Interactive Exploration of Iridescence Using Rough Bragg Mirrors

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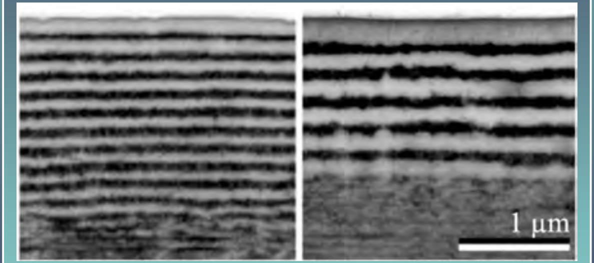
GDR 2044 cnrs APPAMAT

Inria inventeurs du monde numérique

What is iridescence ?

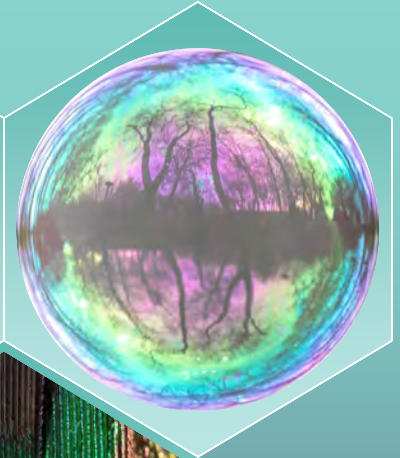
goniochromism ⇒ color changes with viewing angle

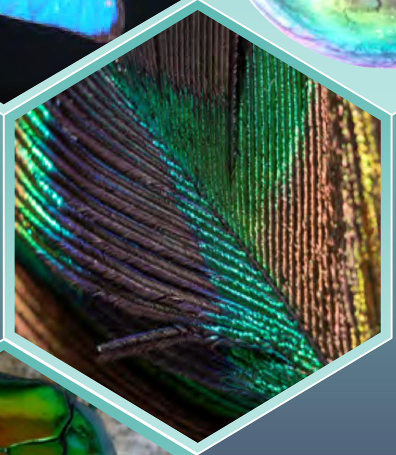
nanoscale structures



create angle-dependant spectra

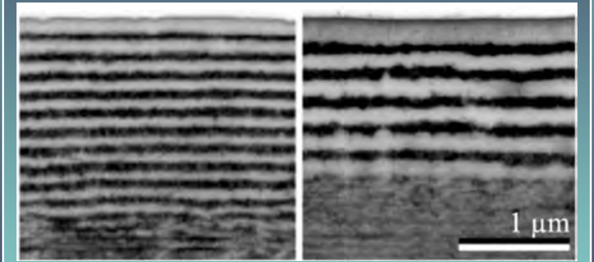
Structural Colors



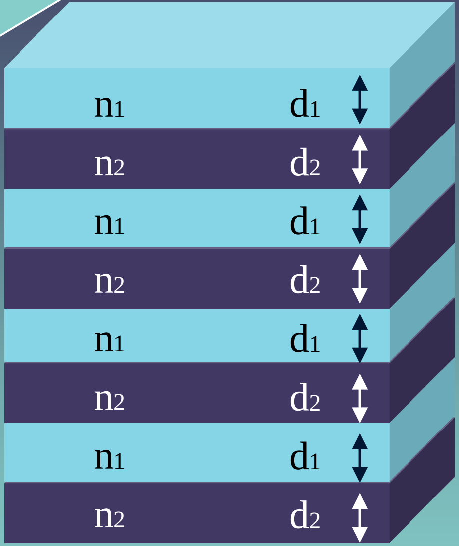


Bragg mirrors

nanoscale structures



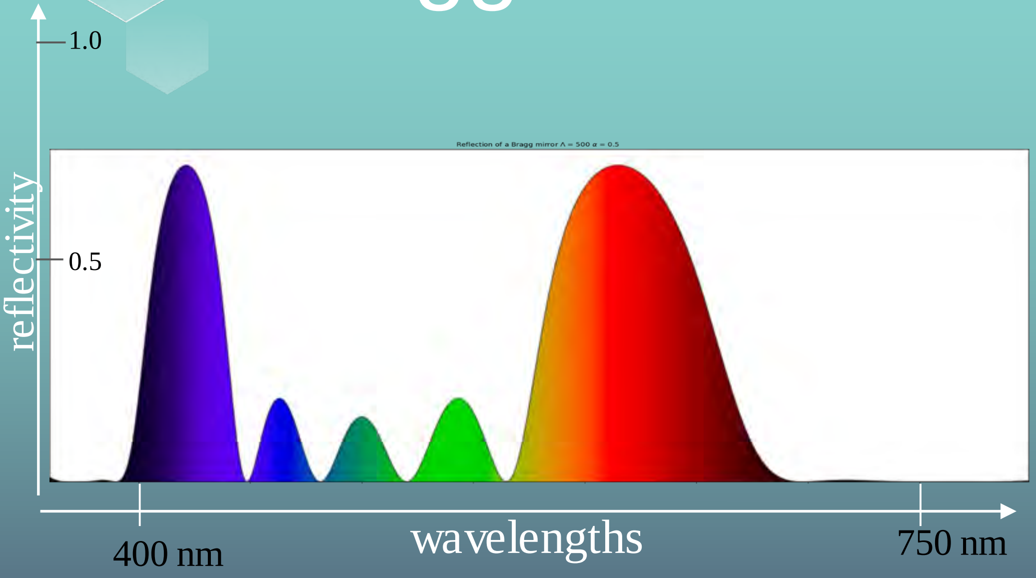
create angle-dependant spectra

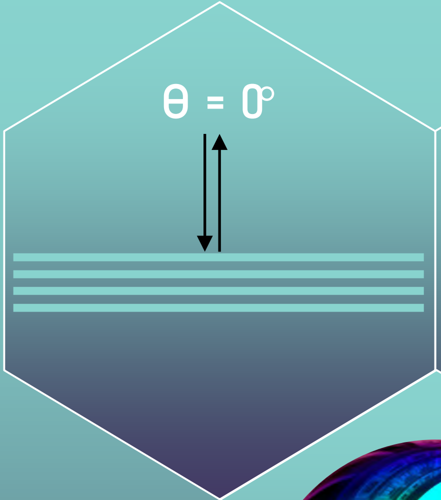


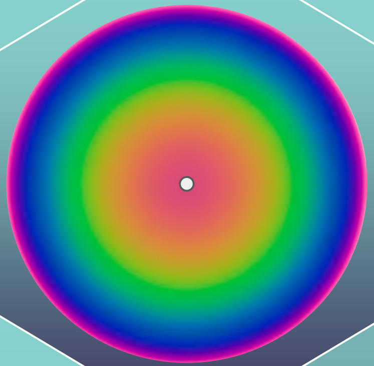
1D photonic crystal

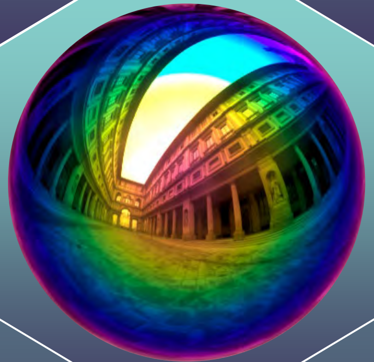
periodic arrangement of thin layers with distinct optical indices and widths

