Pigmentos de Efecto – Características y problemática

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Dpto. Interuniversitario de Óptica

Werner Rudolf Cramer
info@wrcramer.de

Manipulation of light

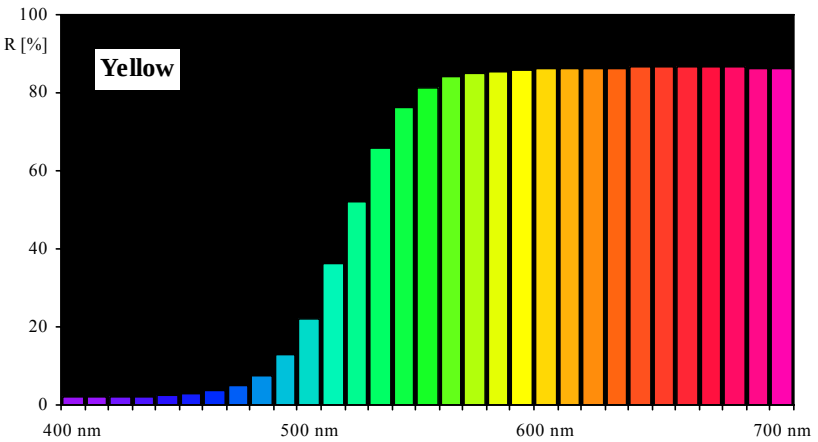
- The sun - our main light source - sends rays in all directions. Under 1% of them reach our blue planet.
- Some rays pass the atmosphere and are visible for us.
- Altogether, these rays create a white impression in our eye and brain.
- If their are manipulated, they create colors.
- The kind of manipulation can be different: absorption and scattering, reflection and refraction

Different Pigments

- Manipulation and impact of light rays by:
  - absorbing pigments (pigmentum = color):
  - aluminum pigments,
  - and interference pigments.
- These pigments are used as stand-alones or in mixtures with others.
- Interference pigments are very common in the industrial and automotive industries.
- Interference pigments may be classified by their structure or the method employed for their manufacture.

Absorbing pigments

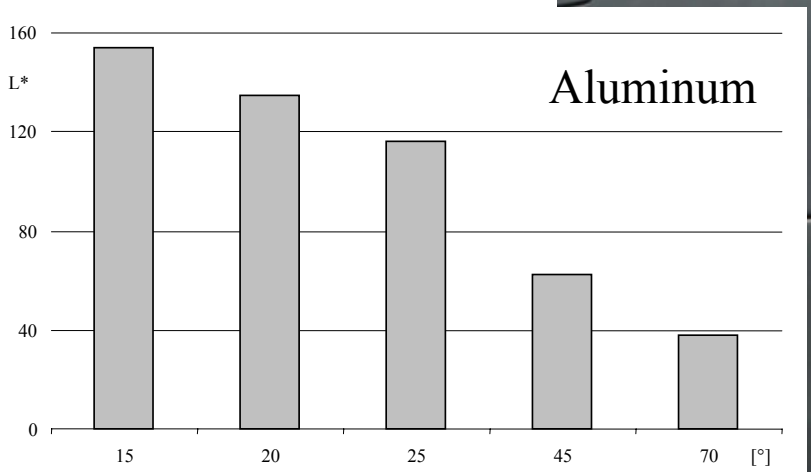
Scattering in all directions: same color



Aluminium pigments

Reflection in favored directions:

Angle of incident = angle of reflection

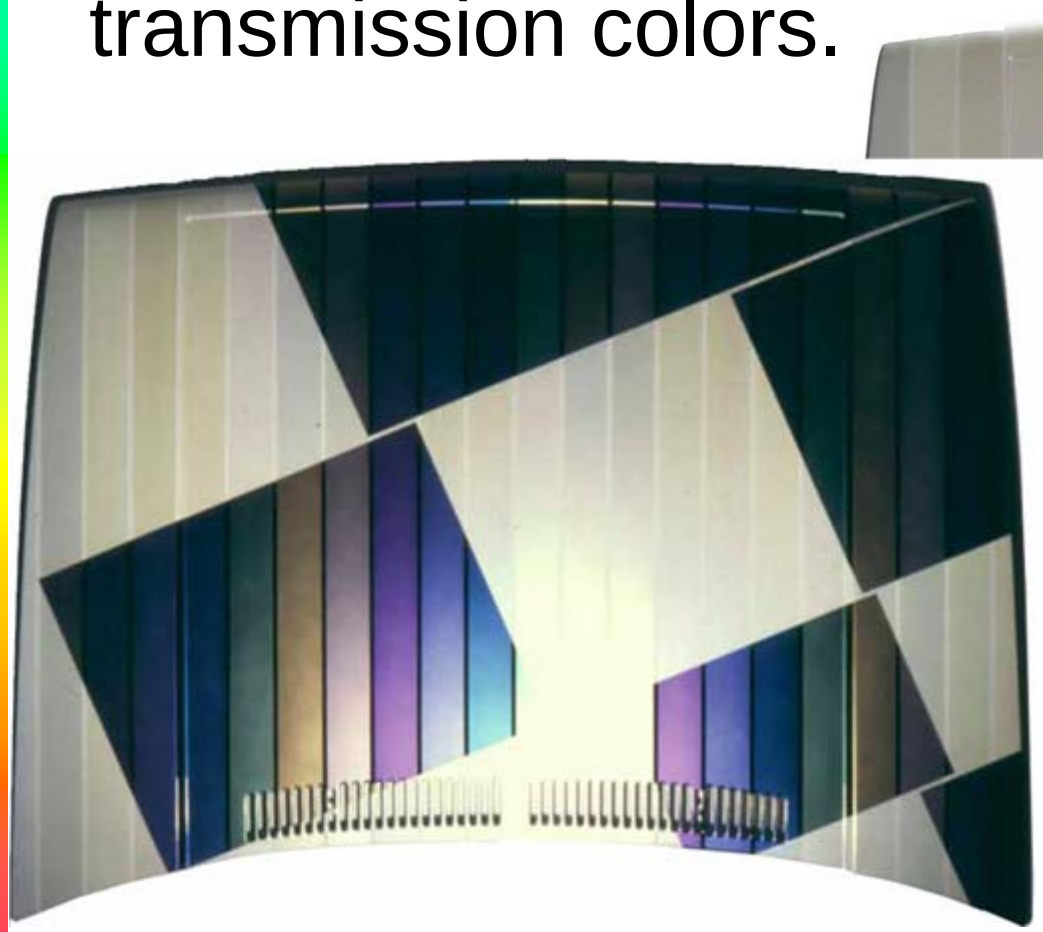


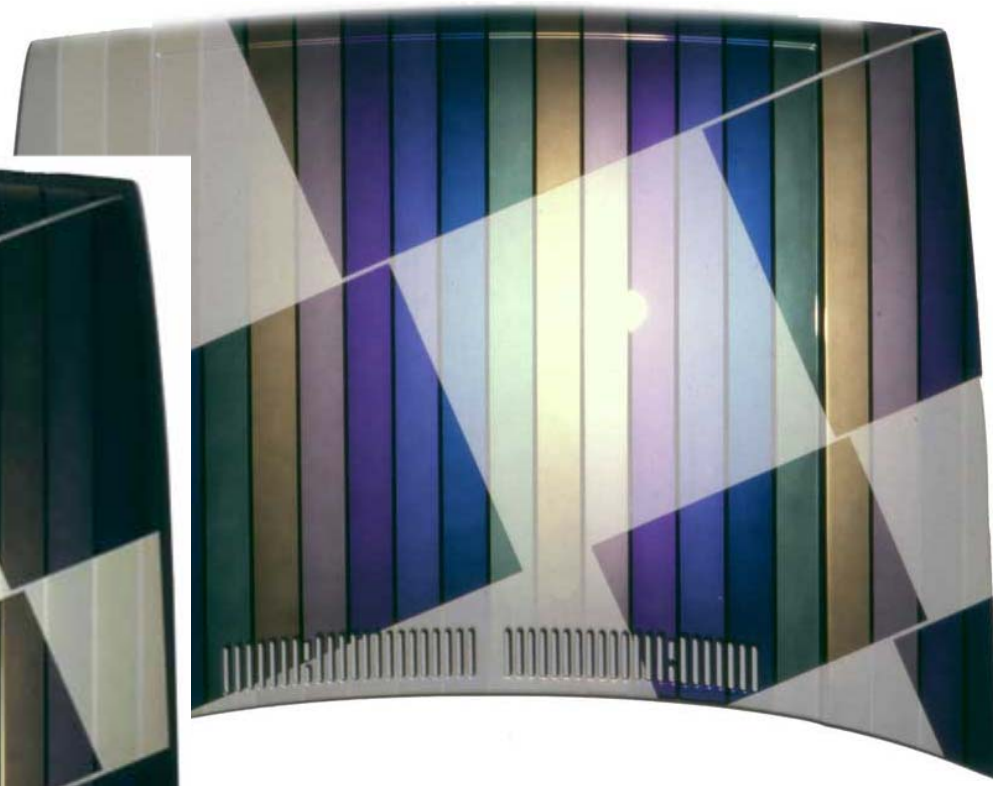
Interference pigments

Selective reflection/interference: assigned wavelengths are preferred

Interference pigments

Playing with the undercoat:
Combination of reflection colors and transmission colors.





Interference pigments: overview

- *Iriodin/Afflair Merck*
  natural mica coated with high refractive metal oxides like TiO_2 or Fe_2O_3.

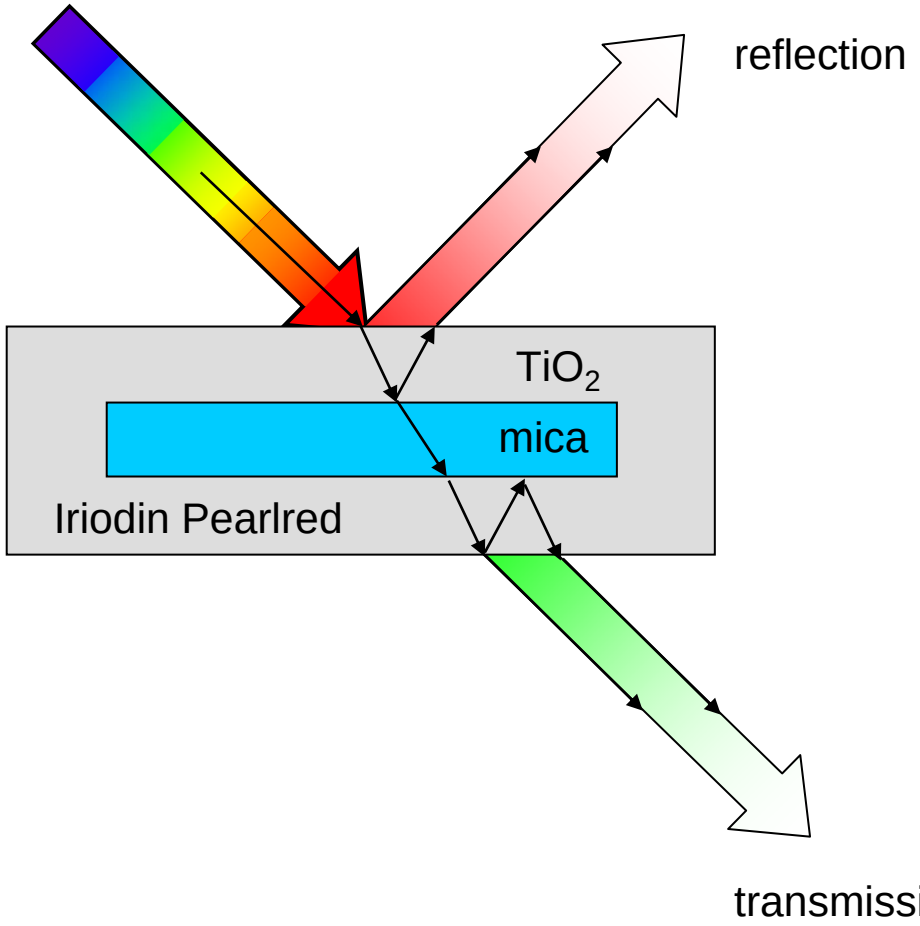
- *Xirallic Merck*
  Al_2O_3-platelets coated with high refractive metal oxides.

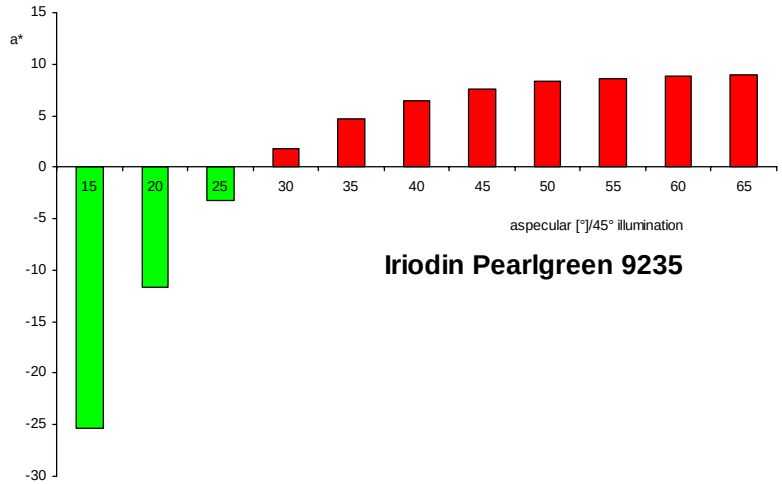
- *Colorstream Merck*
  SiO_2-platelets coated with high refractive metal oxides.

