OPTICAL RESPONSE OF MATERIALS

- **In a common spectroscopy experiment where monochromatic electromagnetic radiation (plane wave) probes a material**

$$\boldsymbol{E}(\boldsymbol{x},t) = \boldsymbol{E}_0 e^{i(\tilde{\boldsymbol{q}}\cdot x-\omega t)}$$

complex wavevector

$\omega=2\pi\nu$

- Upon solving the Maxwell's equations, we find **All PROPERTIES OF THE MATERIAL are enclosed within the COMPLEX DIELECTRIC FUNCTION OR COMPLEX REFRACTIVE INDEX.**
- **The ABSORPTION COEFFICIENT is related to the IMAGINARY PART OF THE REFRACTIVE INDEX (or of dielectric constant).**
- The **IMAGINARY PART OF THE REFRACTIVE INDEX (k)** is responsible for **ABSORPTION PHENOMENA**,

$$\boldsymbol{E}(\boldsymbol{x},t) = E_0 e^{i\left[\frac{\omega}{c}nx-\omega t\right]} e^{-\frac{\omega}{c}kx} \qquad \tilde{q} = \frac{\omega}{c}(n+ik) \qquad \tilde{\boldsymbol{n}} = \boldsymbol{n}+\boldsymbol{ik}$$

- The **REAL PART (n)** is responsible for **PROPAGATION PHENOMENA** whithin the medium (**optical path = $\boldsymbol{nx}$**).

