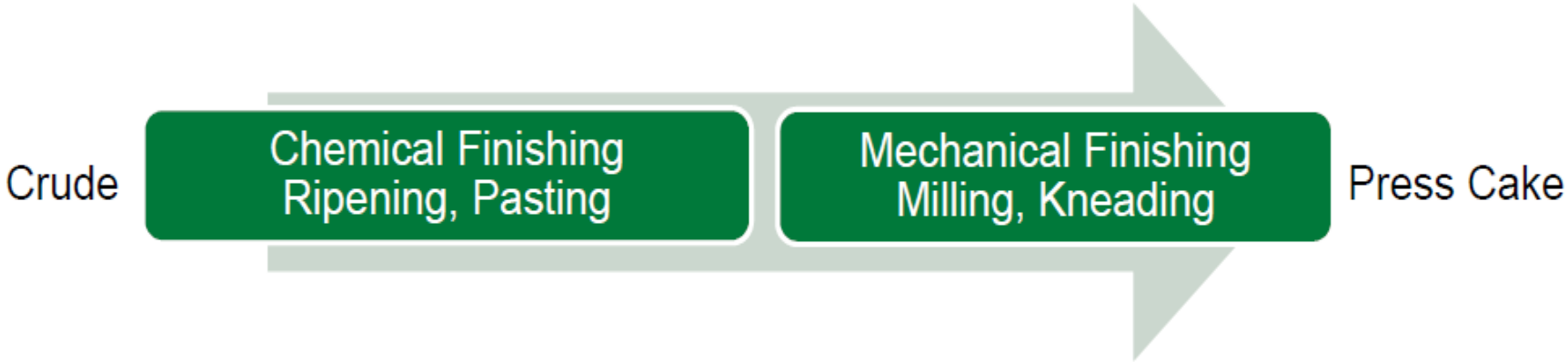
Pigment Manufacture

BRANDTtechnologies, LLC
a Xenon arc company

Synthesis


Raw Materials
Temperature
Time
Addition Rate
Agitation
Crude

Chemical and Physical Conditioning

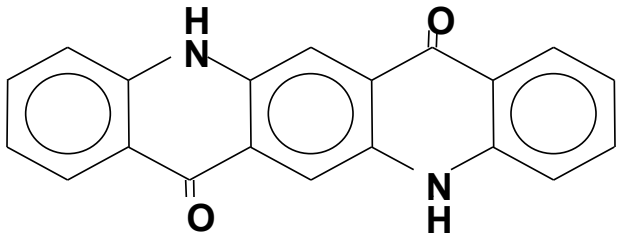


Finishing


Press Cake
Surface Treatment
Drying
Blending Packaging
Finished Product

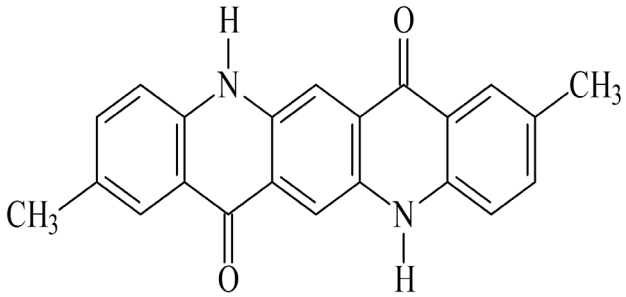
Organic Pigments - Auxochromes

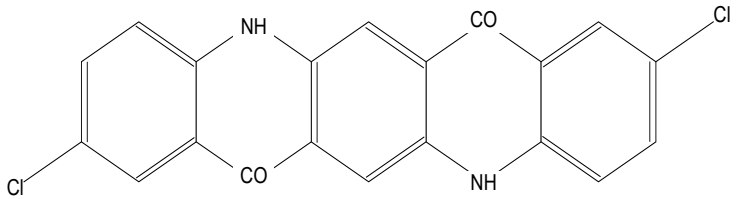
Organic Pigments: Auxochromes



Pigment Violet 19

Pigment Red 122



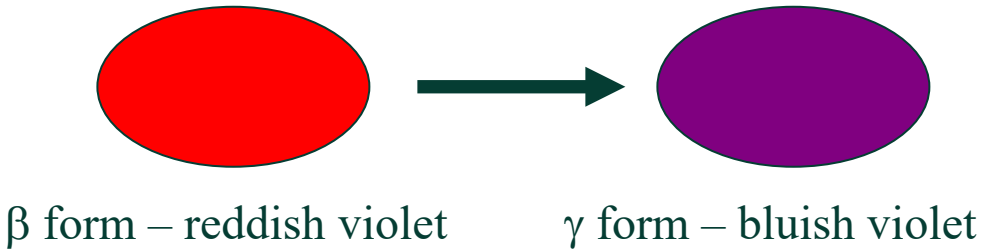


Pigment Red 202

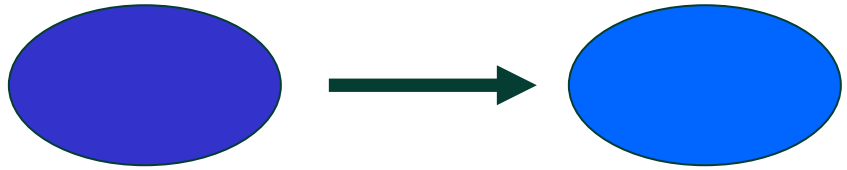
Pigment Crystallography

Polymorphism

Arrangement of a molecule can be different in the crystal lattice. This leads to different pigments with different colour and performance :



β form – reddish violet γ form – bluish violet



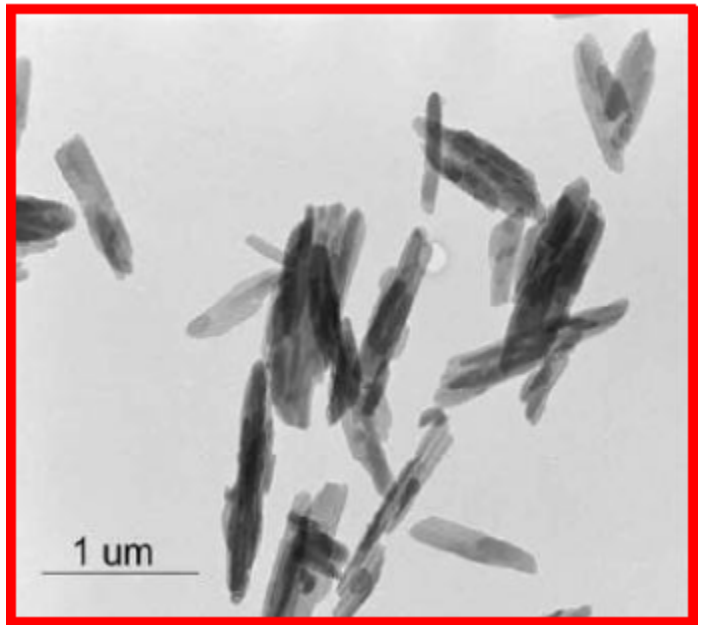
α form – reddish blue β form – bluish violet

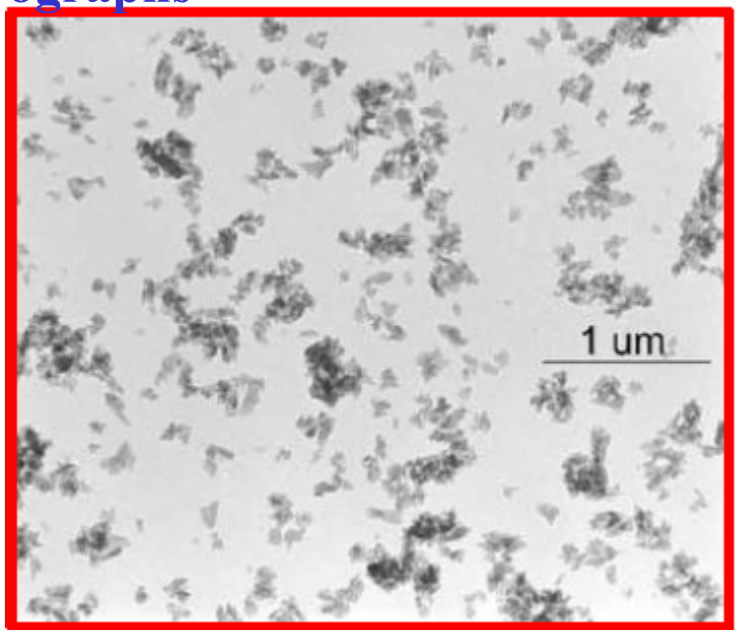
Pigment Crystallography

Particle Size

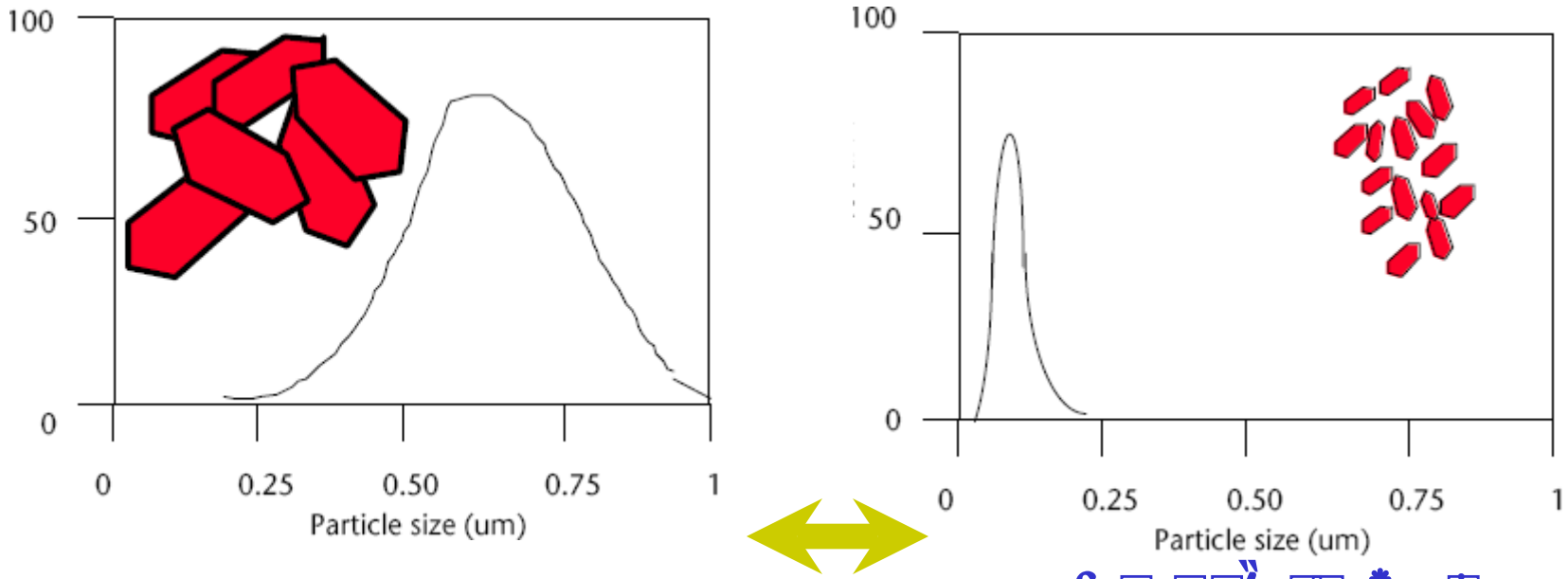
Crystal shape and size can be manipulated by both physical and chemical methods employed during the stages of manufacture and will play a key role in the end properties of the pigment.