Interference pigments: overview

- *Variocrom BASF*
  Optical Variable Pigments (OVP)
  chemical vapor deposition
- *ChromaFlair Flex Products*
  5-layers with opaque reflector, dielectrical and semi-transparent layers.
- *SpectraFlair Flex Products*
  microstructure surface and opaque reflector layer.
- *Helicone Wacker Chemie*
  Liquid Crystals Polymers (LCP)

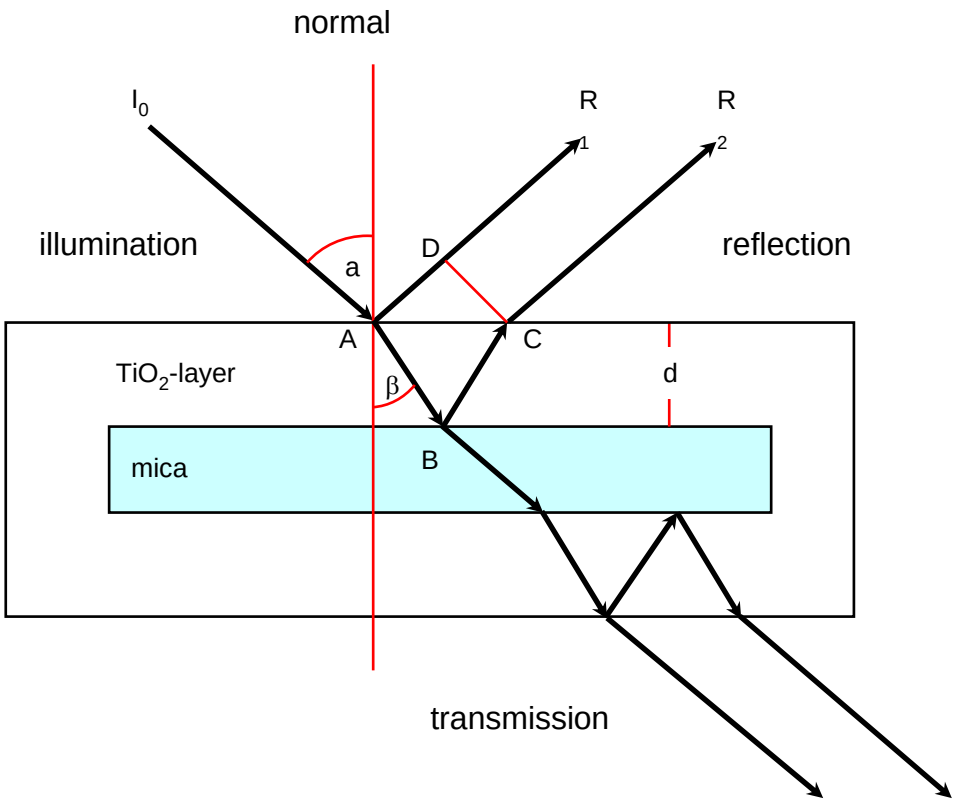
Reflection and transmission





Interference of white light leads to a reflection color and a complementary transmission color.

Ray tracing at mica pigment



$$\delta = n(AB + BC) - AD$$

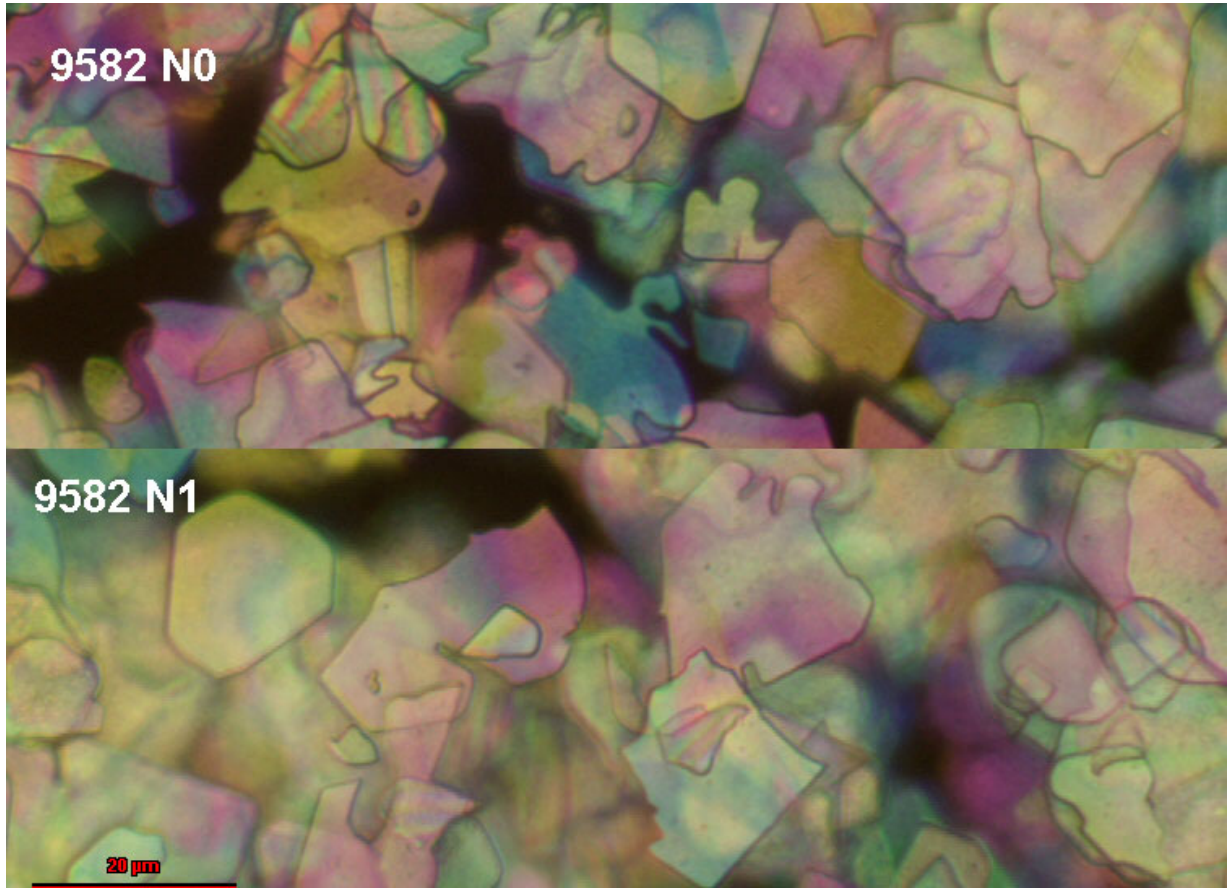
$$\delta = 2d\sqrt{n^2 - \sin^2\alpha}$$