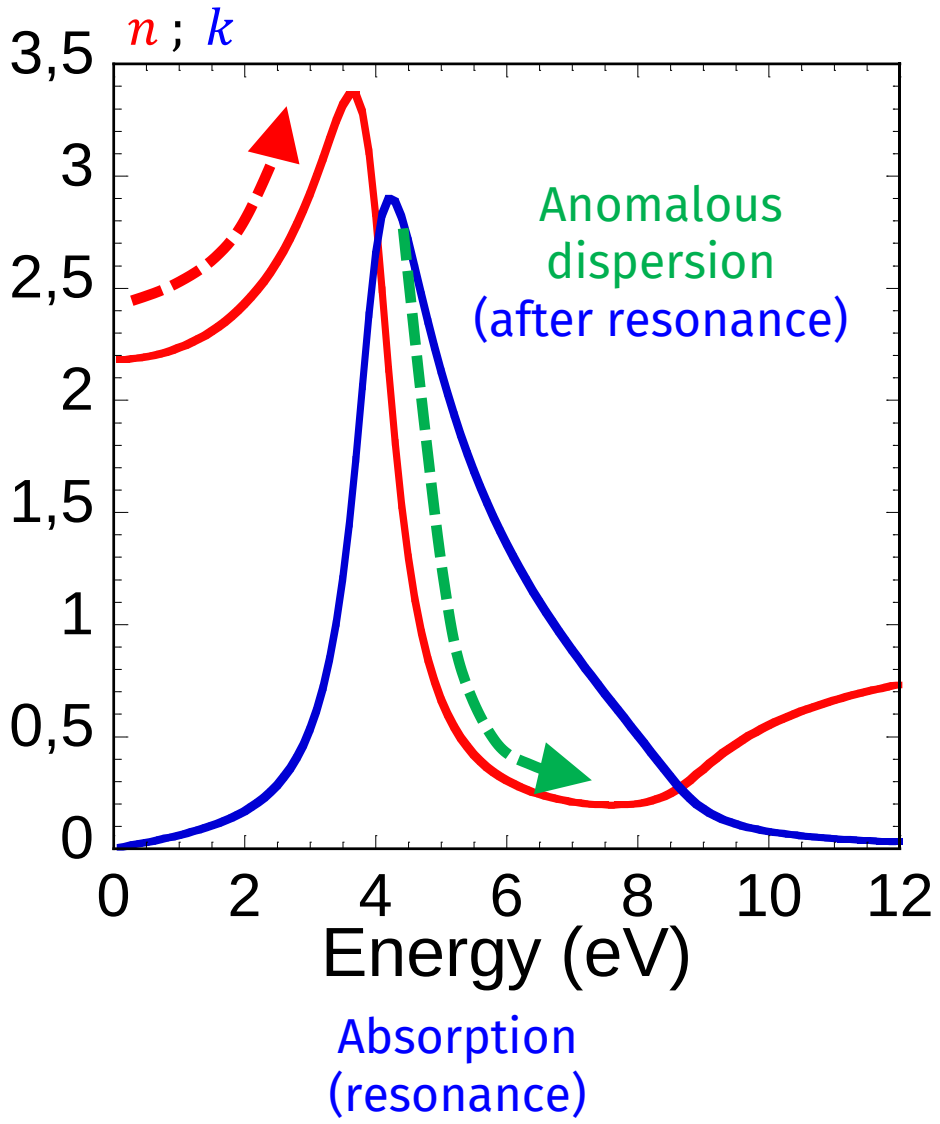
OPTICAL RESPONSE OF MATERIALS

$$\varepsilon_1(\omega) = n^2 - k^2$$

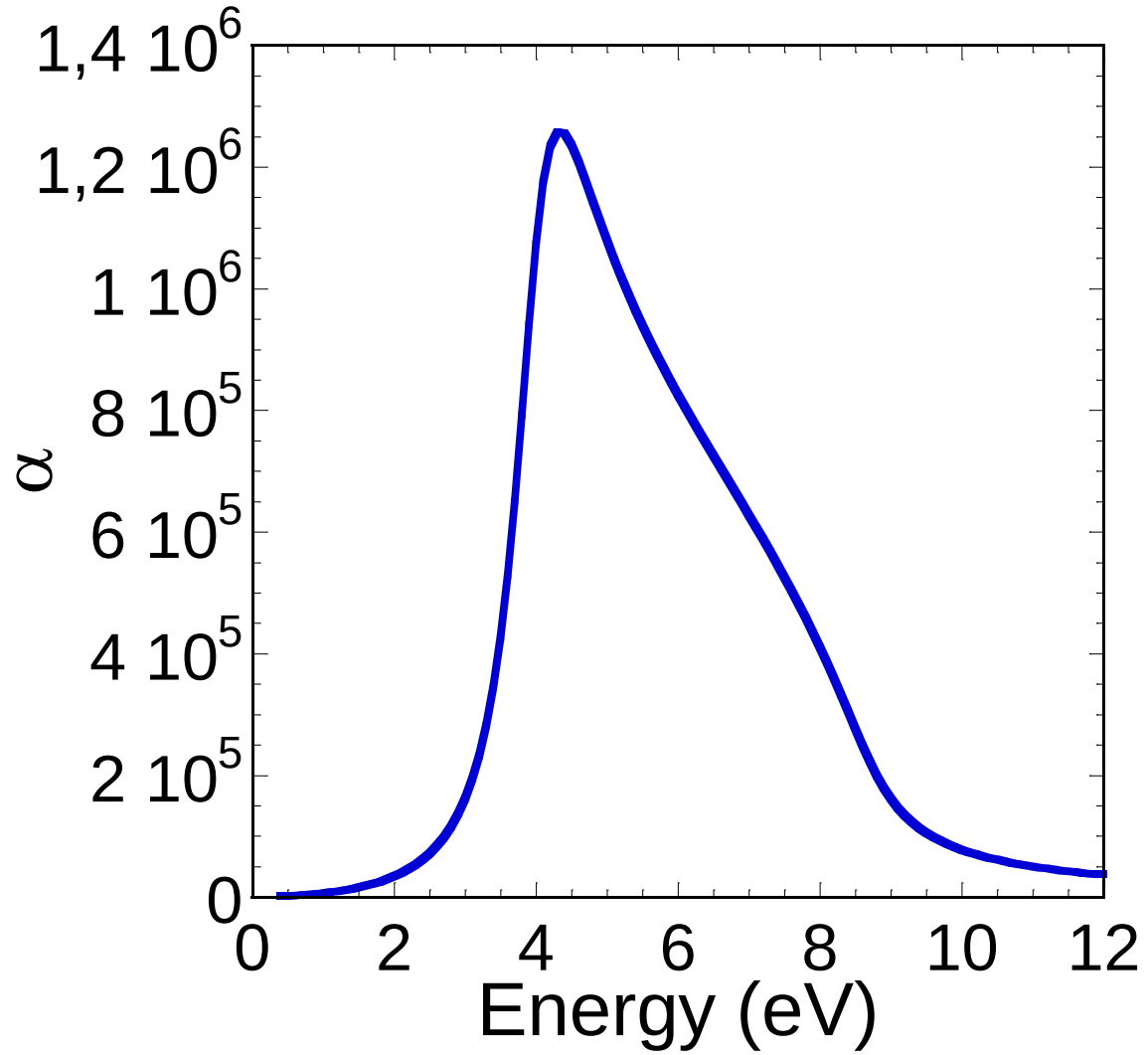
$$\varepsilon_2(\omega) = 2nk$$

$$n = \sqrt{\frac{1}{2}\left(\sqrt{\varepsilon_1^2 + \varepsilon_2^2} + \varepsilon_1\right)}$$

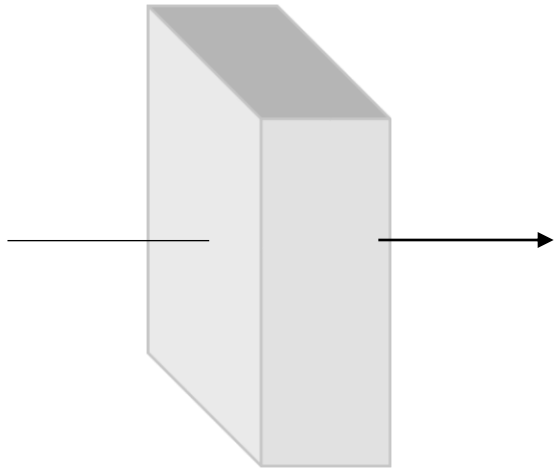
$$k = \sqrt{\frac{1}{2}\left(\sqrt{\varepsilon_1^2 + \varepsilon_2^2} - \varepsilon_1\right)}$$