Bragg mirrors









d1 = 250

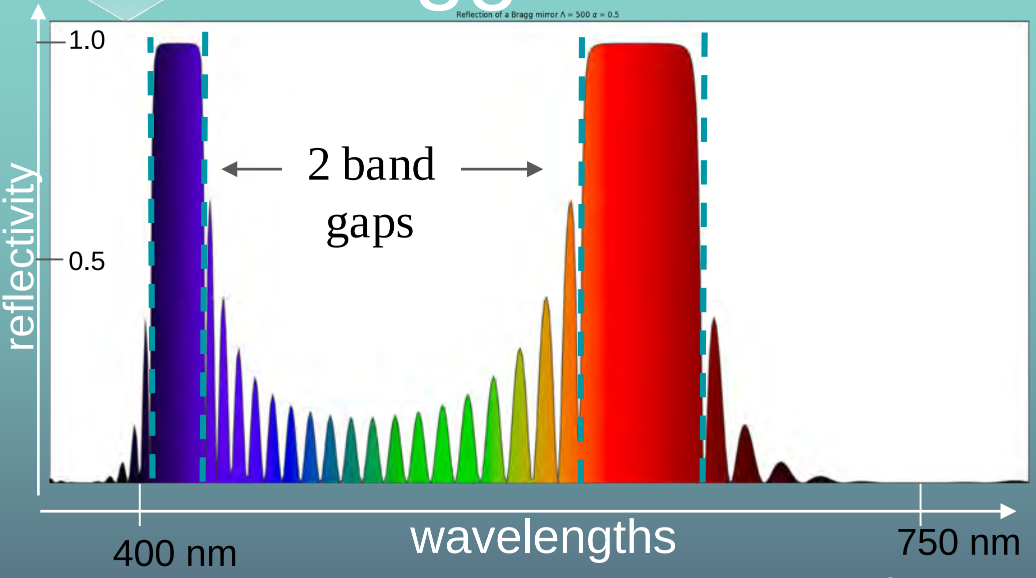
d2 = 250

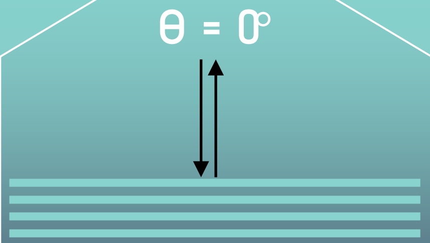
n1 = 1.0

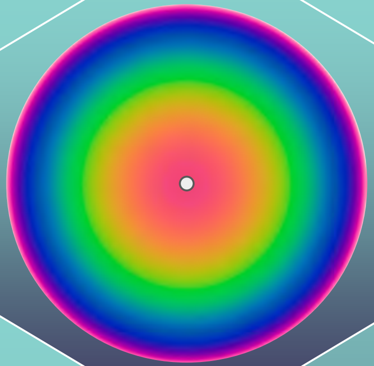
n2 = 1.5

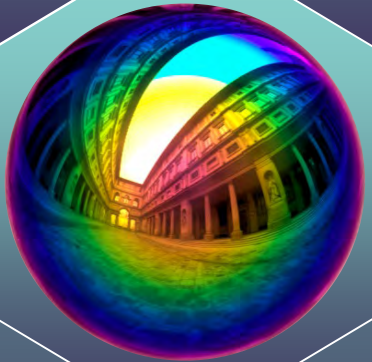
5 repetitions

Bragg mirrors









d1 = 250

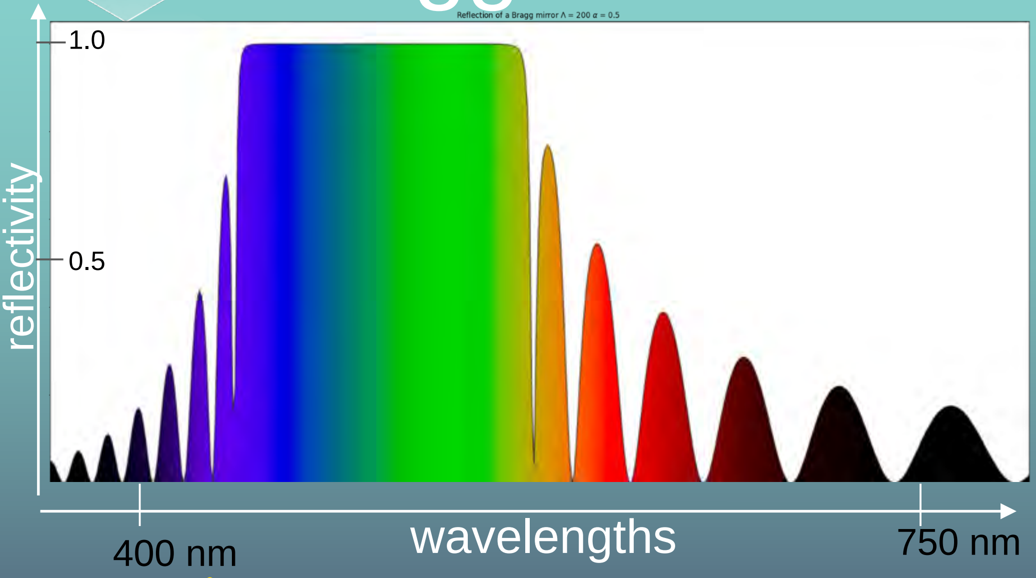
d2 = 250

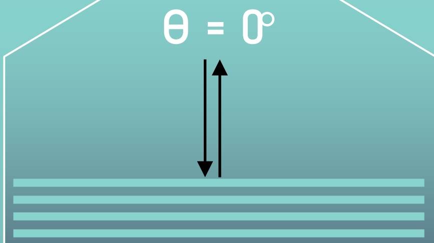