$$\Delta = 2d\sqrt{n^2 - \sin^2\alpha} + \frac{\lambda}{2}$$

Resulting color depends upon

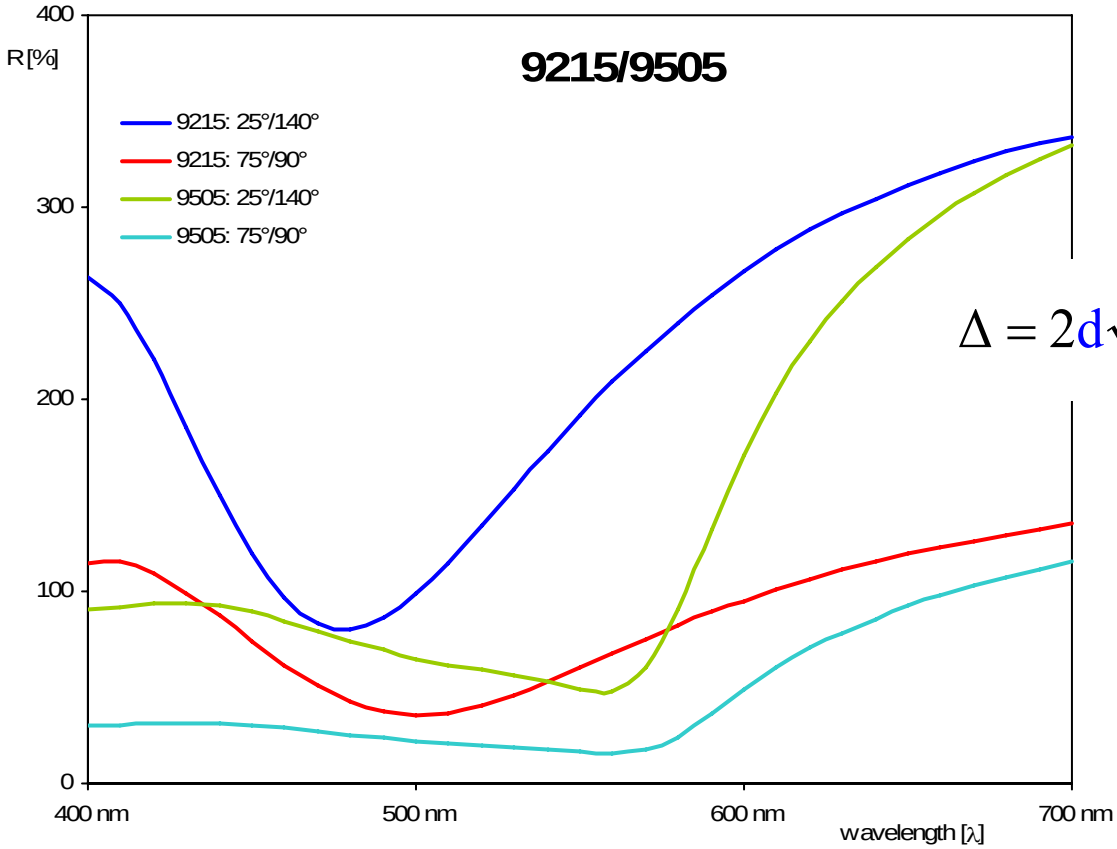
- thickness of TiO_2-layer,
- refractive index,
- angle of illumination.

Impact of angle of illumination



The method of application can influence the color impression:
Top: basecoat system with two spraying layers
Below: Same system with additional effect layer

Impact of refractive index

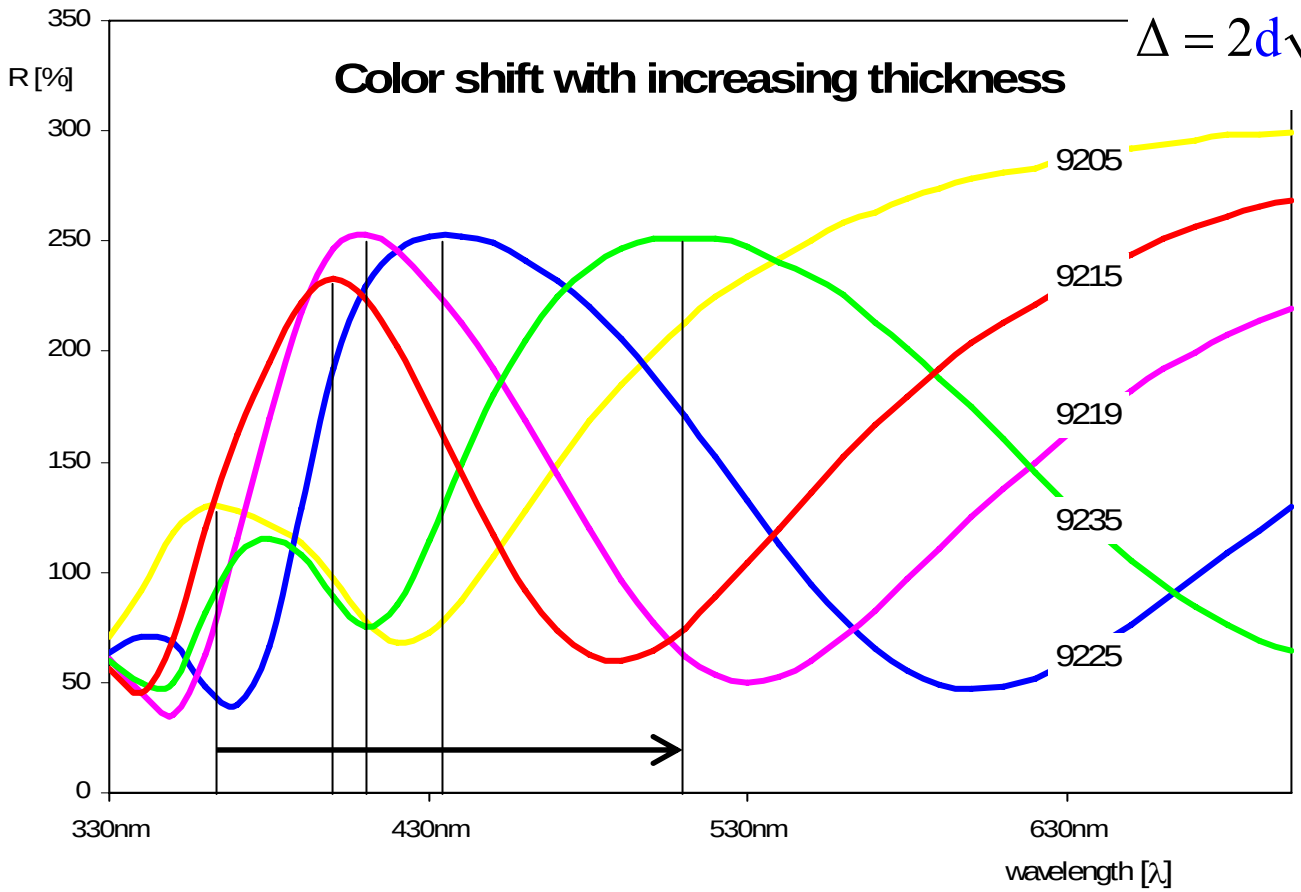


$$\Delta = 2d\sqrt{n^2 - \sin^2\alpha} + \frac{\lambda}{2}$$

Deposition of materials with different indices of refraction on same platelets leads to different colors.
Coating materials: 9215 titanium oxide, 9505 iron oxide