OPTICAL RESPONSE OF MATERIALS

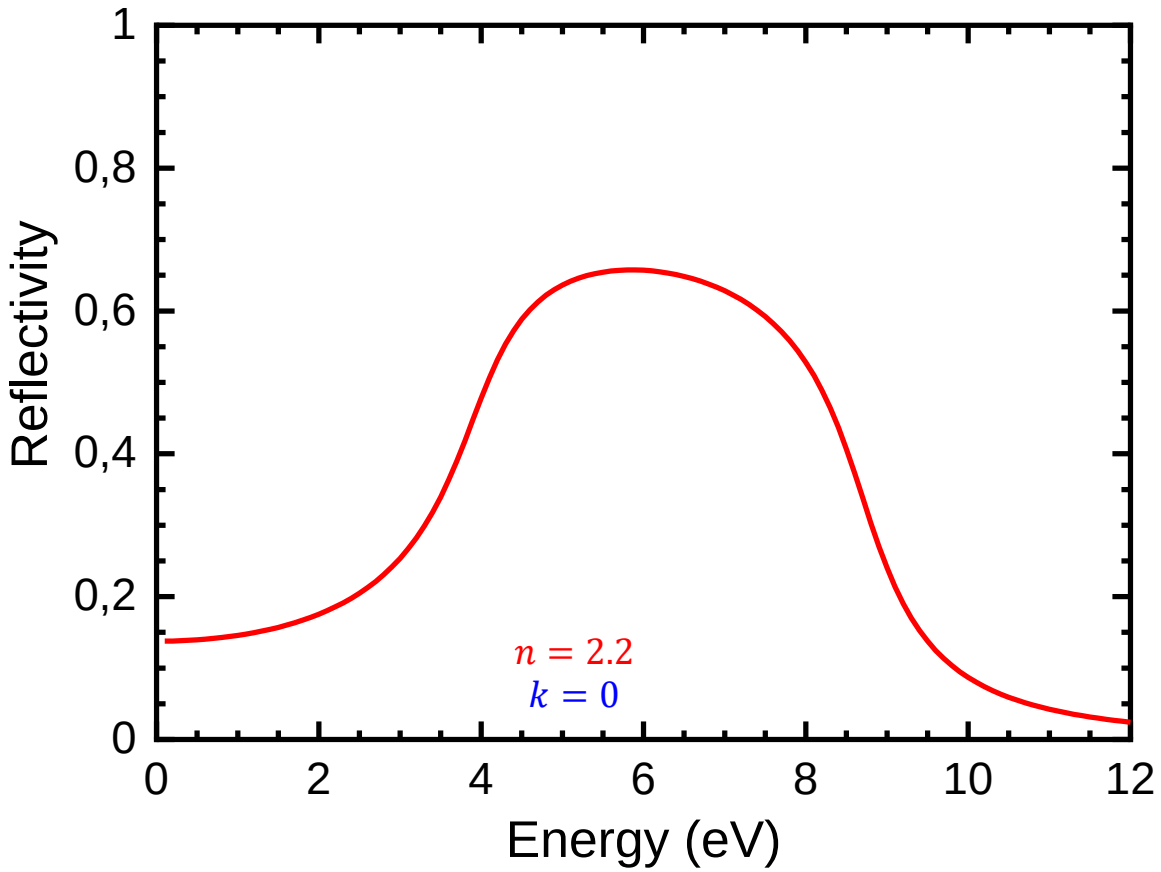


$$\alpha = -\frac{1}{I}\frac{dI}{dx} = 2\frac{\omega}{c}k$$



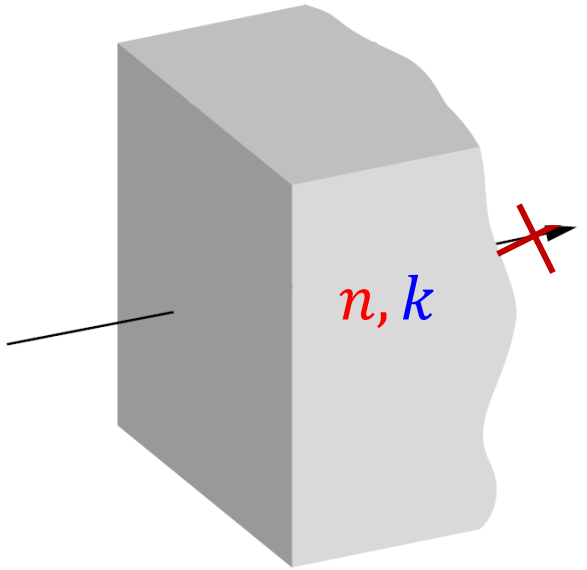
$I_t = I_0 e^{-\alpha d}$ $T = I_t / I_0 = e^{-\alpha d}$

OPTICAL RESPONSE OF MATERIALS



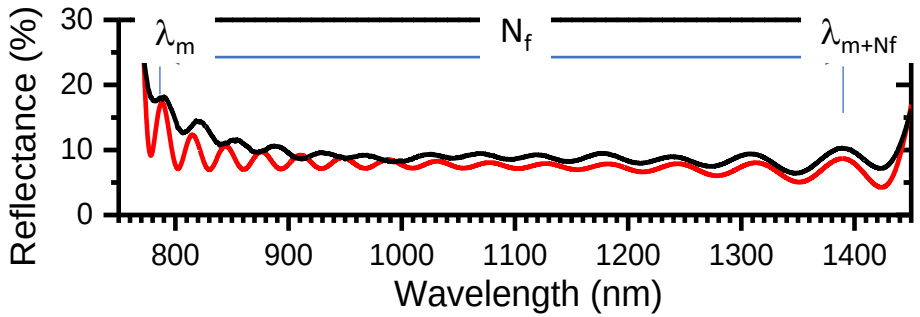
$$R = \frac{(n-1)^2 + k^2}{(n+1)^2 + k^2}$$

(semi-infinite slab)