n1 = 1.0

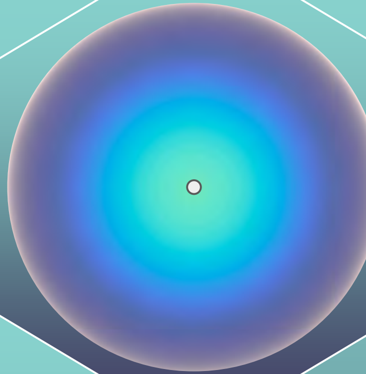
n2 = 1.5

20 repetitions

Bragg mirrors







d1 = 100

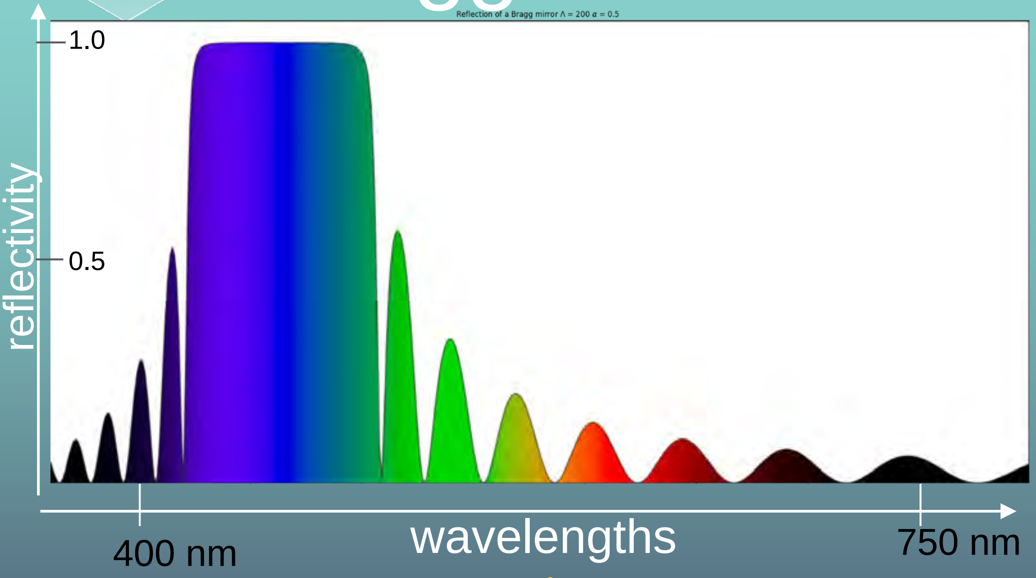
d2 = 100

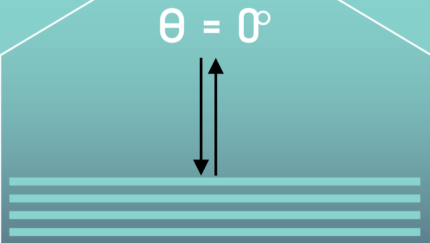
n1 = 1.0

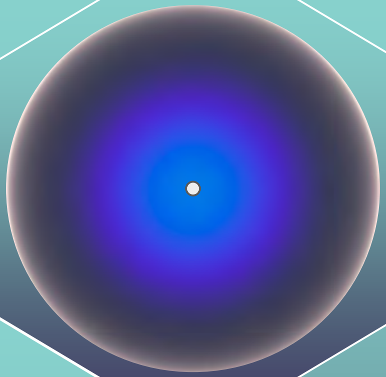
n2 = 1.5

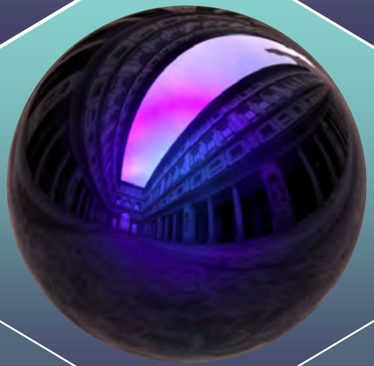
20 repetitions

Bragg mirrors









d1 = 100