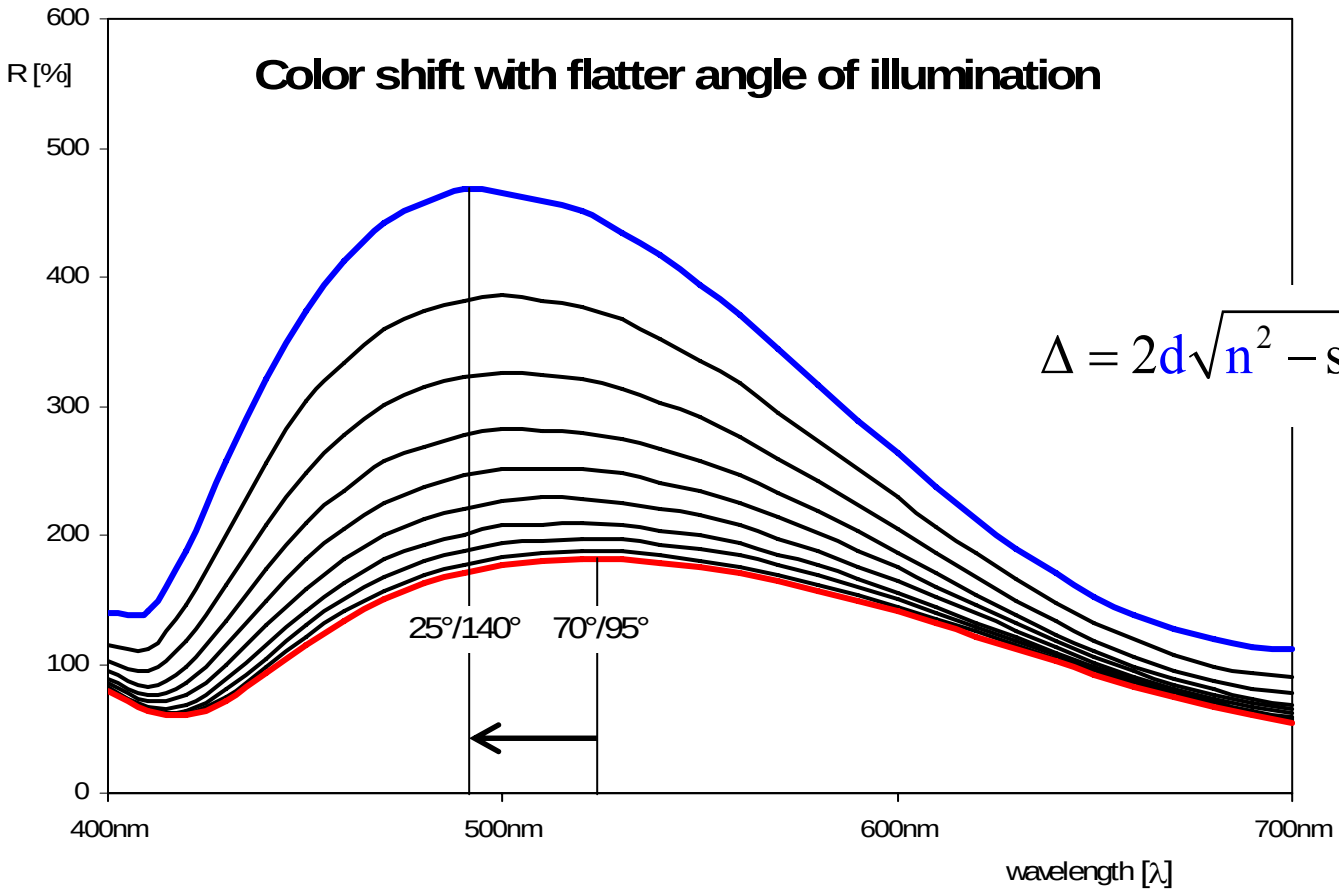
Impact of thickness

$$\Delta = 2d\sqrt{n^2 - \sin^2\alpha} + \frac{\lambda}{2}$$



The resulting color (reflection) shifts to longer wavelength with increasing thickness of the layer.