REFRACTIVE INDEX DETERMINATION

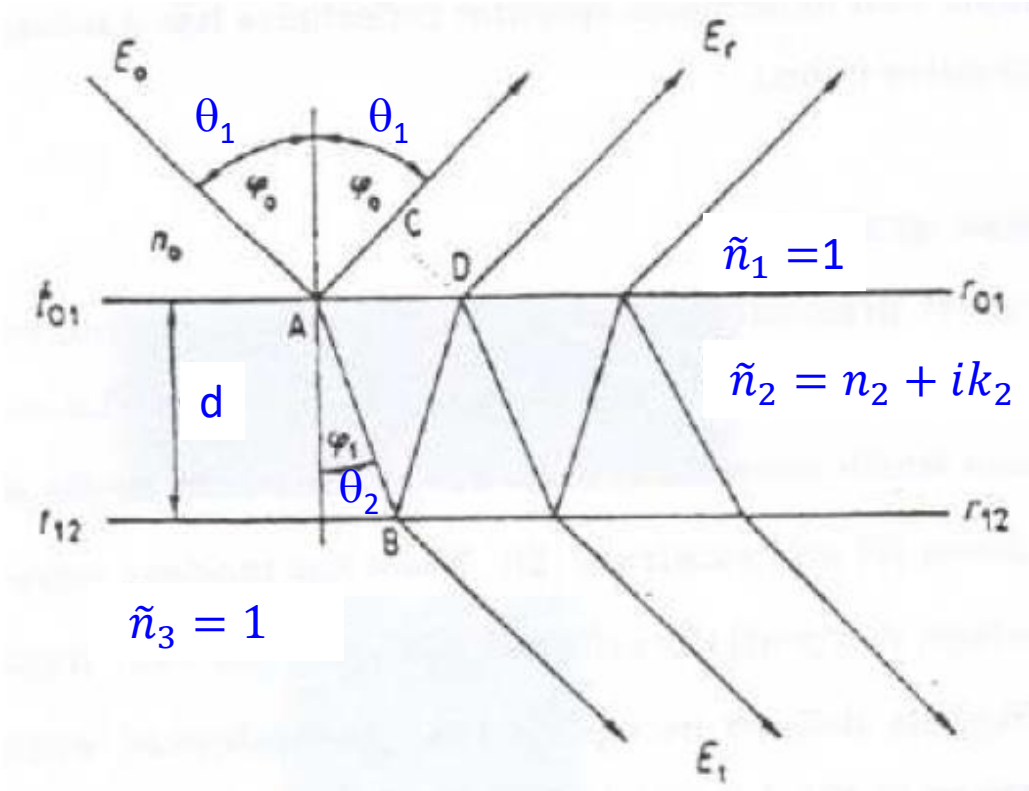
- **Transparent region: interference fringes**