Electron Micrographs

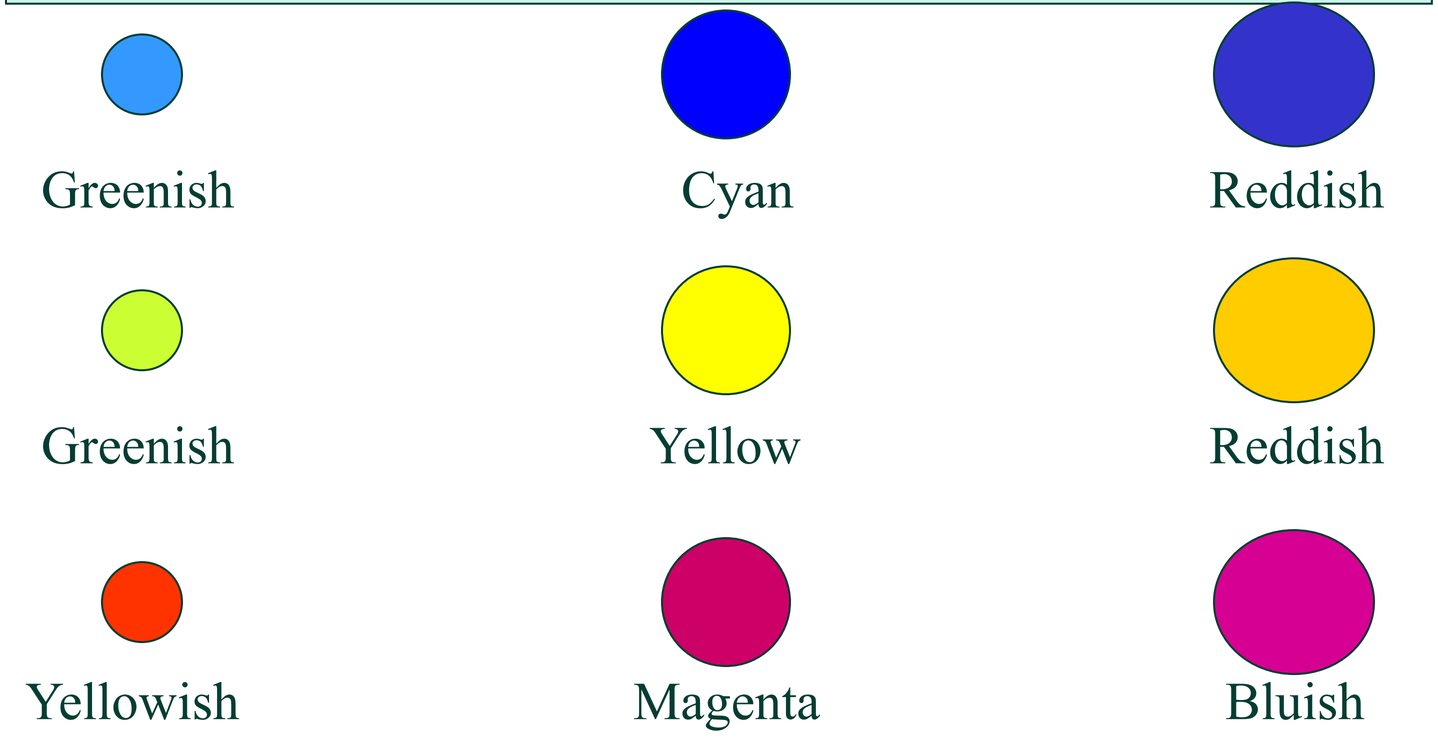




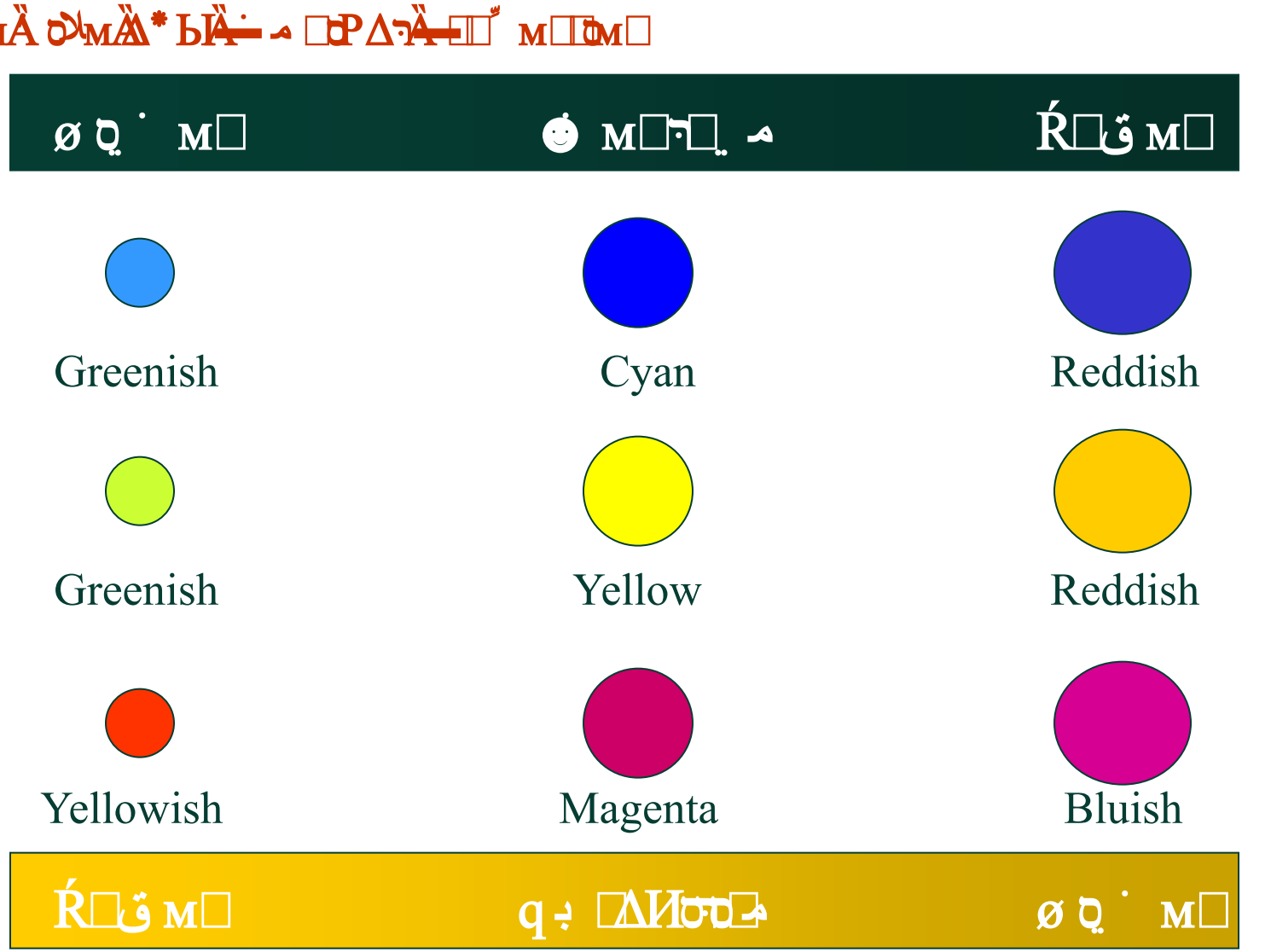
Pigment Crystallography



Pigment Crystallography



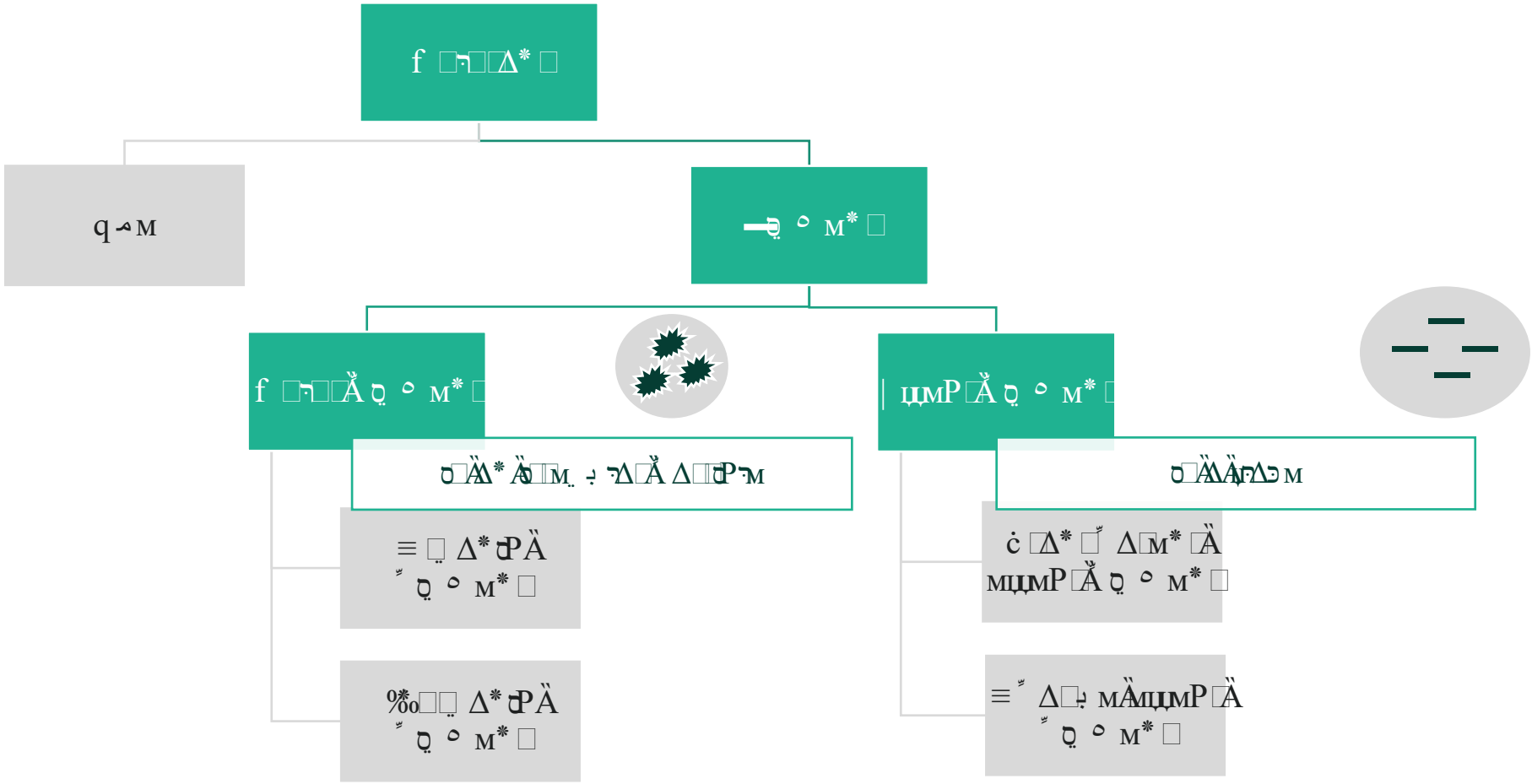
Pigment Crystallography



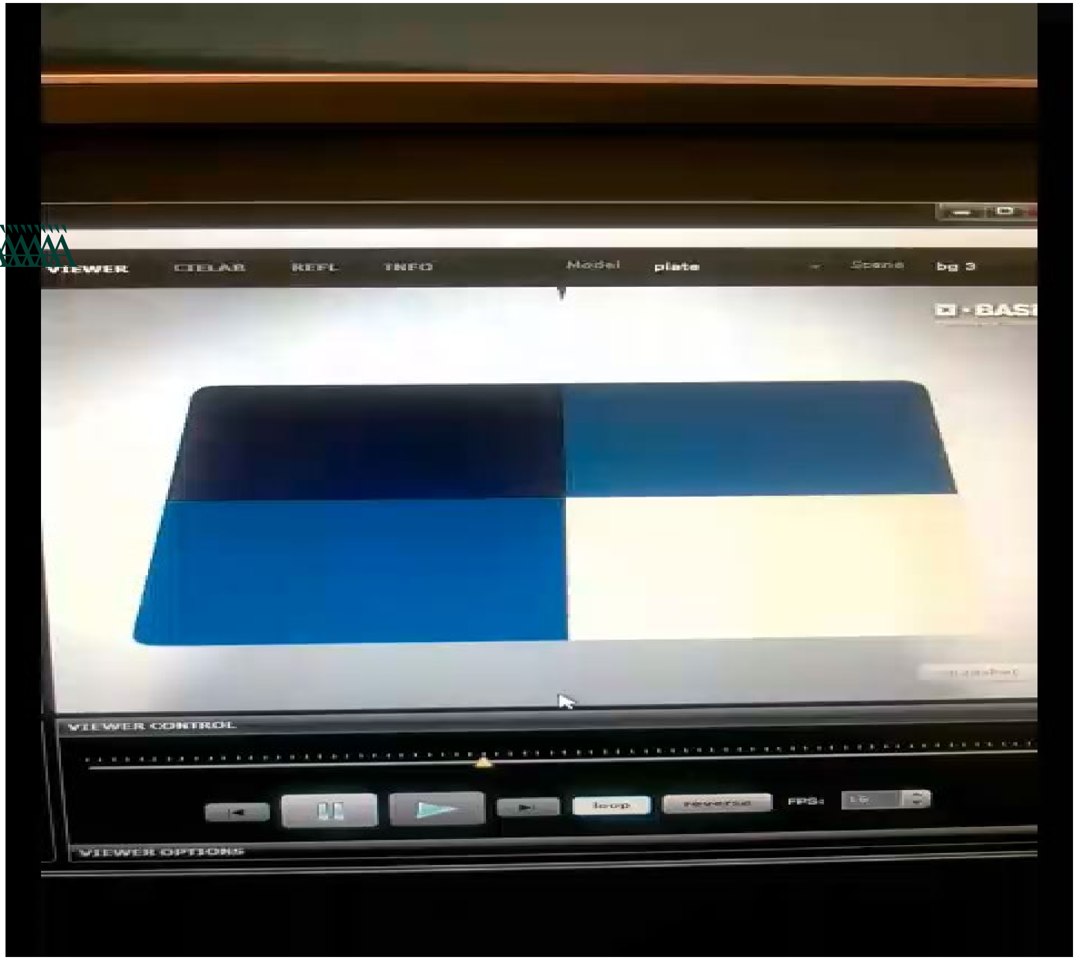
Effect Pigments

What is the difference between color and effect pigments?