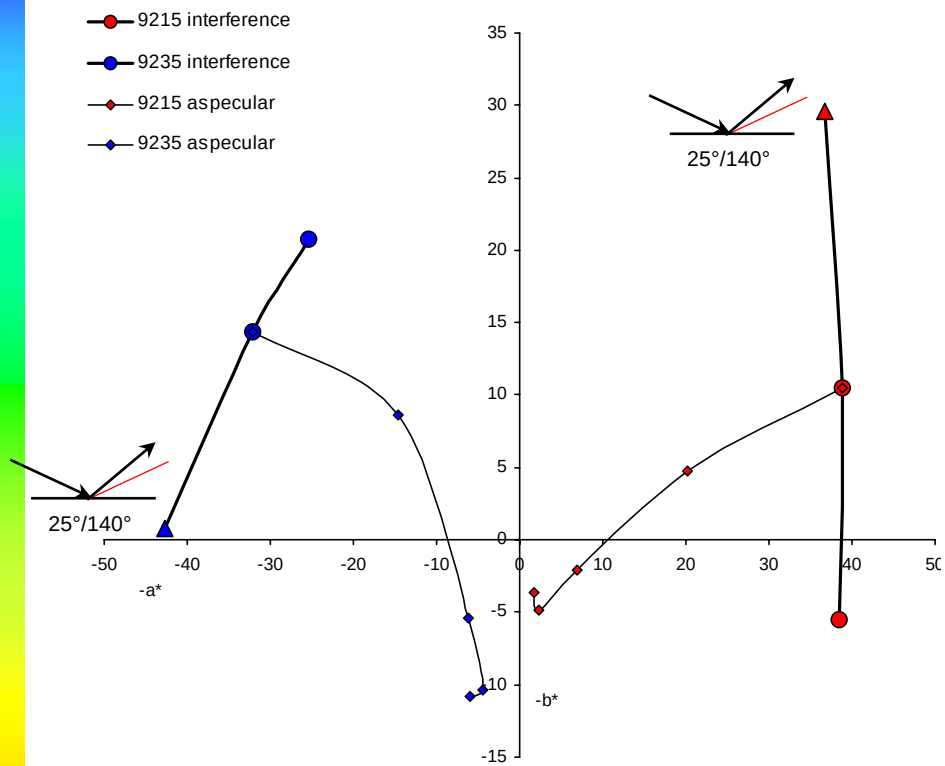
Impact of angle of illumination

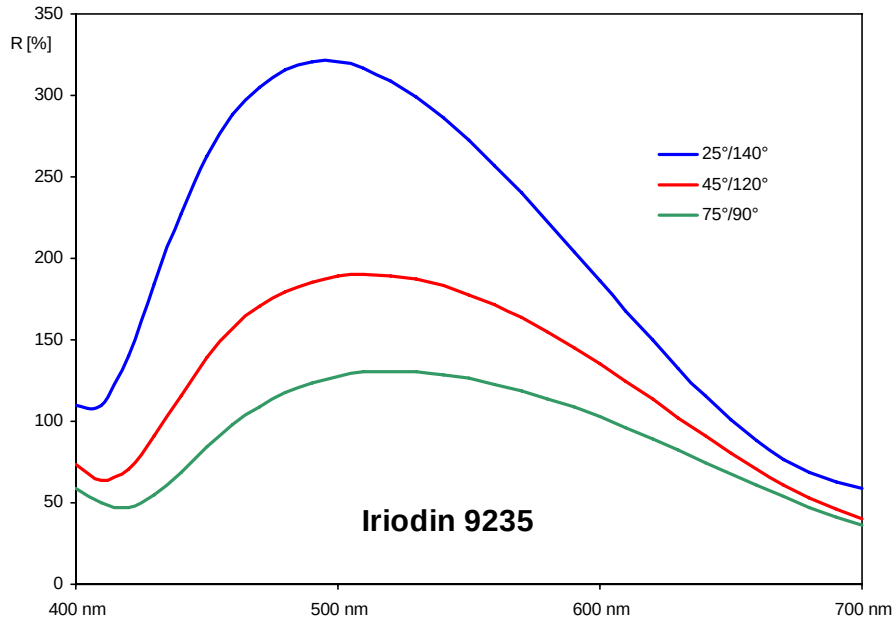


$$\Delta = 2d\sqrt{n^2 - \sin^2\alpha} + \frac{\lambda}{2}$$

The resulting color (reflection) shifts to shorter wavelength if the angle of illumination becomes flatter.

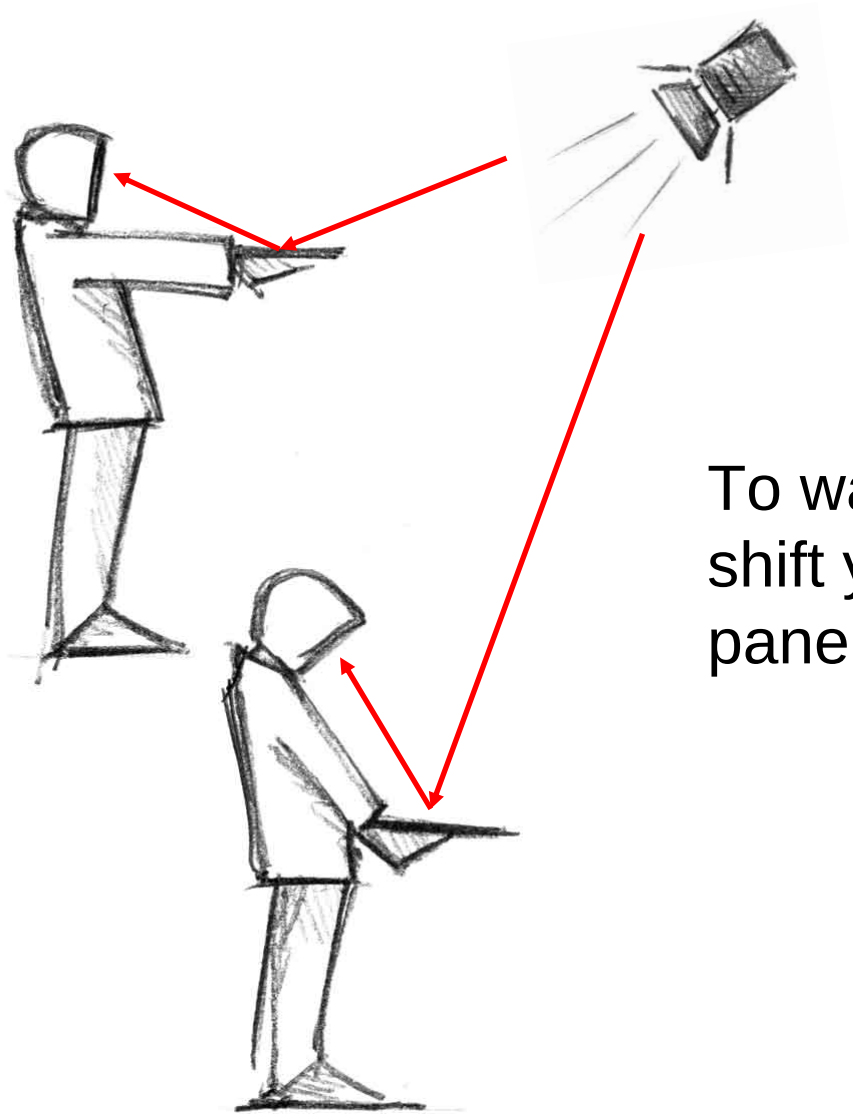
Characterizating the pigments





Interference pigments are characterized by the „interference line“ and the „aspecular line“:
Interference line: varied illumination angle, constant aspecular angle
Aspecular line: constant illumination angle, varied aspecular angles

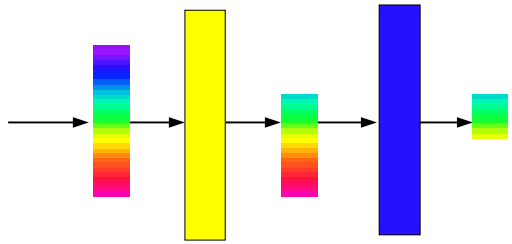
Observing the interference



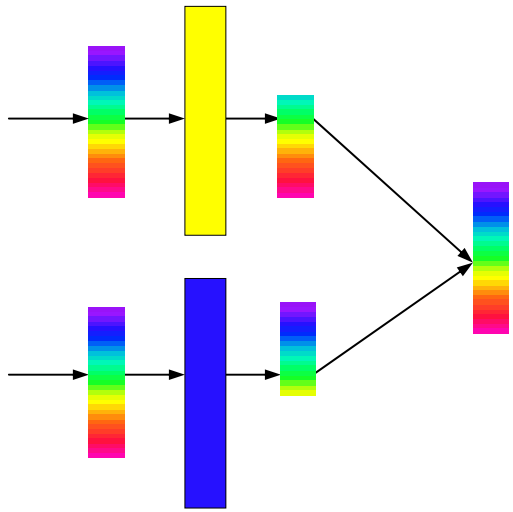
To watch the interference shift you have to move the panel parallel up and down.