$$2nd = N_f \frac{\lambda_m \lambda_{m+N_f}}{(\lambda_m - \lambda_{m+N_f})}$$

d = film thickness

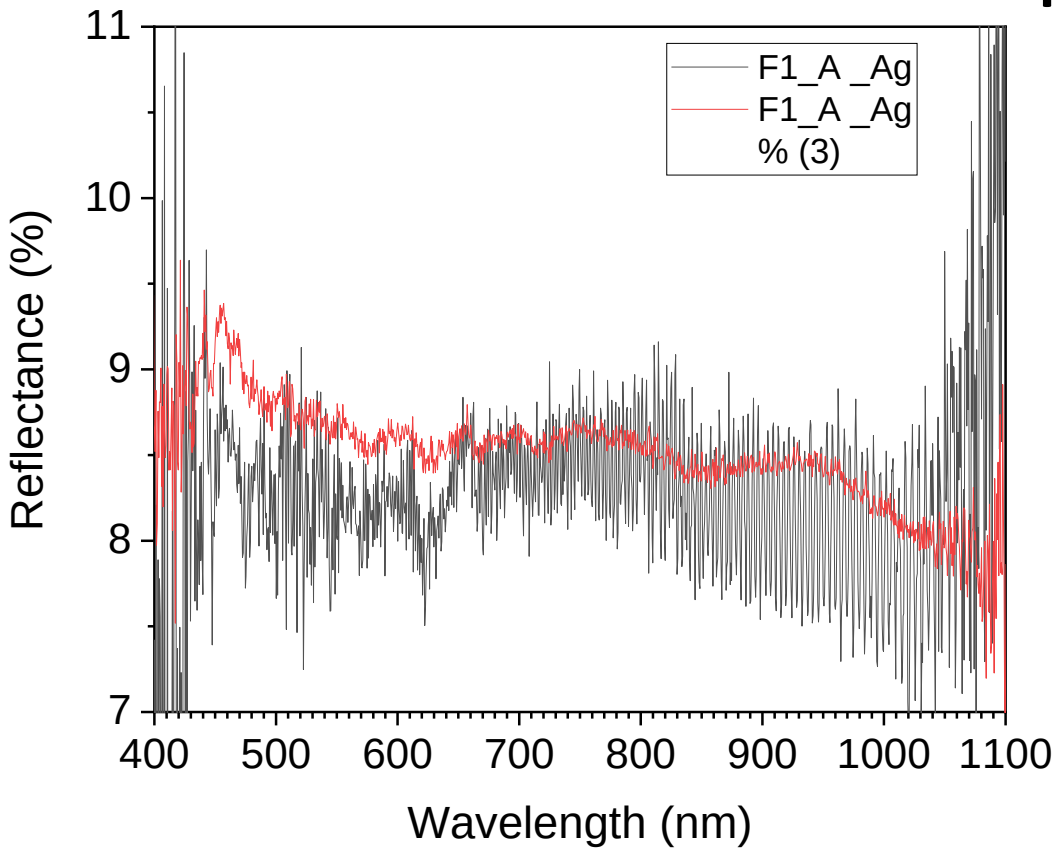
N_f, number of fringes

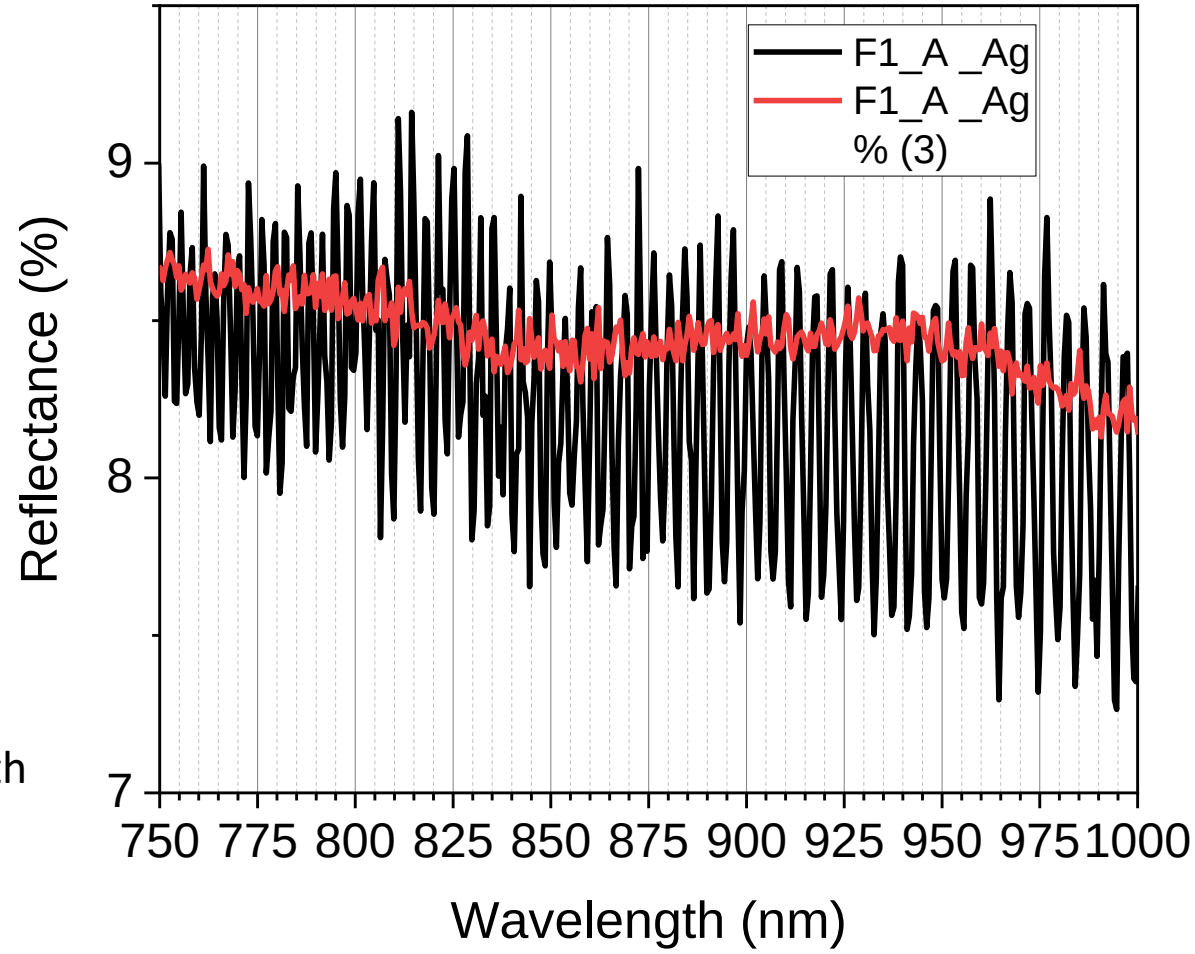


$$\tilde{n}_2 = n + i0$$

We assume the material to be perfectly transparent, i.e. the imginary part of the refractive index is negligible, k=0