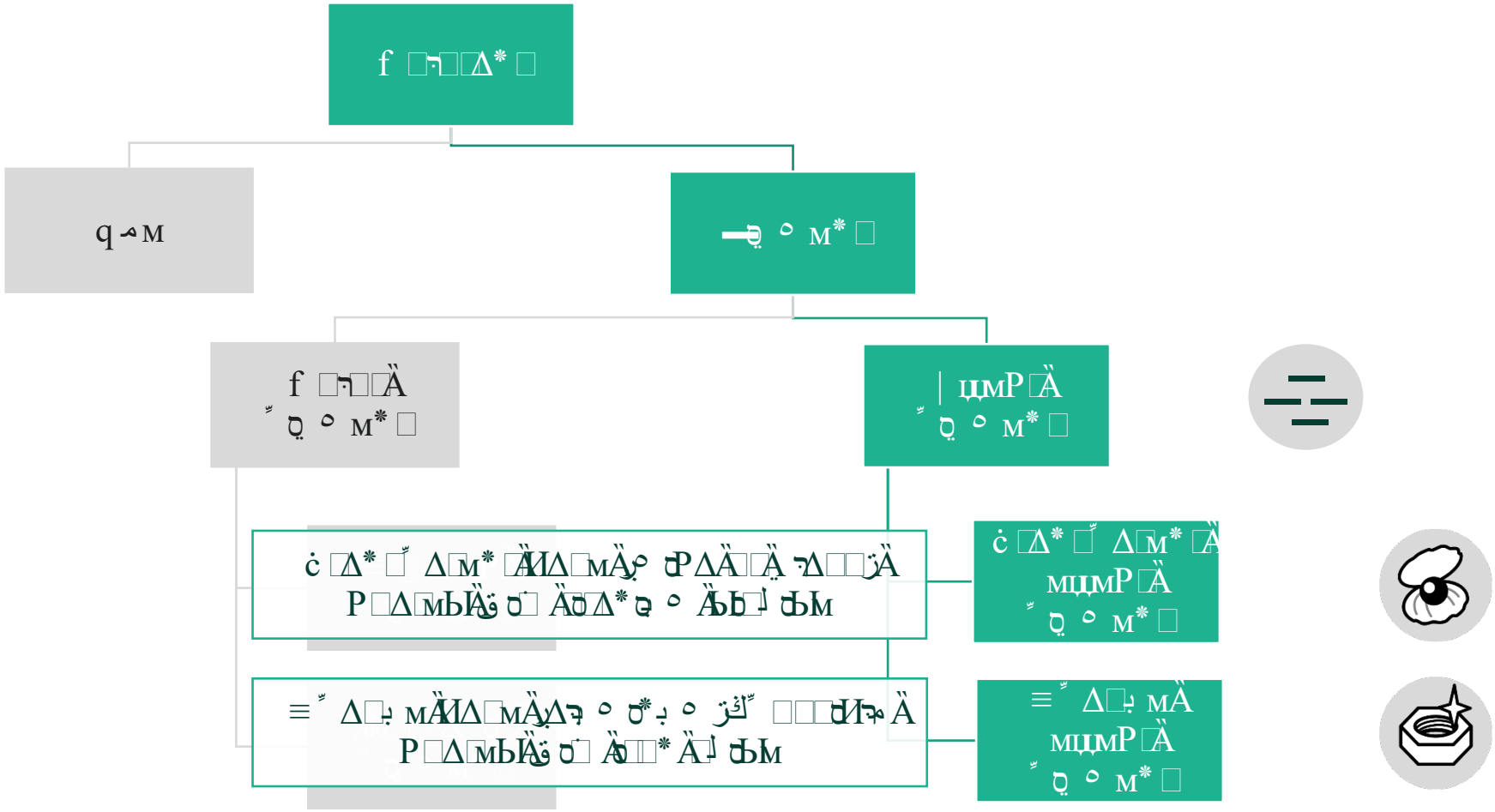
What is the difference between color and effect pigments?



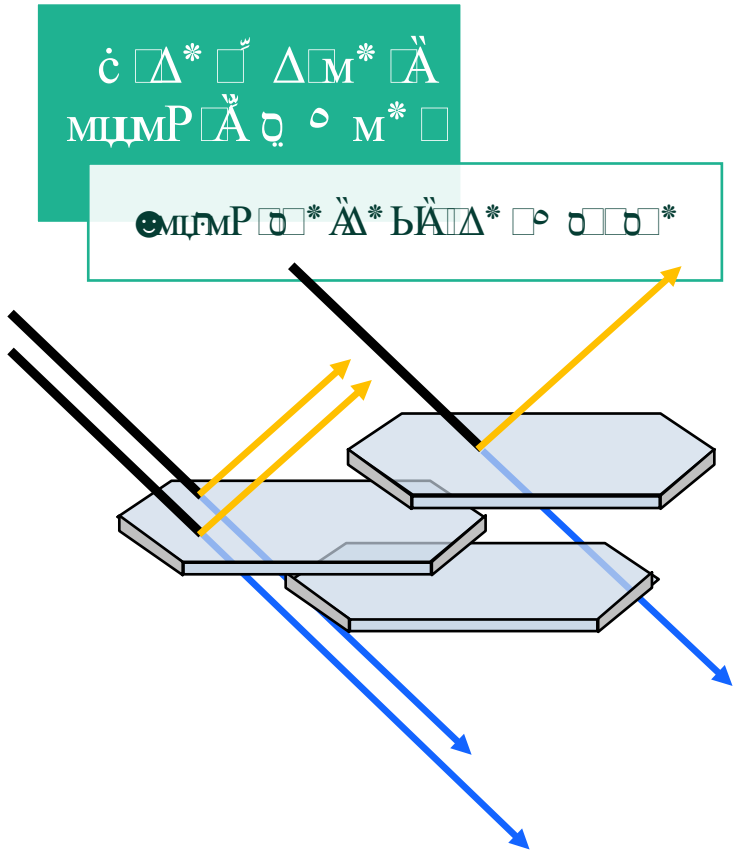
What is the difference between color and effect pigments?

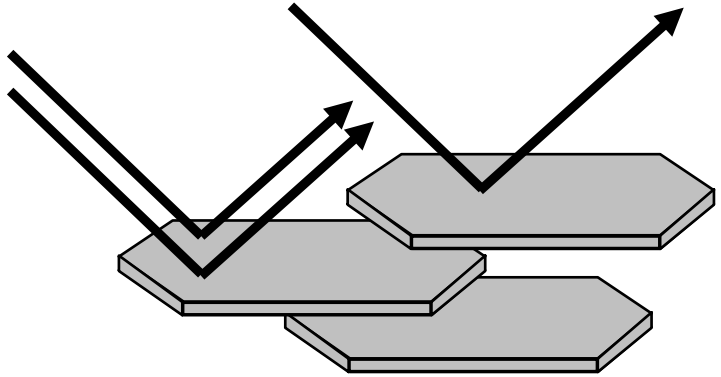


What is the structure of effect pigments?



How do effect pigments function?