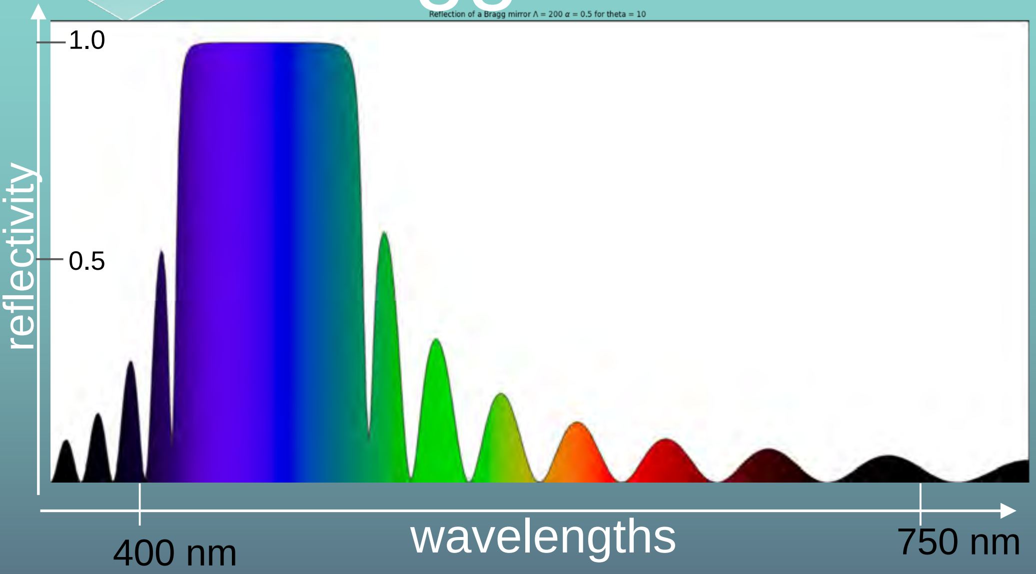
d2 = 100

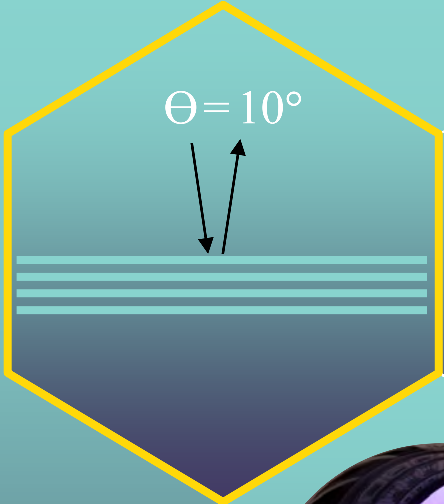
n1 = 1.0

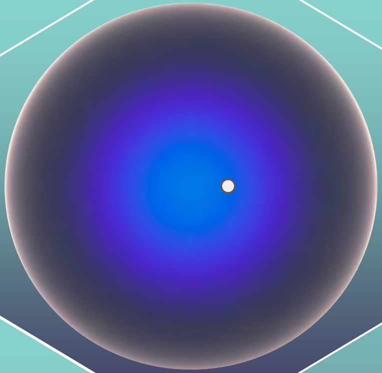
n2 = 1.3

20 repetitions

Bragg mirrors







$d1 = 100$

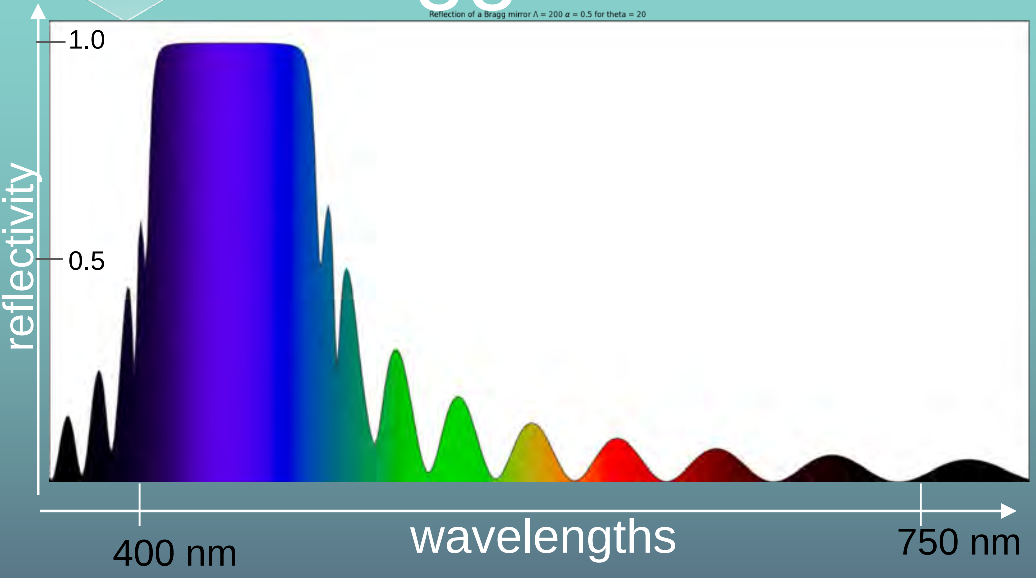
$d2 = 100$

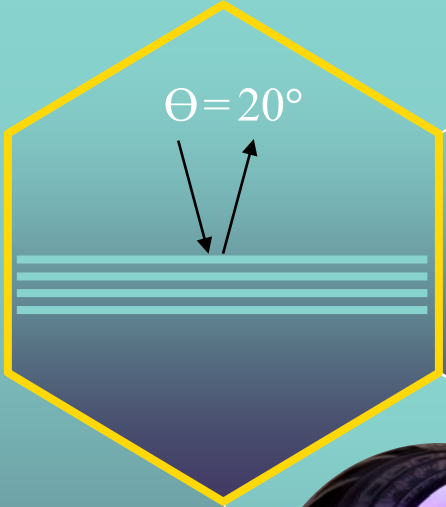
$n1 = 1.0$

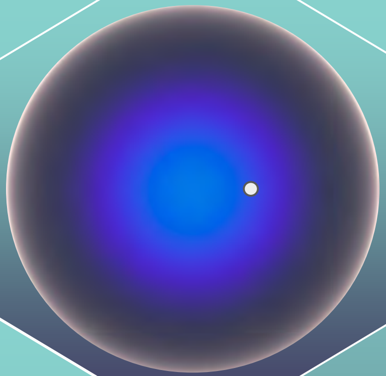
$n2 = 1.3$

20 repetitions