Mixing behavior

Subtractive mixing:
Absorbing pigments

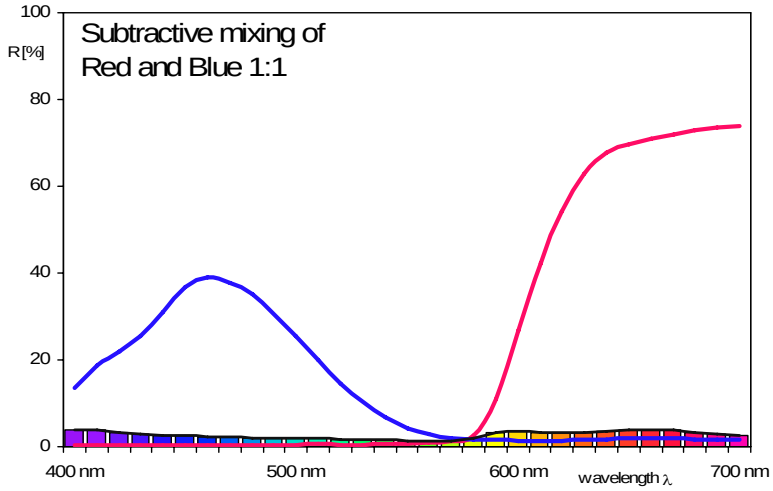


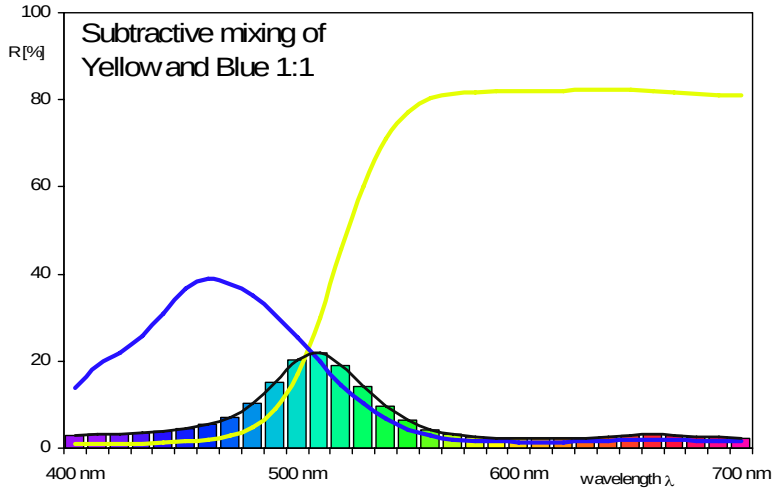
Additive mixing:
Interference pigments

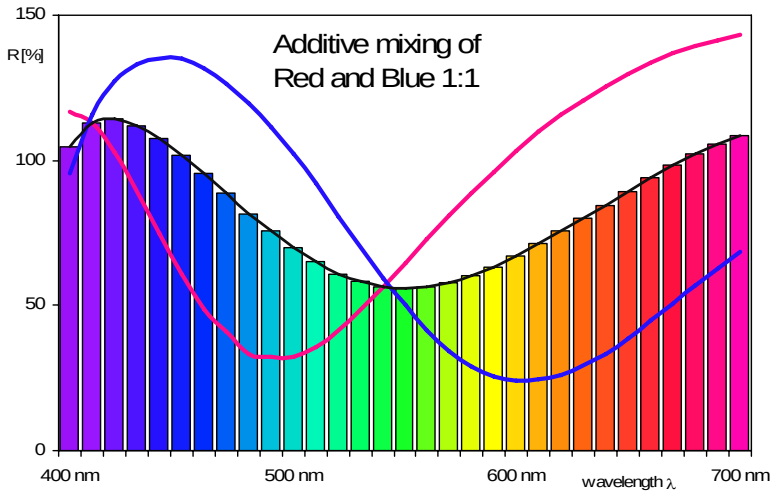


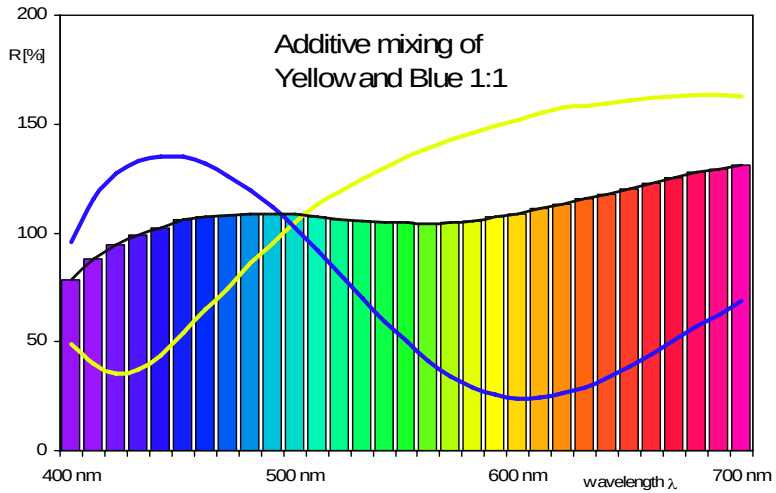
Absorbing pigments: Yellow + Blue = Green
Interference pigments: Yellow + Blue = White