Transparent effect pigments e.g. based on mica

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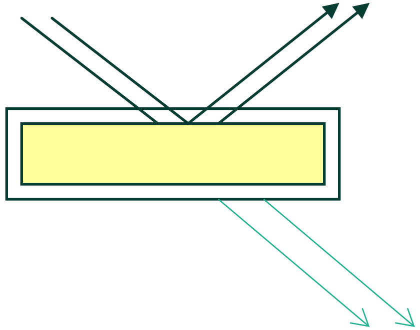
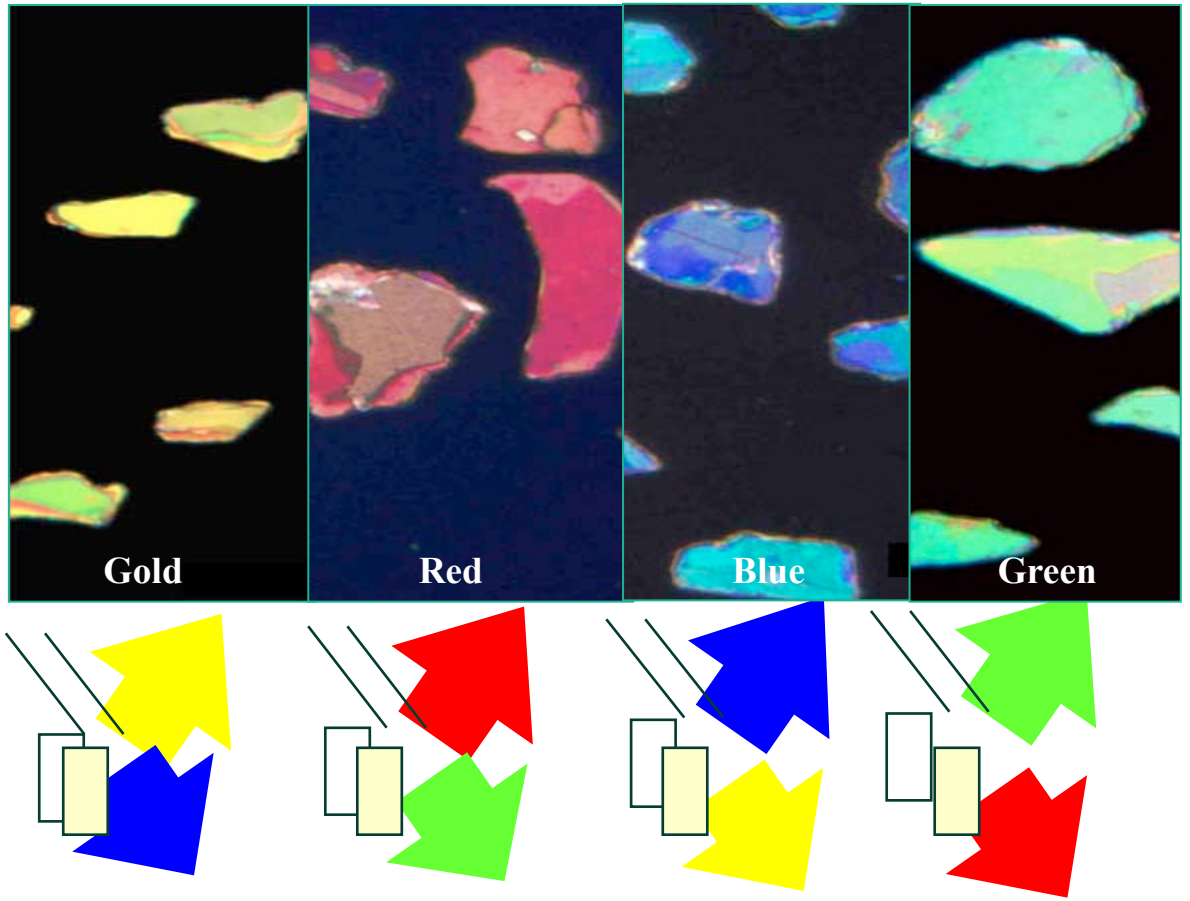
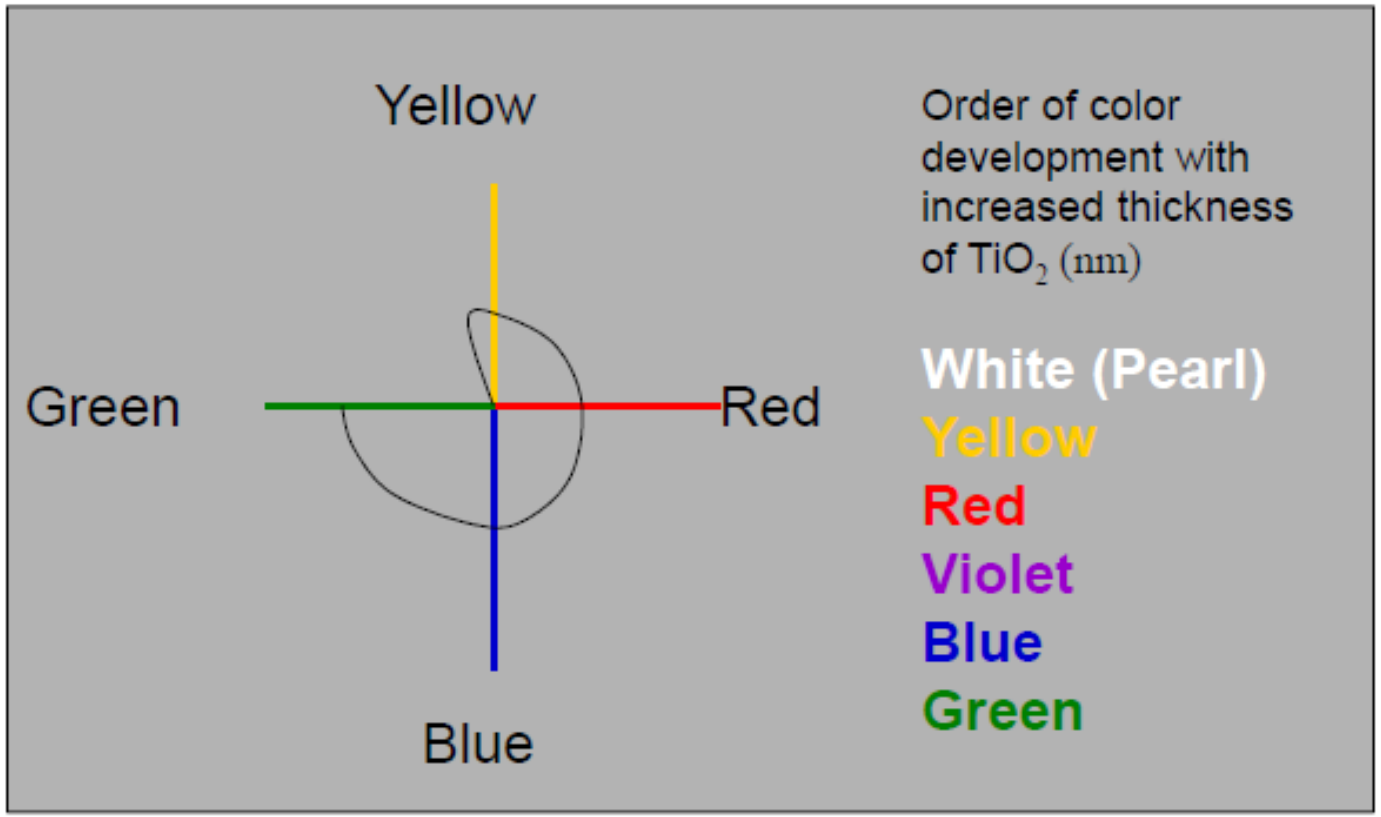


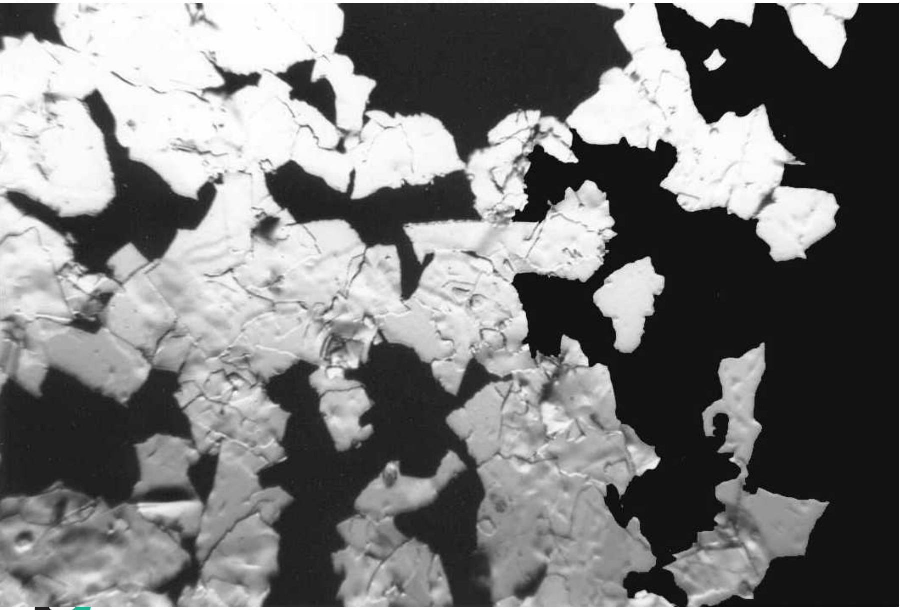
Transparent effect pigments
Influence of coating thickness



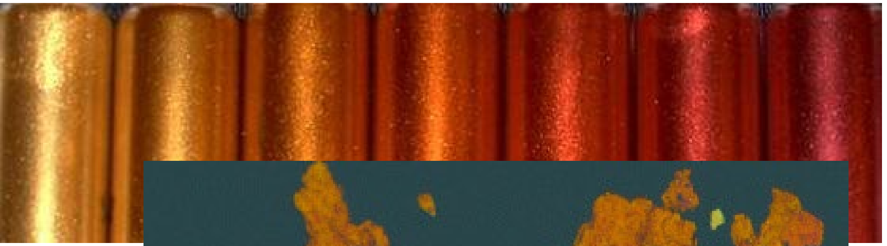
Thickness of layer determines the interference color