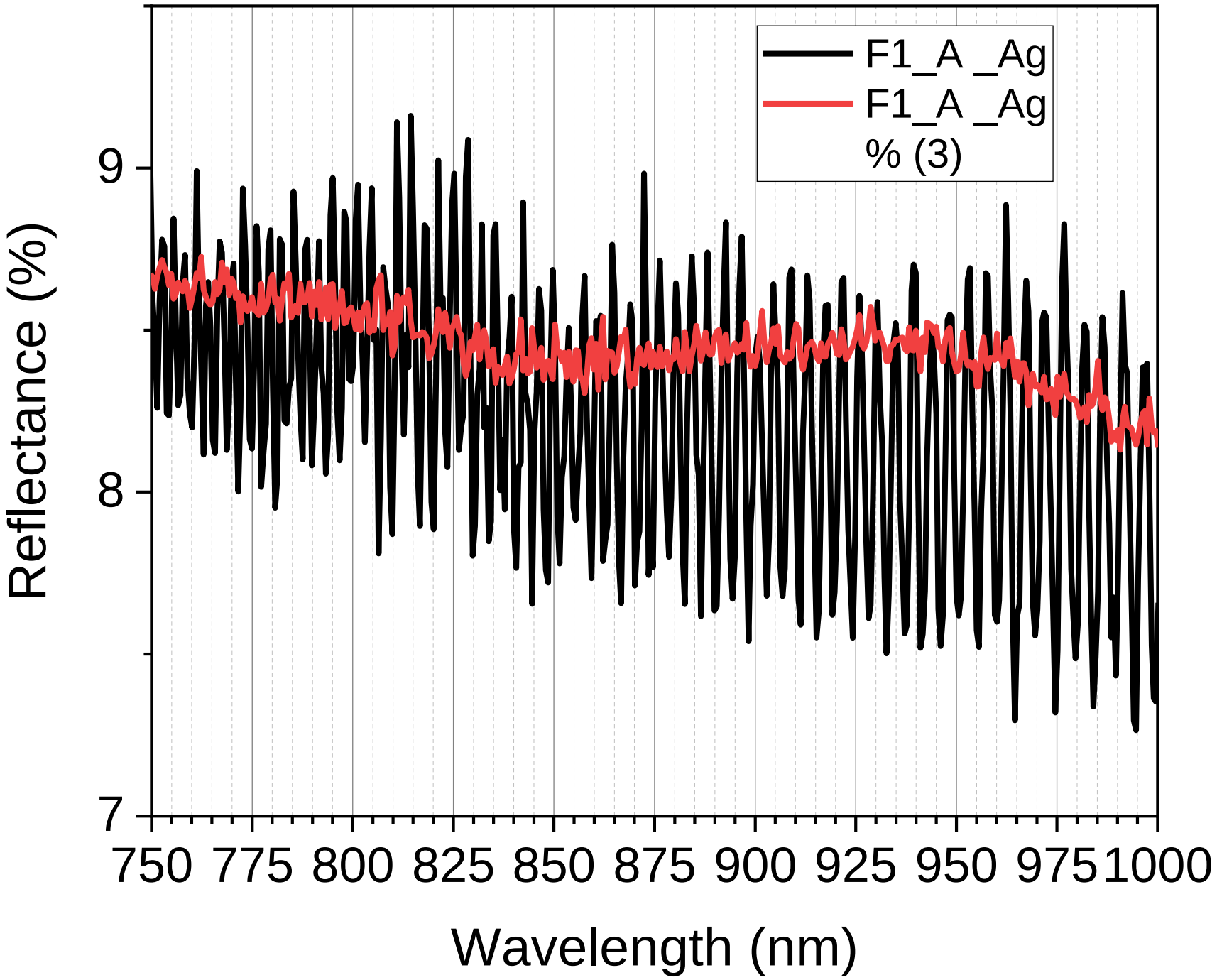
Frazione 1_A