Bragg mirrors







$d1 = 100$

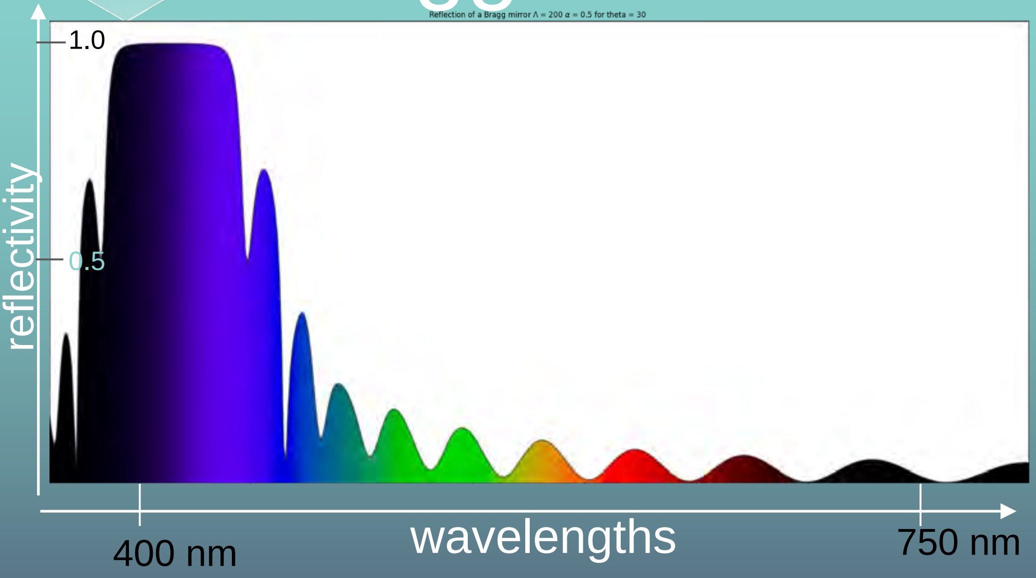
$d2 = 100$

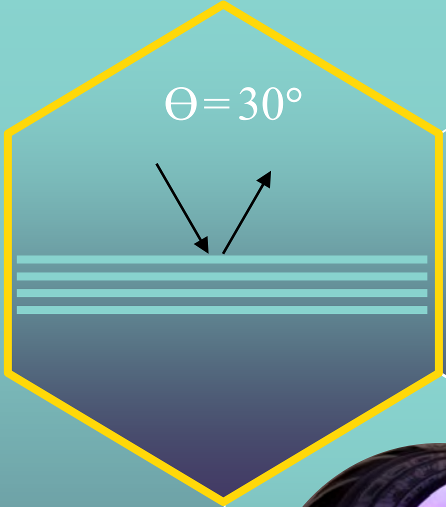
$n1 = 1.0$

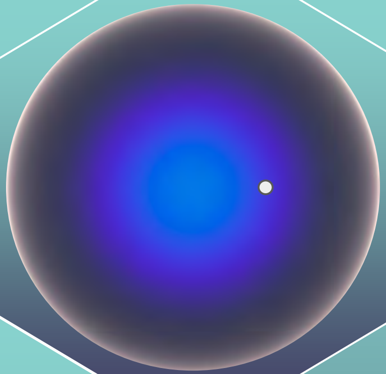
$n2 = 1.3$

20 repetitions

Bragg mirrors







$d1 = 100$

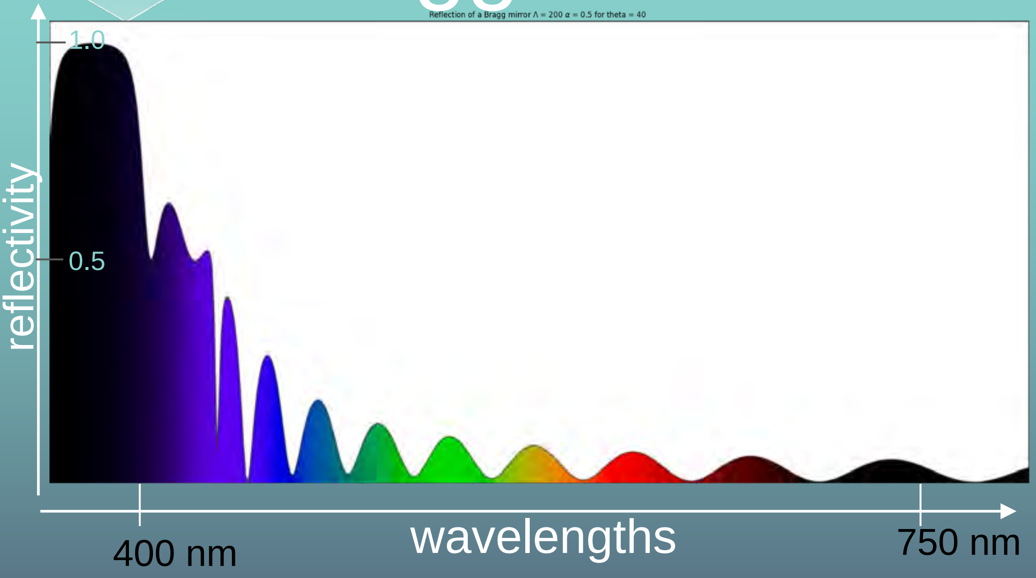
$d2 = 100$

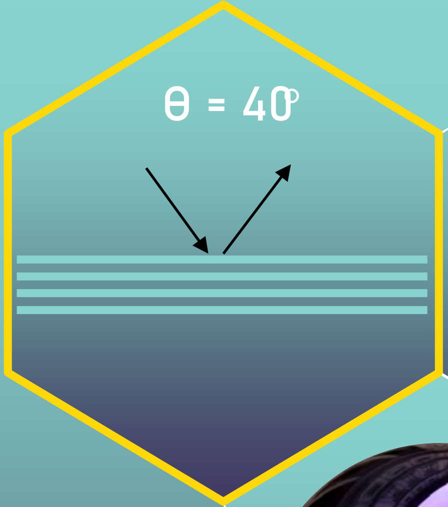
$n1 = 1.0$