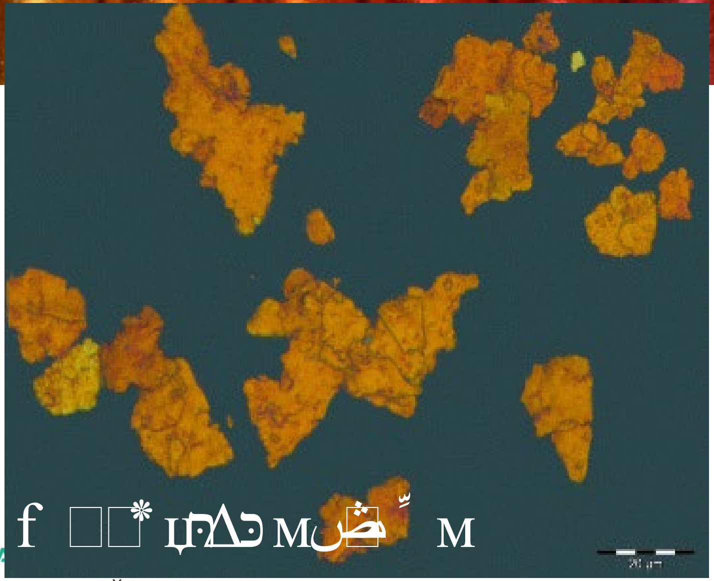


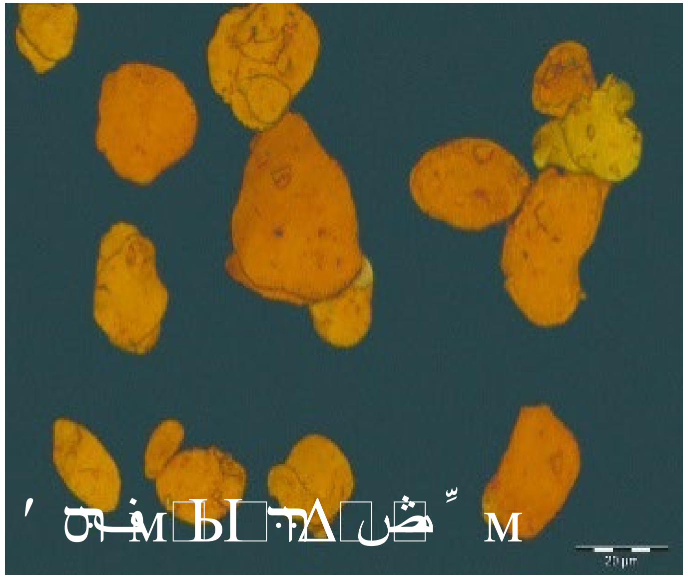
Opaque effect pigments – aluminum



Opaque effect pigments – coated aluminum







Effect Pigment Key Points

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Fluorescent Pigments

Daylight Fluorescent-Defined

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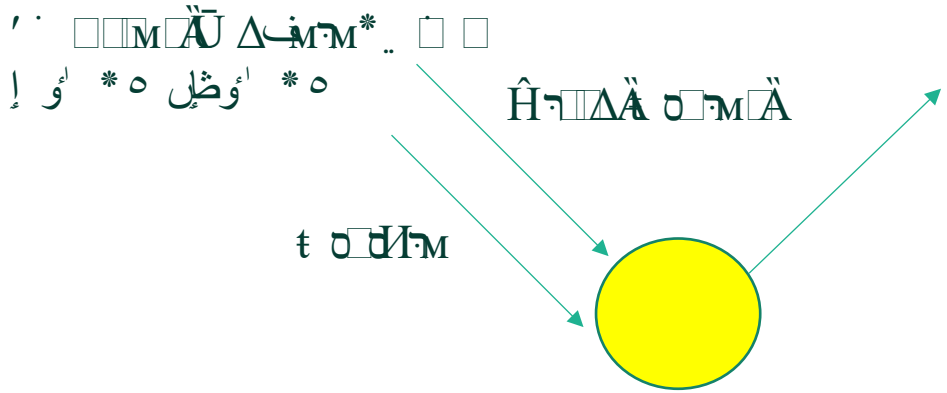
Visual Model



Fluorescent Pigment Technology-Chemistry

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Fluorescent Pigment Manufacturing Technology

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Fluorescent Pigment Manufacturing Technology

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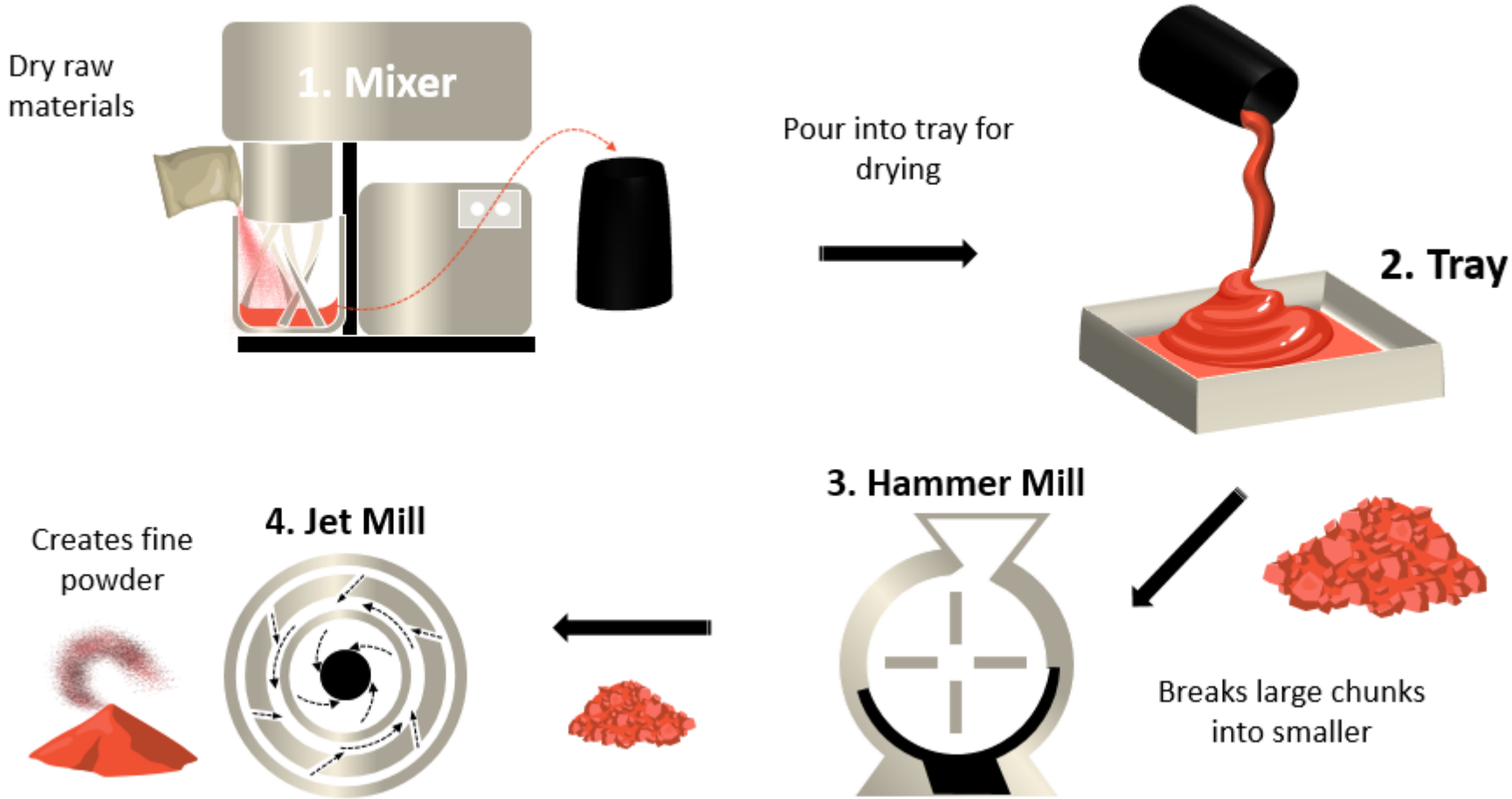
Production



BRANDTtechnolog
a Xenon arc

Fluorescent Pigment Manufacturing Technology

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Fluorescent Pigment Manufacturing Technology

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Fluorescent Pigments-Product Types

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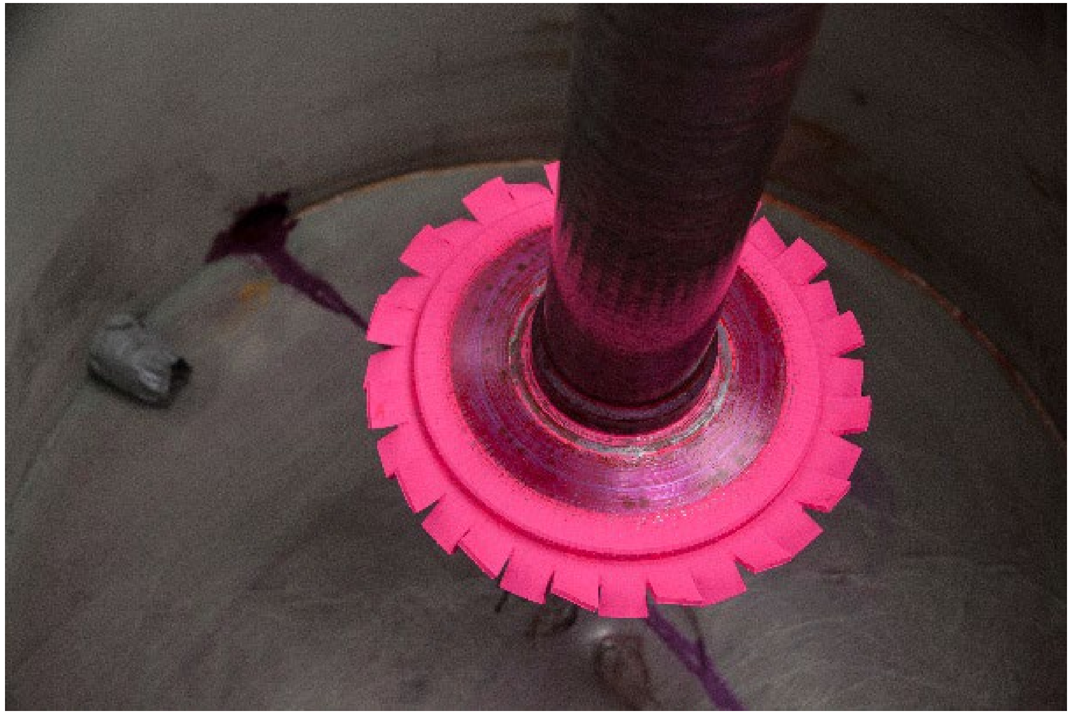

Fluorescent Pigments-Product Types

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        - [illegible]
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Fluorescent Pigments-Applications

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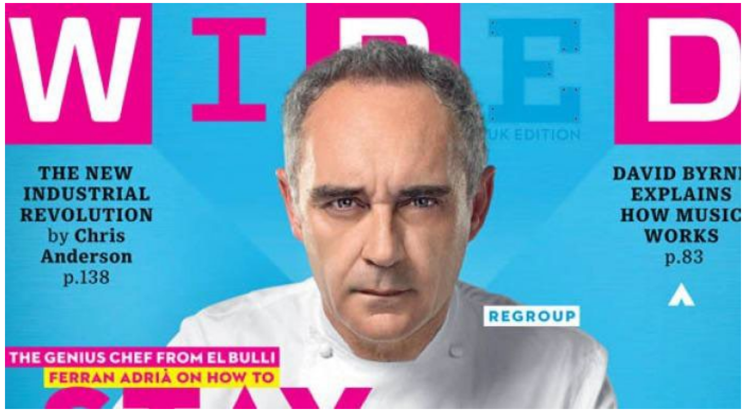
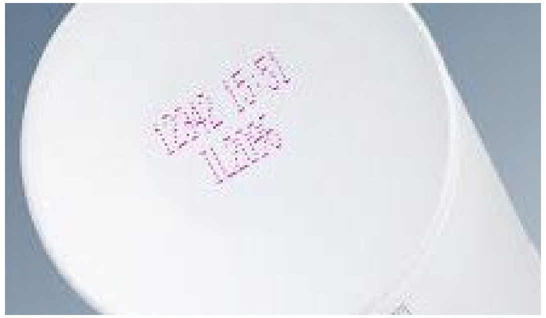
Fluorescent Pigments For Inks





Fluorescent Pigments:
Many Chemistries + Applications

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How are colorants used in inks?

How do you make sure the pigment sticks to the substrate?