Mixing behavior

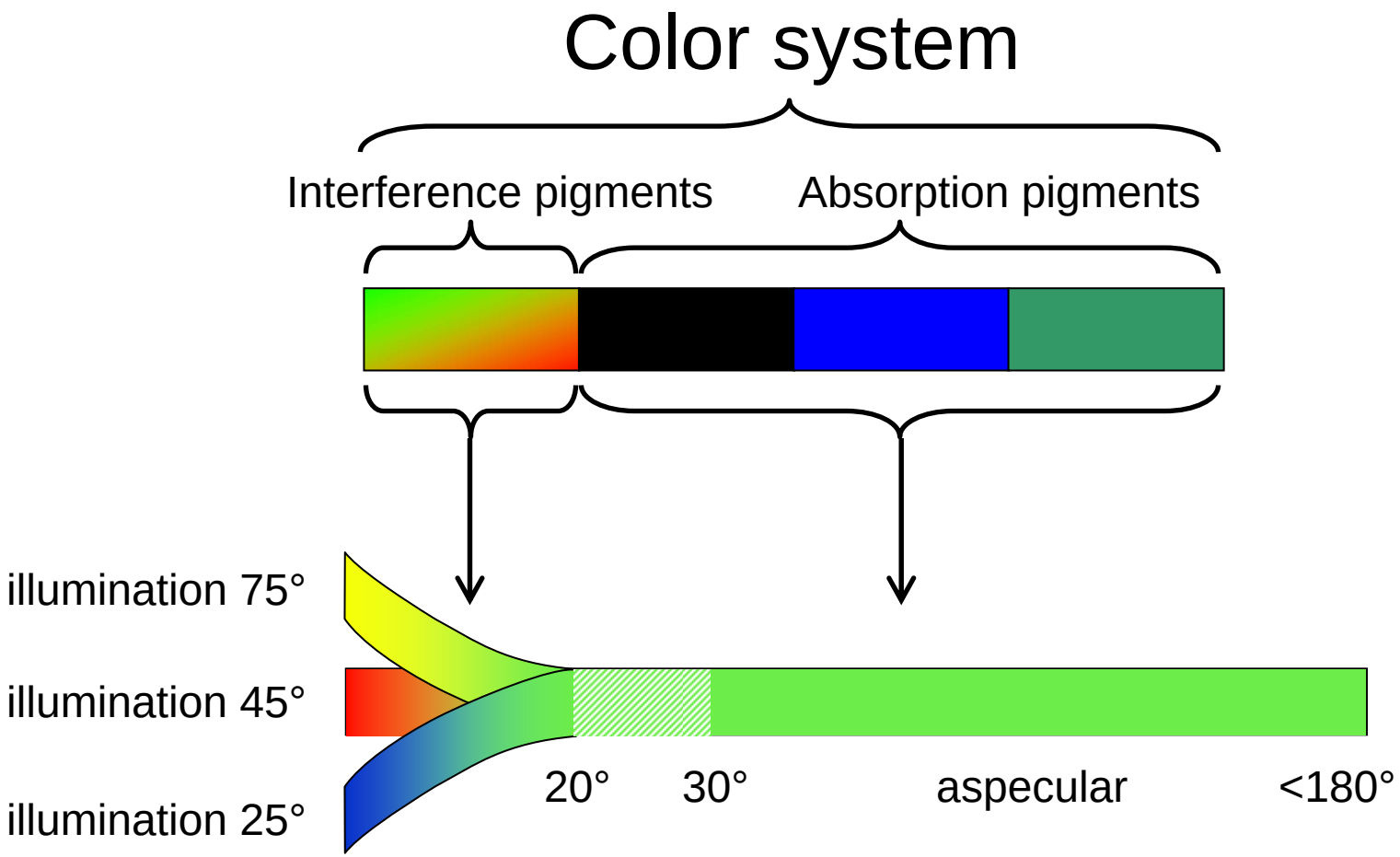






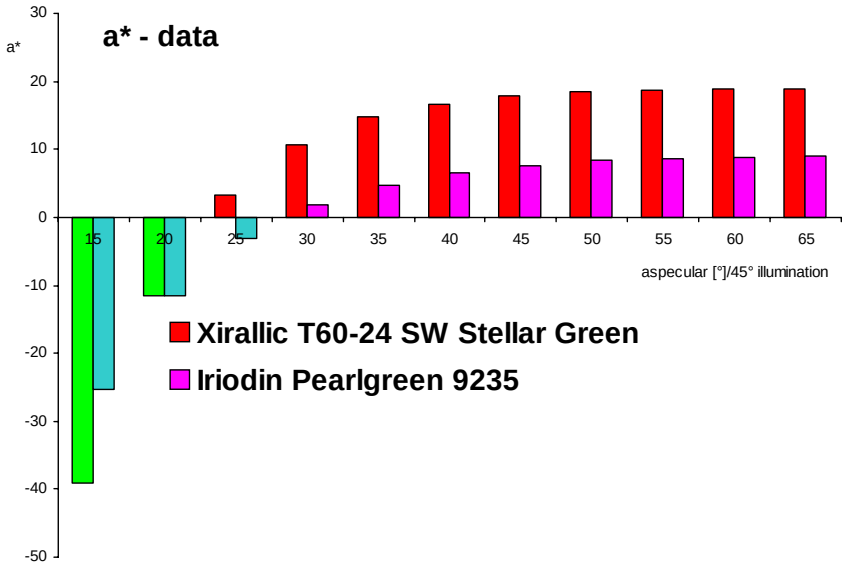


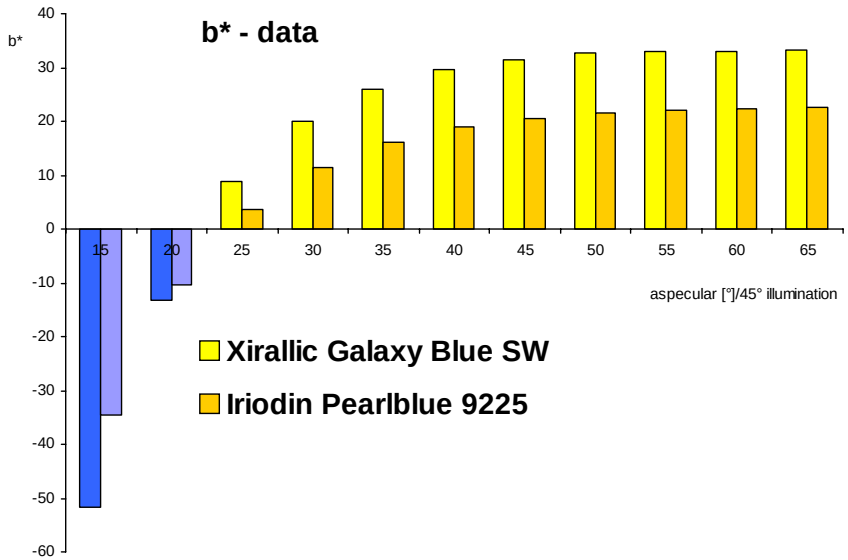
Two components of colors



Mixtures of interference pigments and absorbing pigments lead to different „fields of interest“.

Two components of colors





Transparent pigments on white background: Color change at aspecular angles between 20° and 30°.

Conclusions

- Interference pigments ensure for selctive reflection of the white light (interference).
- Their resulting colors depend on influences like:
  - angle of illumination,
  - angle of observing,
  - aspecular angle (difference between specular angle and oberserving angle),
  - method of application etc.
- In color systems, their influence on the color is up to 25° aspecular.

El fin. Muchas gracias!