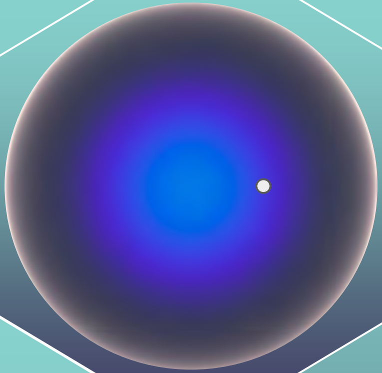
$n2 = 1.3$

20 repetitions

Bragg mirrors







$d1 = 100$

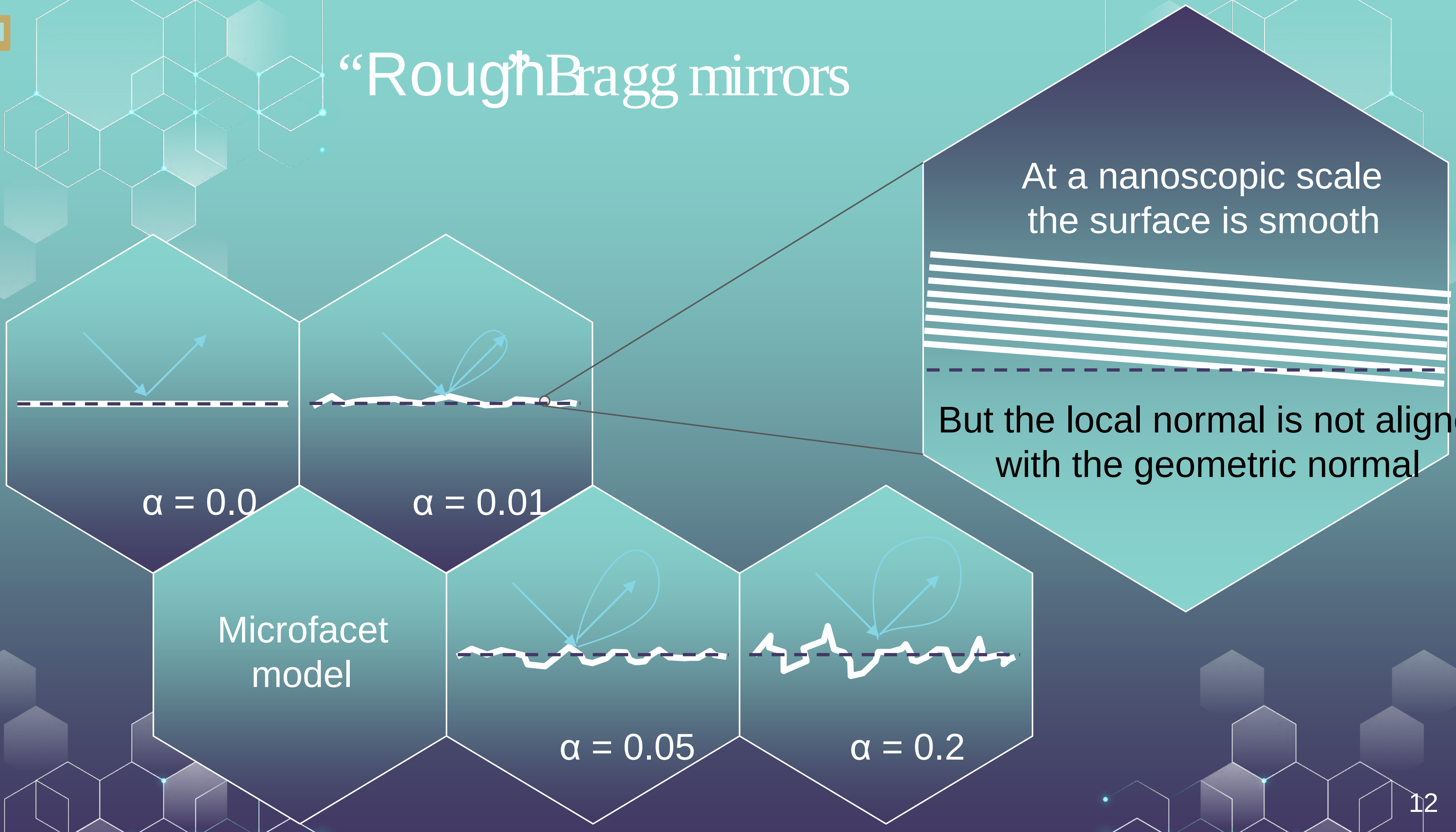
$d2 = 100$

$n1 = 1.0$

$n2 = 1.3$

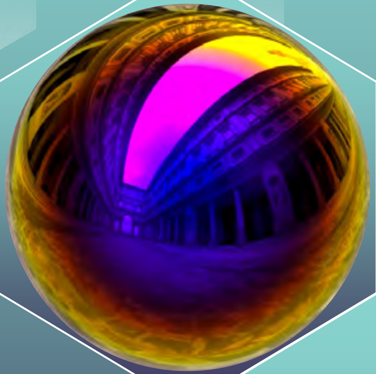
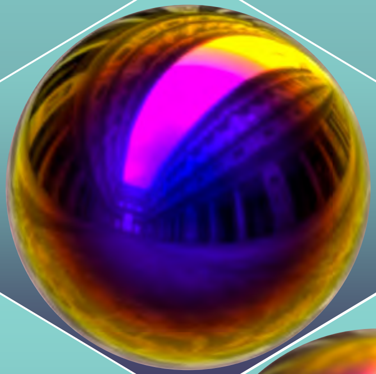
20 repetitions

"Rough" Bragg mirrors

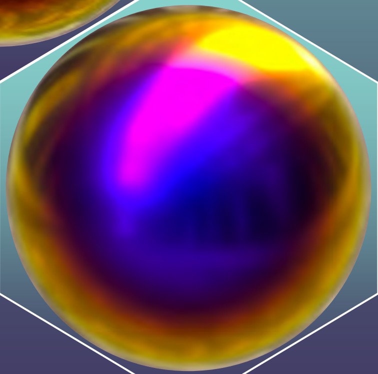
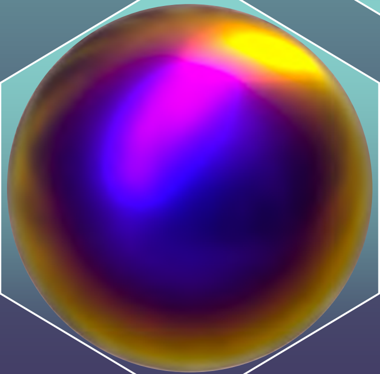