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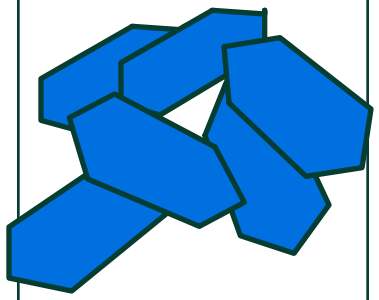
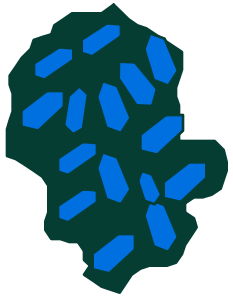
Product Forms

Pigment



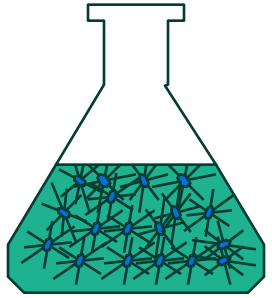
Insoluble Particles
Fine Powder
Coarse Powder-SG
Granules
Presscake

Pigment Preparations



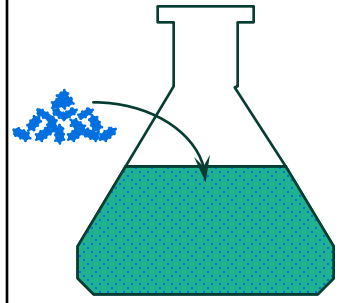
Insoluble Particles,
Soluble Binder

Liquid Dispersions



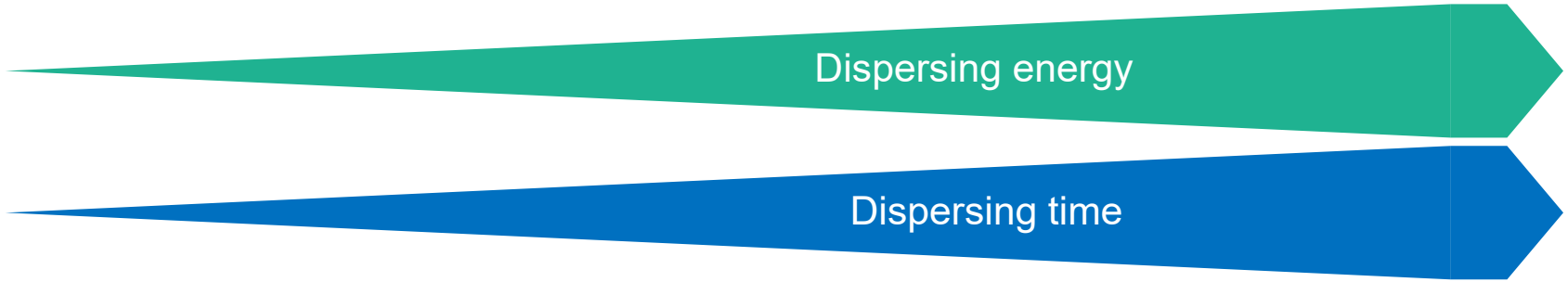
Insoluble Particles,
Dispersion Agent
(Soluble Binder)
Stable Dispersion
Includes flushes

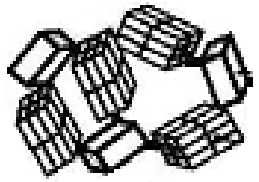
Dyes

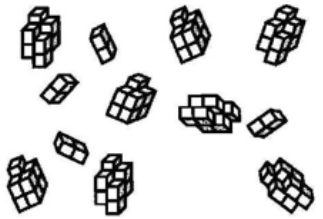


Soluble Particles
Molecular
Distribution

Dispersion process







Agglomerates

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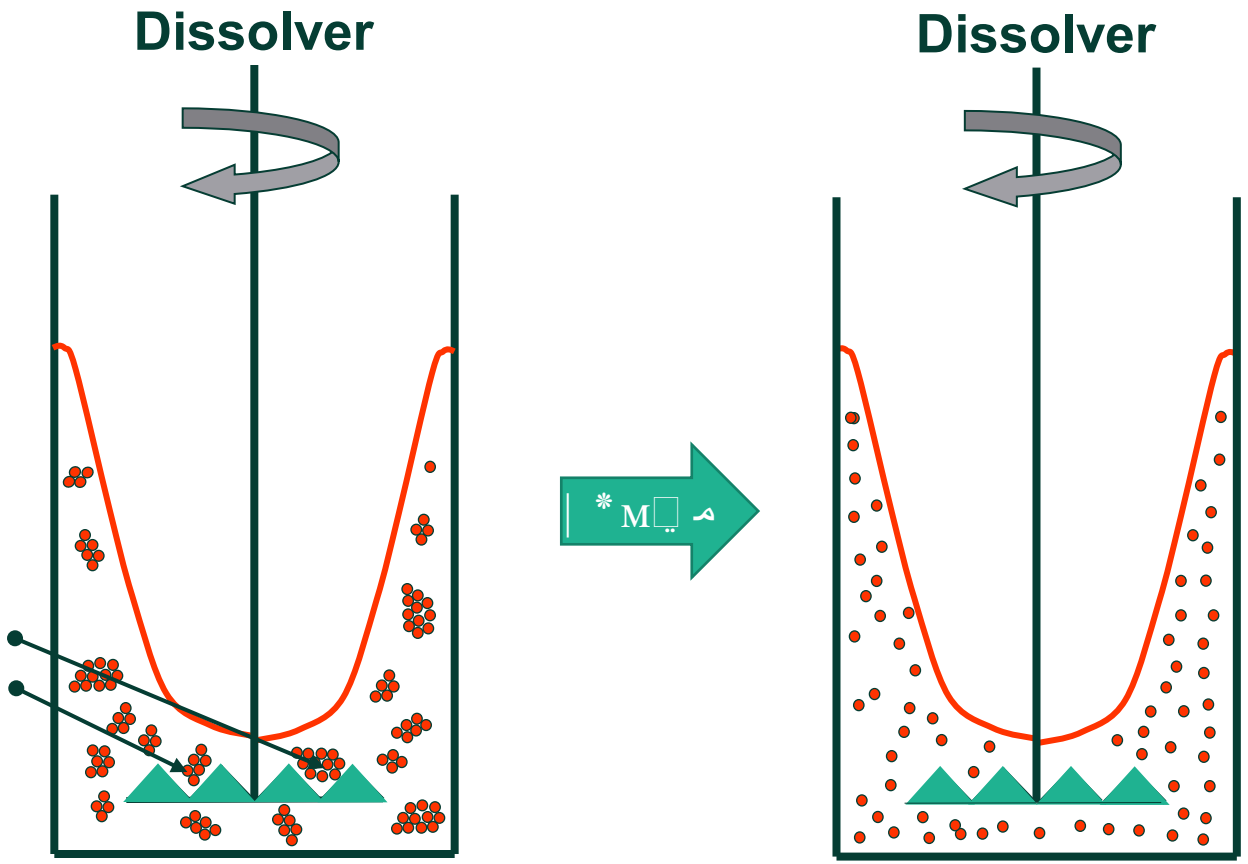
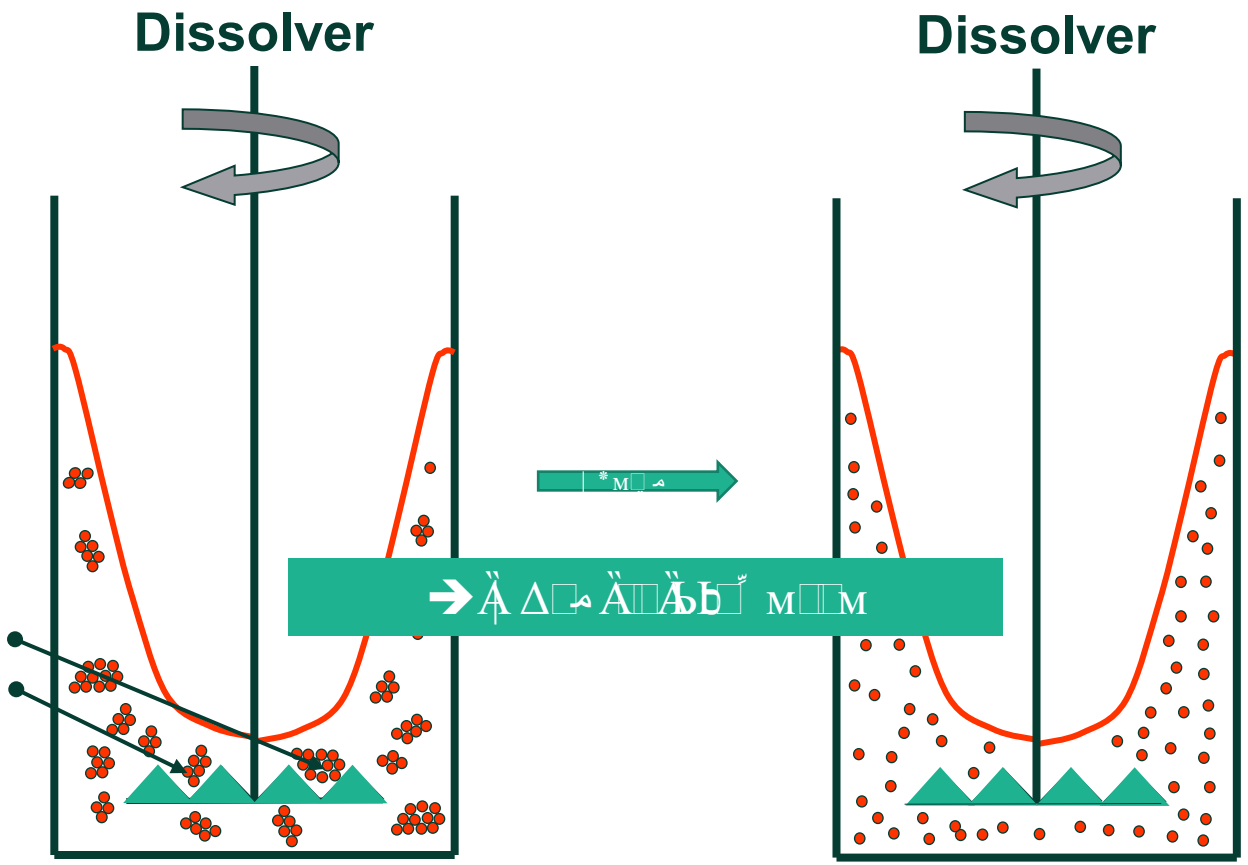
White reductions of the dispersed blue pigment at different stages of the dispersing process:

Dispersing with a dissolver

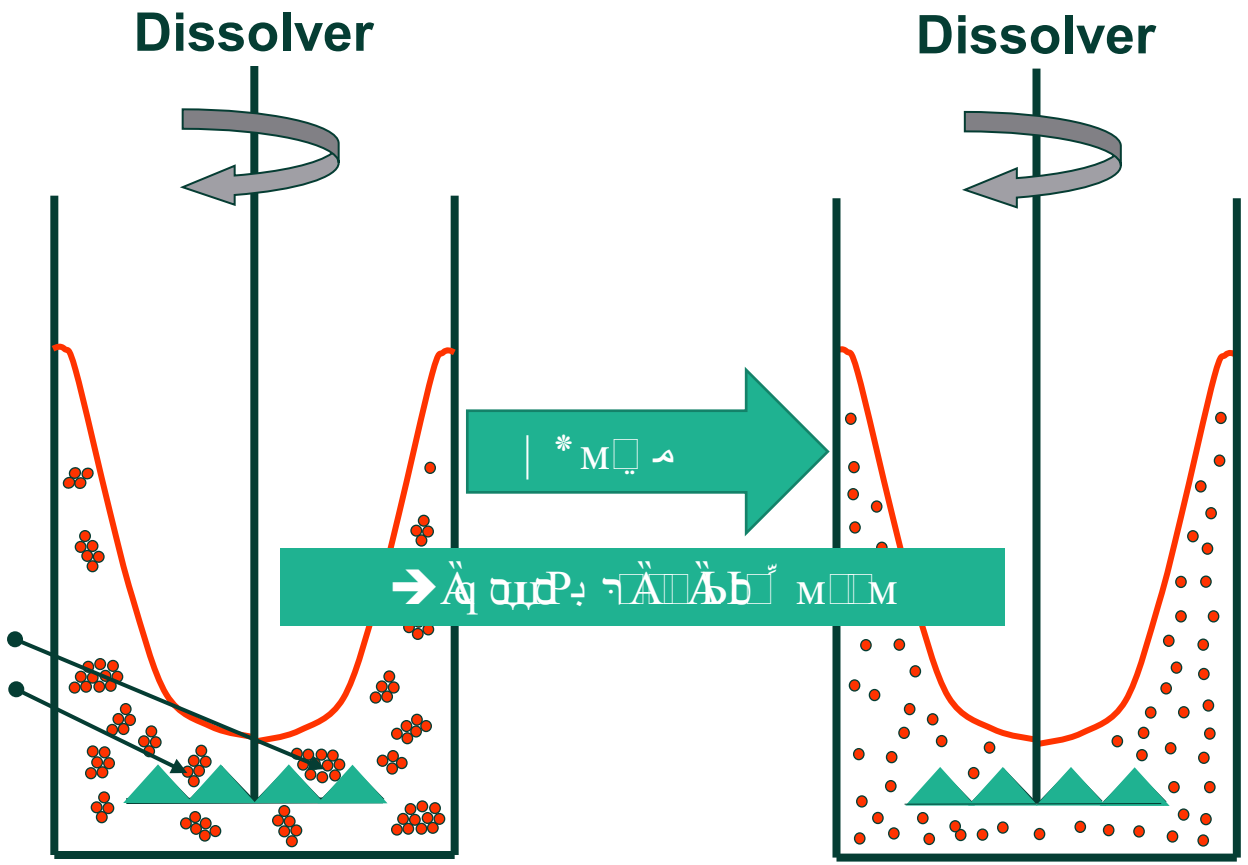
Zones with max. shearing force



Dispersing with a dissolver



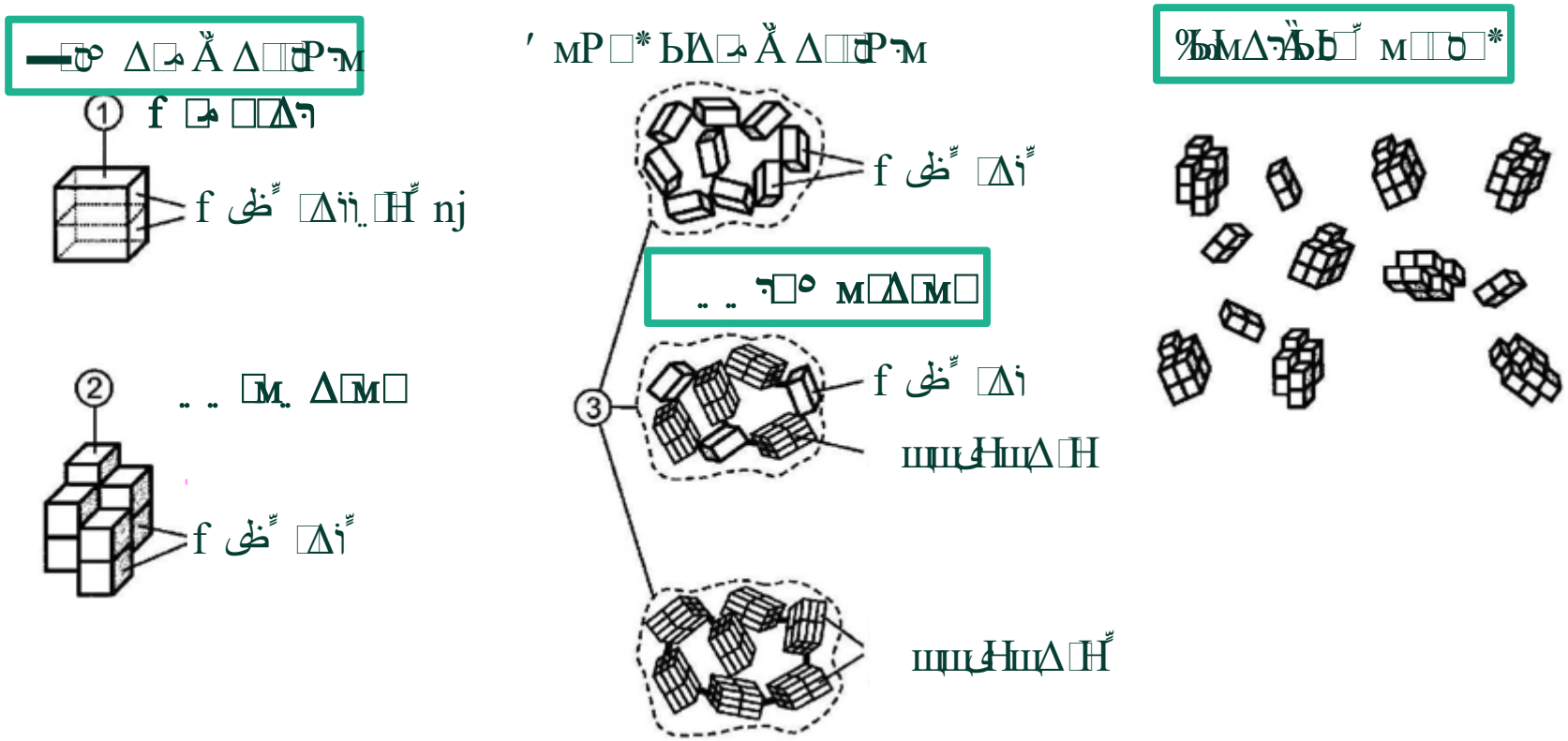
Dispersing with a dissolver



Types of Dispersing Equipment

Courtesy of Buhler

The pigment model (DIN 53206)

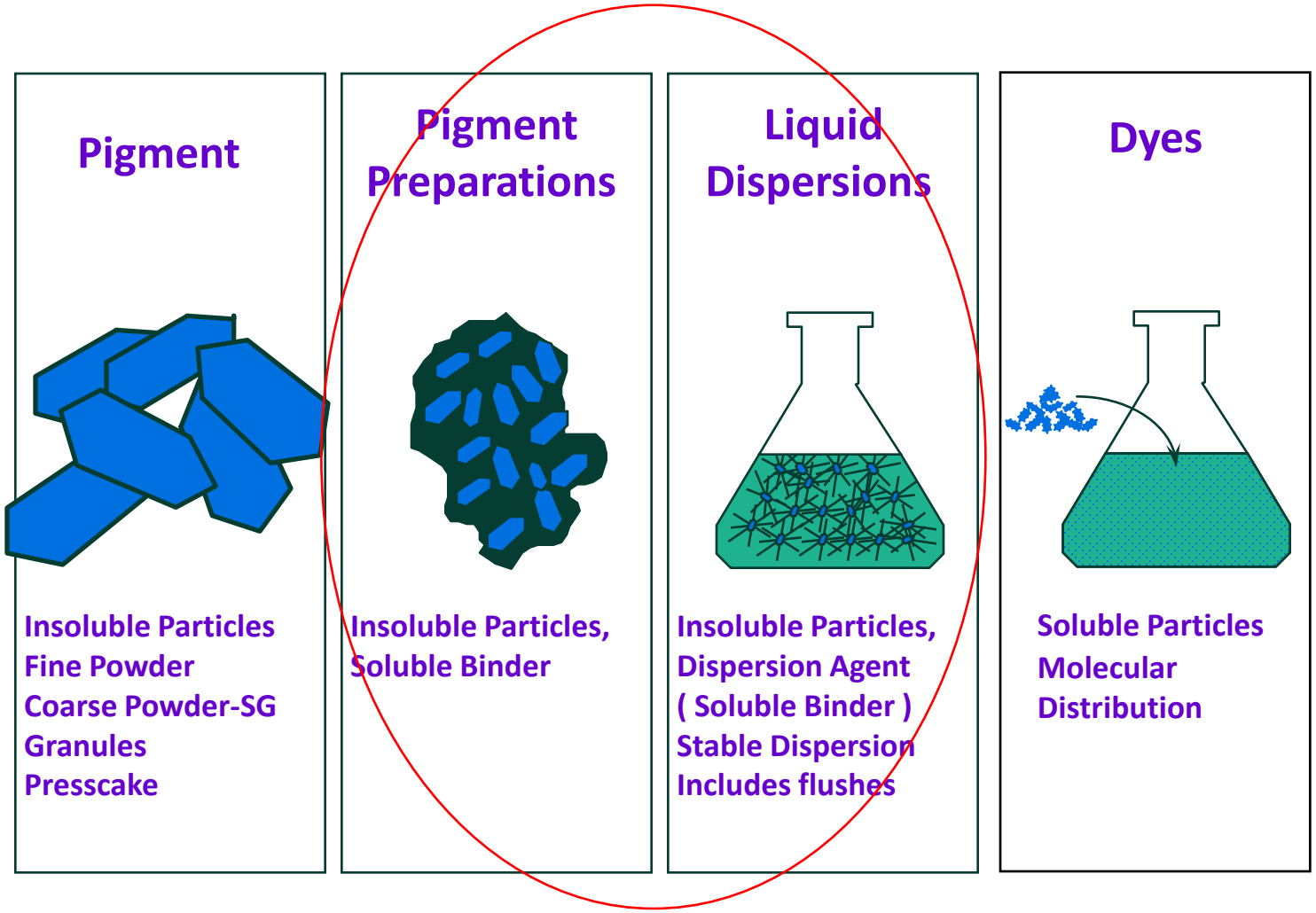


How do properties of organic and inorganic pigments relate to particle size?

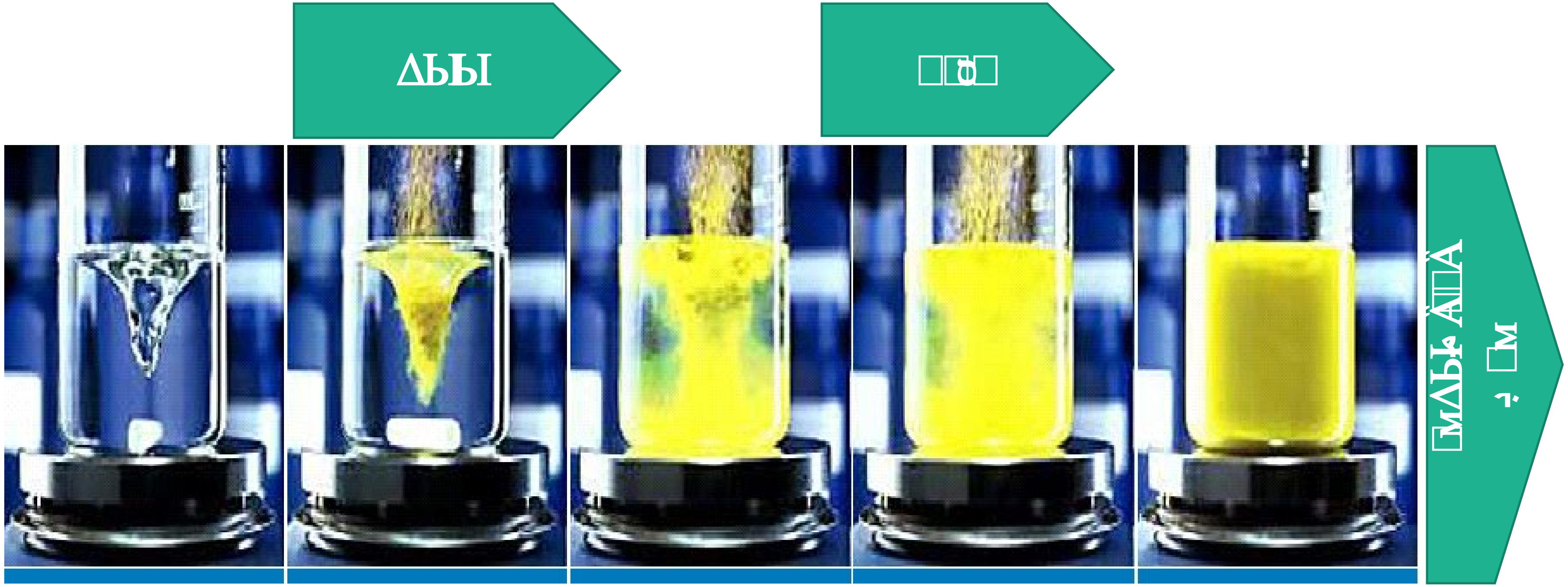
Property	Organic	Inorganic
Particle size		
Transparency	☺	☹
Opacity	☹	☺
Color strength	☺	☹
Chroma	☺	☹
Fastness properties	😐	☺
Dispersibility	😐	☺