D

$$f_r(i,o) = \frac{D(h)G(i,o,h)R_\lambda(i.h)}{4|i.n||o.n|}$$

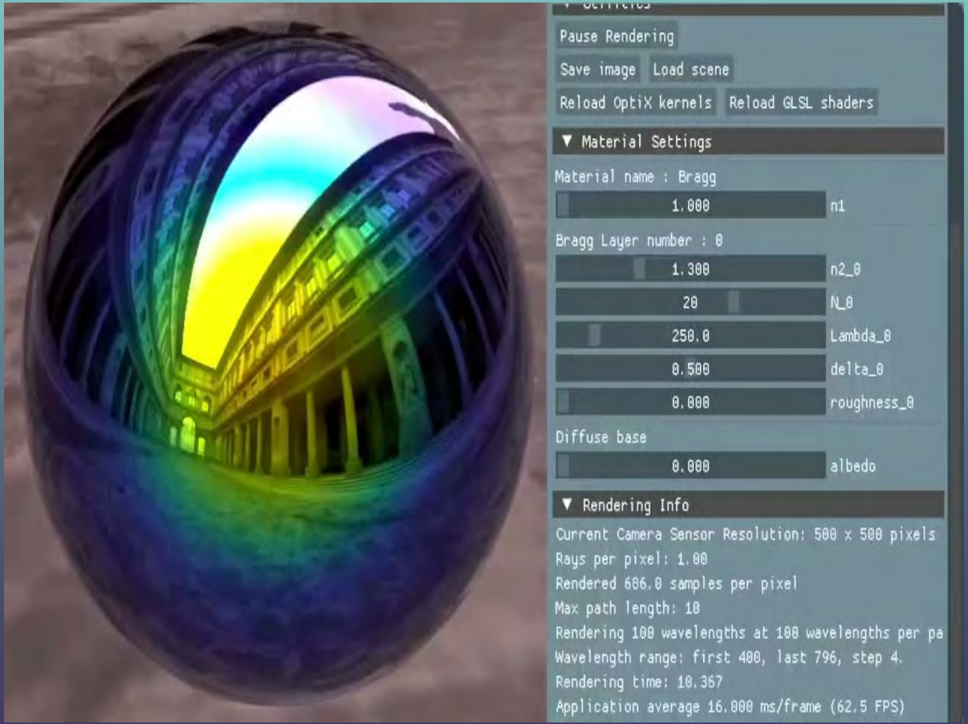
d1 = 188
d2 = 188
n1 = 1.0
n2 = 1.5

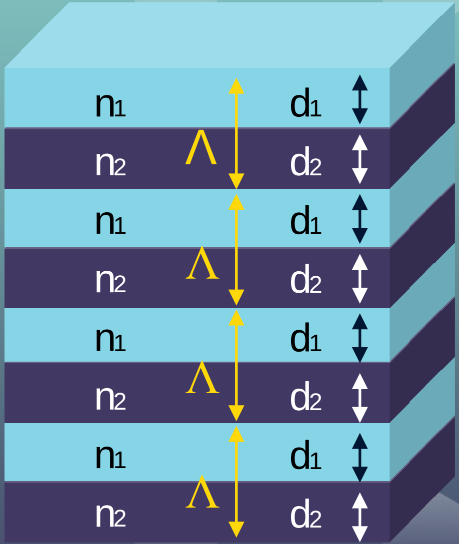



Interactive exploration in a Progressive spectral renderer

Lambda = d1 + d2

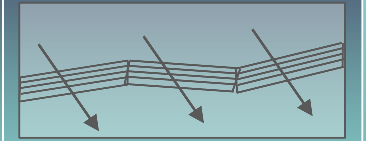
delta = d1/(d1 + d2)

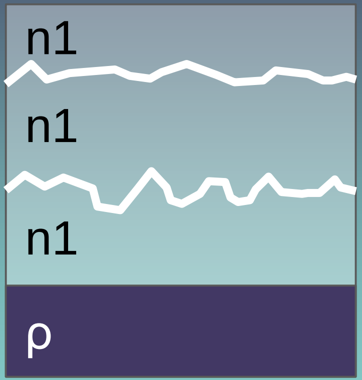




With multiple layers

Transmission through a Bragg layer is ballistic





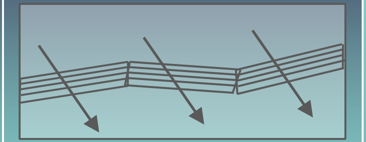
Smooth coating

Multiple rough bragg layers With differents parameters

Diffuse base

With multiple layers

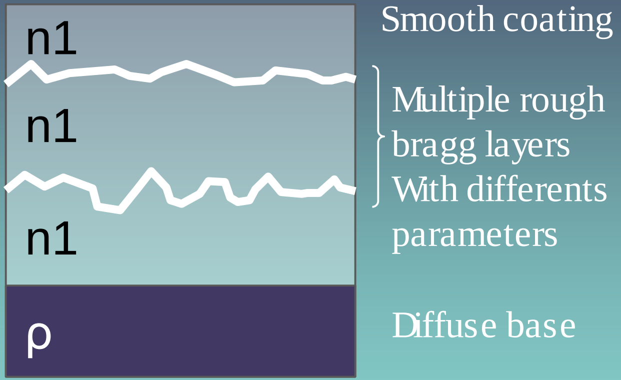
Transmission through a Bragg layer is ballistic



Sum the contribution of every micro-facet on CPU

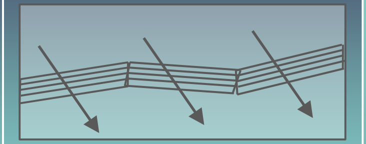
$$T_\lambda = 1 - R_\lambda$$

$$\iint T_\lambda G D d\omega$$



With multiple layers

Transmission through a Bragg layer is ballistic



Sum the contribution of every micro-facet on CPU

$$T_\lambda = 1 - R_\lambda$$

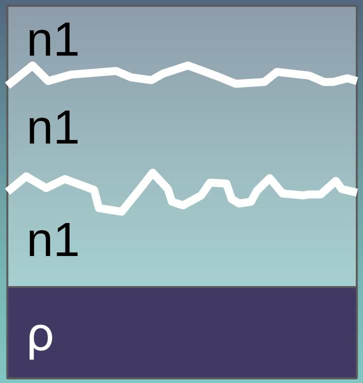
$$\iint T_\lambda G D \, d\omega$$

Computation of an achromatic filter

$$F_\alpha$$

Compute only if T_λ changes

$$\int_0^{\pi/2} T_\lambda(\theta_d) F_\alpha(\theta_i, \theta_d) d\theta_d$$



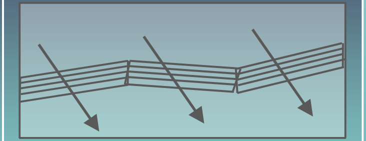
Smooth coating

Multiple rough bragg layers With differents parameters

Diffuse base

With multiple layers

Transmission through a Bragg layer is ballistic



Sum the contribution of every micro-facet on CPU

$$T_\lambda = 1 - R_\lambda$$

$$\iint T_\lambda G D d\omega$$

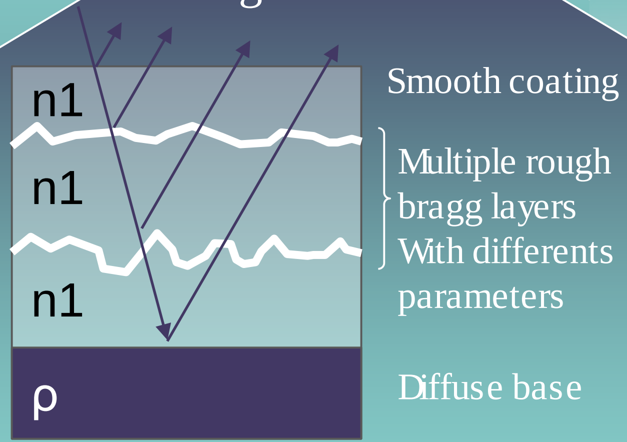
Computation of an achromatic filter

$$F_\alpha$$

Compute only if T_λ changes

$$\int_0^{\pi/2} T_\lambda(\theta_d) F_\alpha(\theta_i, \theta_d) d\theta_d$$

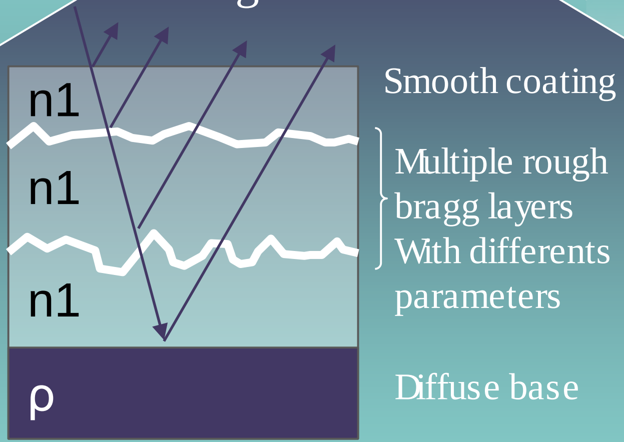
Single reflection



With multiple layers

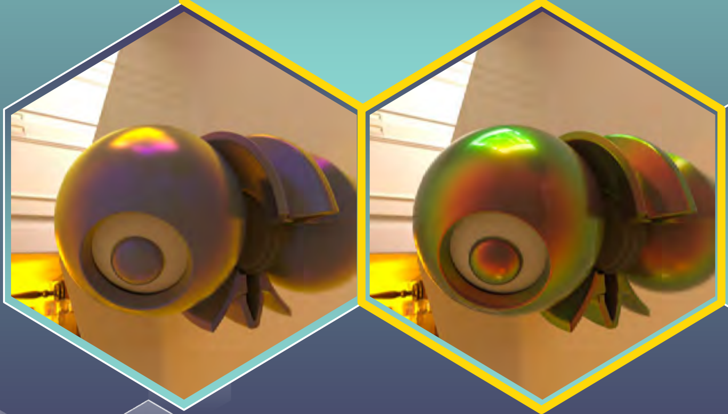
Grey diffuse base

Single reflection

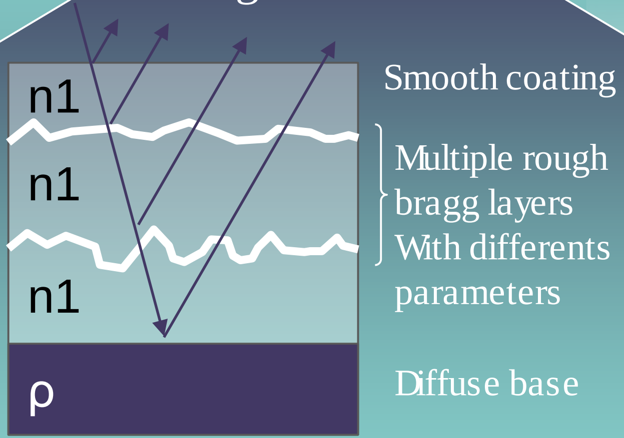


With multiple layers

Smooth coating (notice the hazy gloss)

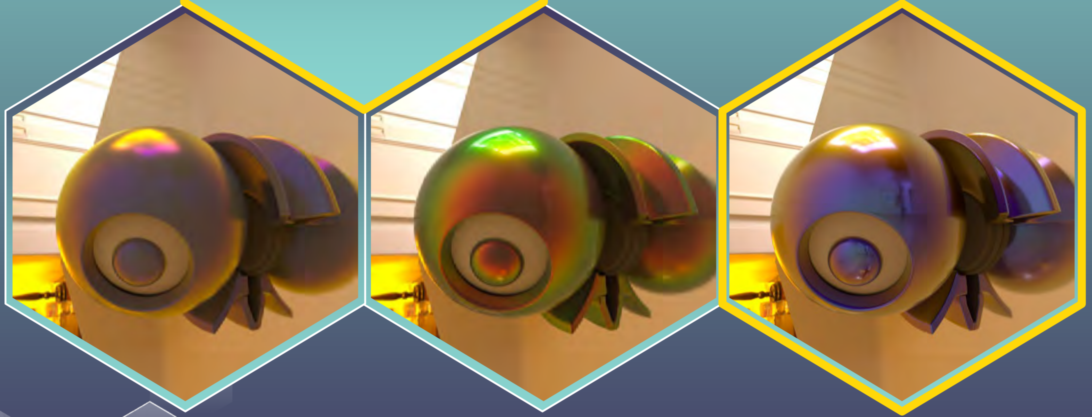


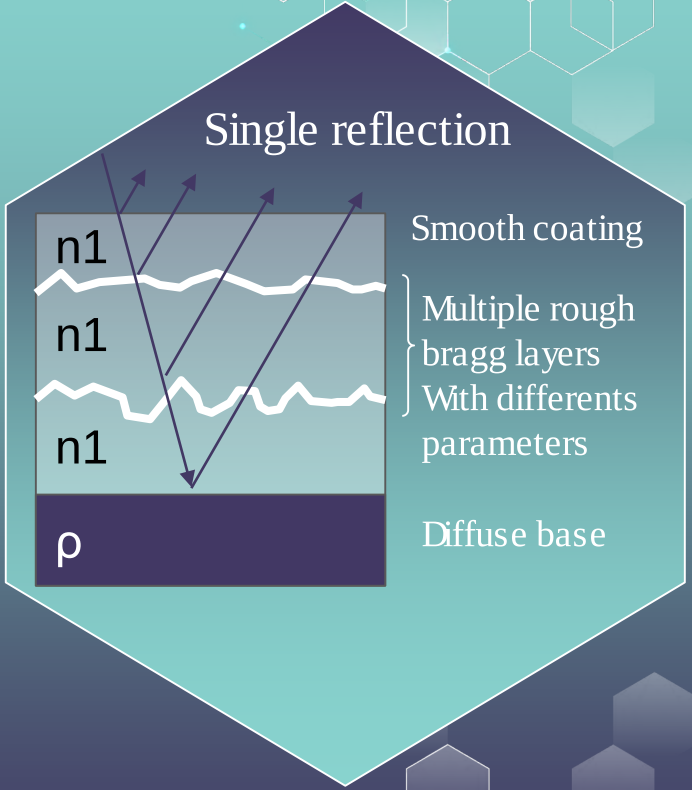
Single reflection



With multiple layers

Smooth Bragg
On Rough Bragg





Thank you for your attention