Pigment Preparations

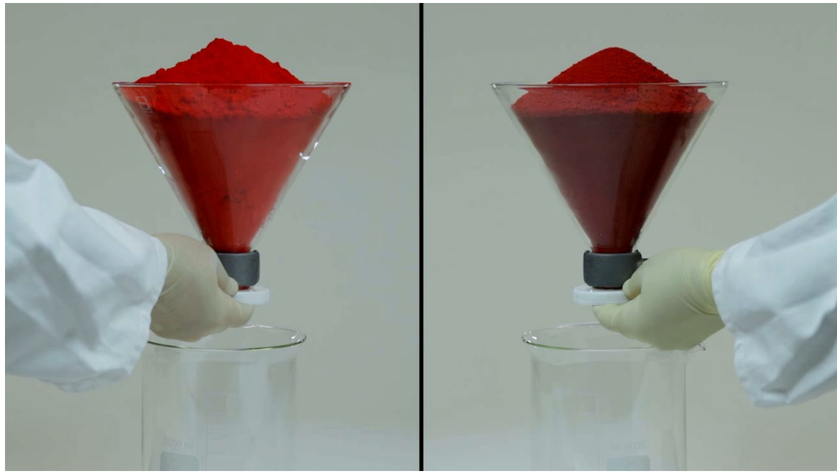
Product Forms



What are pigment preparations?



Properties of preparations



Benefits of Preparations

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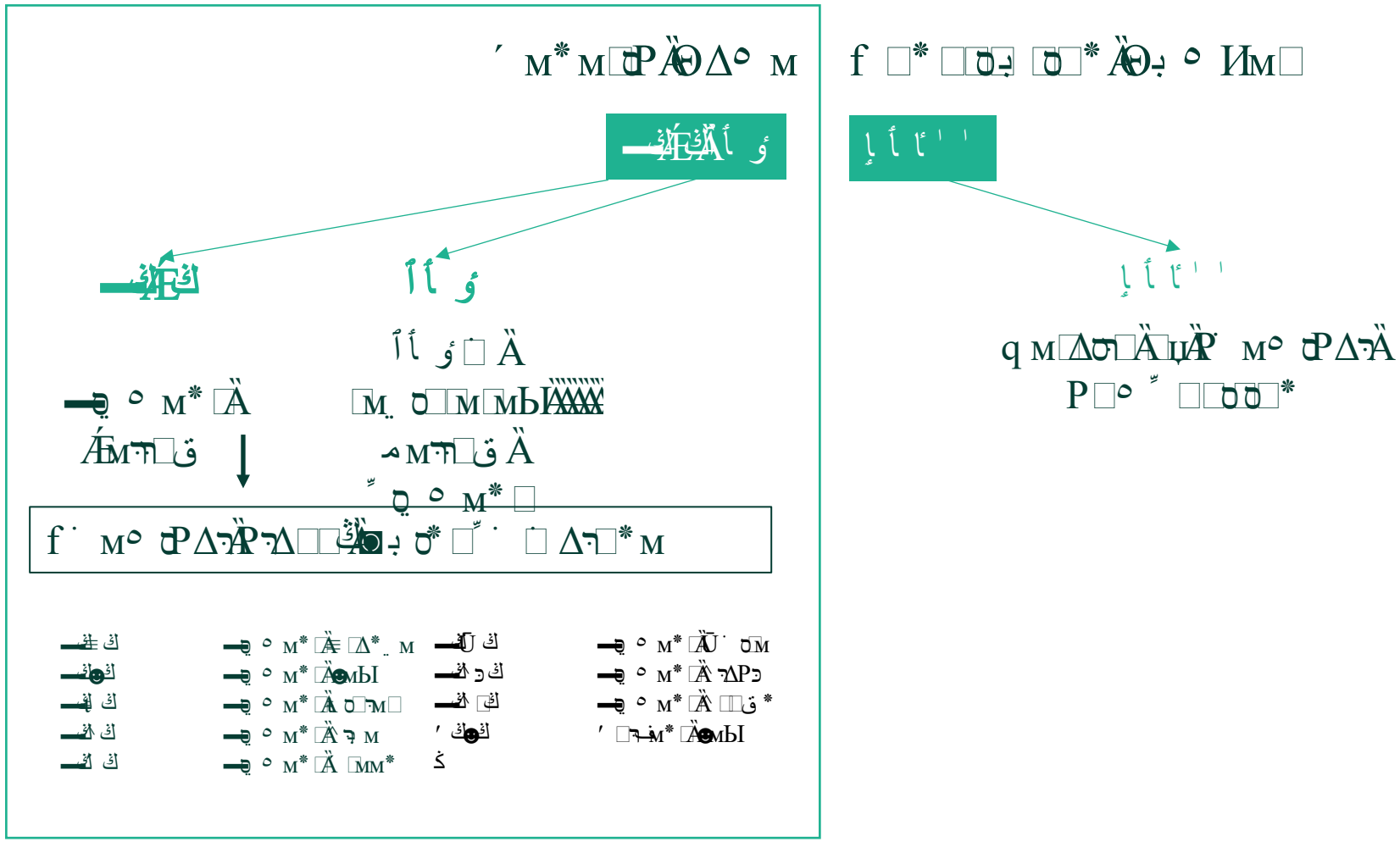
Key takeaways for ink formulators

What if you are asked to develop an ink?

Initial questions

What is Color Index?



Initial questions

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C.I.Pigment Violet 19

Cinquasia
Red
L4100 HD

Cinquasia
Violet
L5120

Mass Tone

Initial questions

Printing Overview

	Gravure	Flexo	Lithography	Screen	Digital
Typical Print Speeds	**Up to 600 m/min**	**~ 450 m/min**	**600-700 (heatset) 15000-18000 iph (SF)**	**100 m/min (rotary)**	**30-100 m/min (state of art)**
Typical Ink Viscosities	**20-25 secs Zahn 2 0.05 – 0.2 Pa.s**	**20-25 secs Zahn 2 0.05 – 0.5 Pa.s**	**40-100 Pa.s**	**1 – 5 Pa.s (flatbed) Lower for rotary**	**6-15 mPa.s solvent/UV 2-5 mPa.s aqueous**
Typical Wet Film Thickness (µm)	**7 – 15**	**3 – 7**	**0.5 – 2**	**8 – 30**	**6 – 12 (multiple passes)**
Typical Particle Size	**< 8µm**	**< 4µm**	**< 4µm**	**-**	**Mean of 0.05 – 0.2µm Max. of 0.5 – 1.0µm**
Main Binders	**Nitrocellulose, Cellulose Acetate Proprionate, Polyvinyl butyral, Polyamide, Polyurethane, Polyvinyl,** Acrylics, Acrylated Oligomers	**Nitrocellulose, Cellulose Acetate Proprionate, Polyvinyl butyral, Polyamide, Polyurethane, polyvinyl,** Acrylics, Acrylated Oligomers	**Modified rosin esters (phenolic), Hydrocarbons, Drying oils (linseed oil, alkyds)** Acylated Oligomers	**Polyvinyls, Plastisol,** Acrylated Oligomers	**Polyvinyl, nitrocellulose,** Acrylated Oligomers
Main Solvents	**Alcohols (ethanol, n-propanol), Esters (ethyl acetate, n-propyl acetate), glycol retarders (ethoxy propanol),** Water **Ketones,** Acrylated Monomers	**Alcohols (ethanol, n-propanol), Esters (ethyl acetate, n-propyl acetate), glycol retarders (ethoxy propanol),** Water **Ketones,** Acrylated Monomers	**Petroleum distillates (heatset inks, 260-290°C), Mineral oils, Vegetable Oils (linsed, soya, rapeseed etc)** Acrylated Monomers	**Glycols,** Acrylated Monomers	**Water, Glycols, esters, ketones,** Acrylated Monomers

Initial questions

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From the Pigment Technical Data Sheet…

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Final Thoughts

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a Xenon arc company

Contact Info

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xasolutions.com

ADO USA
- Ground Barite

AL2CHEM
- Fumed Silica
- Precipitated Silica

brilliant
- Fluorescent Pigments

Chemours
- Titanium Dioxide

Dainichiseika
- Organic Pigments
- Inkjet Pigments
- Acrylic & Urethane Beads

DOW
- Redispersable Polymer Powders
- Cellulose Ethers (HPMC, HEMC)

66INK Group
- Classical Organic Pigments
- High Performance Pigments
- Carbazole Violet Pigments

H.B. Fuller
- Vinyl Acrylic Emulsions
- VAE Emulsions
- Vinyl Acrylic Homopolymers

HARCROS
- Defoamers
- Surfactants

High Divide Minerals
- Talc

IGM Resins
- Monomers
- Oligomers
- Photoinitiators

JRS Fibers for Life.
- Cellulose Fibers
- Colloidal Microcrystalline Cellulose
- Synthetic Fibers

JLS
- Non-halogenated Flame Retardants

KaMin
- Calcined Kaolin
- Hydrous Kaolin

LILY GROUP CO., LTD.
- Classical Organic Pigments
- High Performance Pigments

Lubrizol
- Dispersants and Hyperdispersants
- Graphic Arts Resins & Polymers
- Specialty Additives
- Surface Modifiers

nobel nc
- Nitrocellulose

OPC POLYMERS
- Modified Alkyds
- Oil Modified Urethanes
- Solventborne Alkyds
- Water Reducible Alkyds

OXERRA
- Synthetic Iron Oxide Pigments
- Natural Iron Oxide Pigments
- Complex Inorganic Pigments

Prom
- In-Can Preservatives
- Dry Film Preservatives
- Quick-Kill Biocides

Specialty Minerals
- Dolomite
- Ground Calcium Carbonate
- Precipitated Calcium Carbonate

Specialty Resin Solutions
- DEGALAN® Acrylic Reisns

SOLVAY
- Barium & Strontium Carbonate
- Blanc Fixe

TAYCA
- Micro Titanium Dioxide

Thew Arnott
- Soy Lecithin

TRINSEO
- Styrene Butadiene Latex
- Styrene Acrylic Latex
- Vinyl Acrylic Latex

US SILICA
- Ground Silica
- Silica Sand
- Cristobalite

WACKER
- STP-E Technology
- Alpha and Gamma Hybrids
- Finished Hybrids