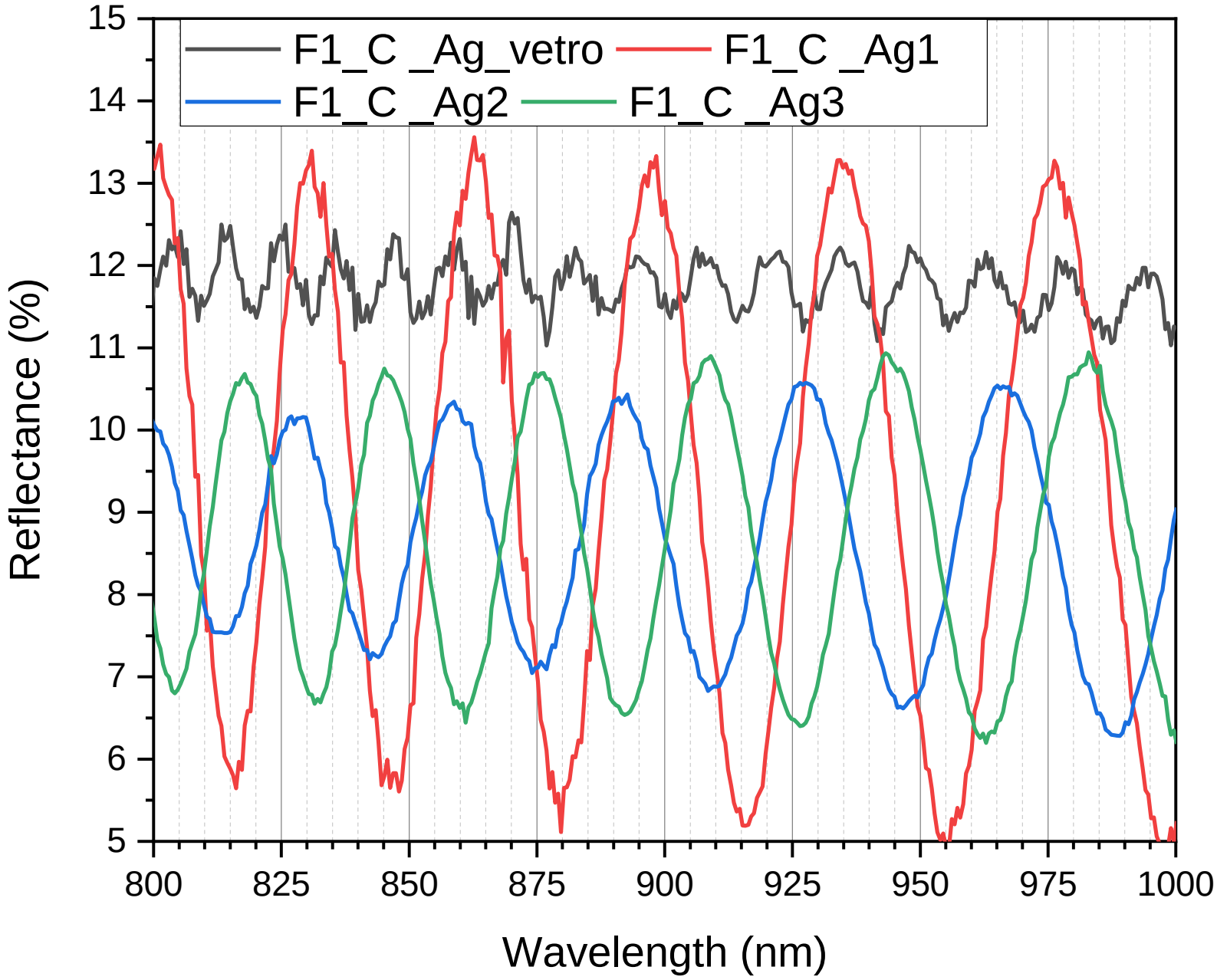


We assume n=1.57-1.58, independent on the wavelength

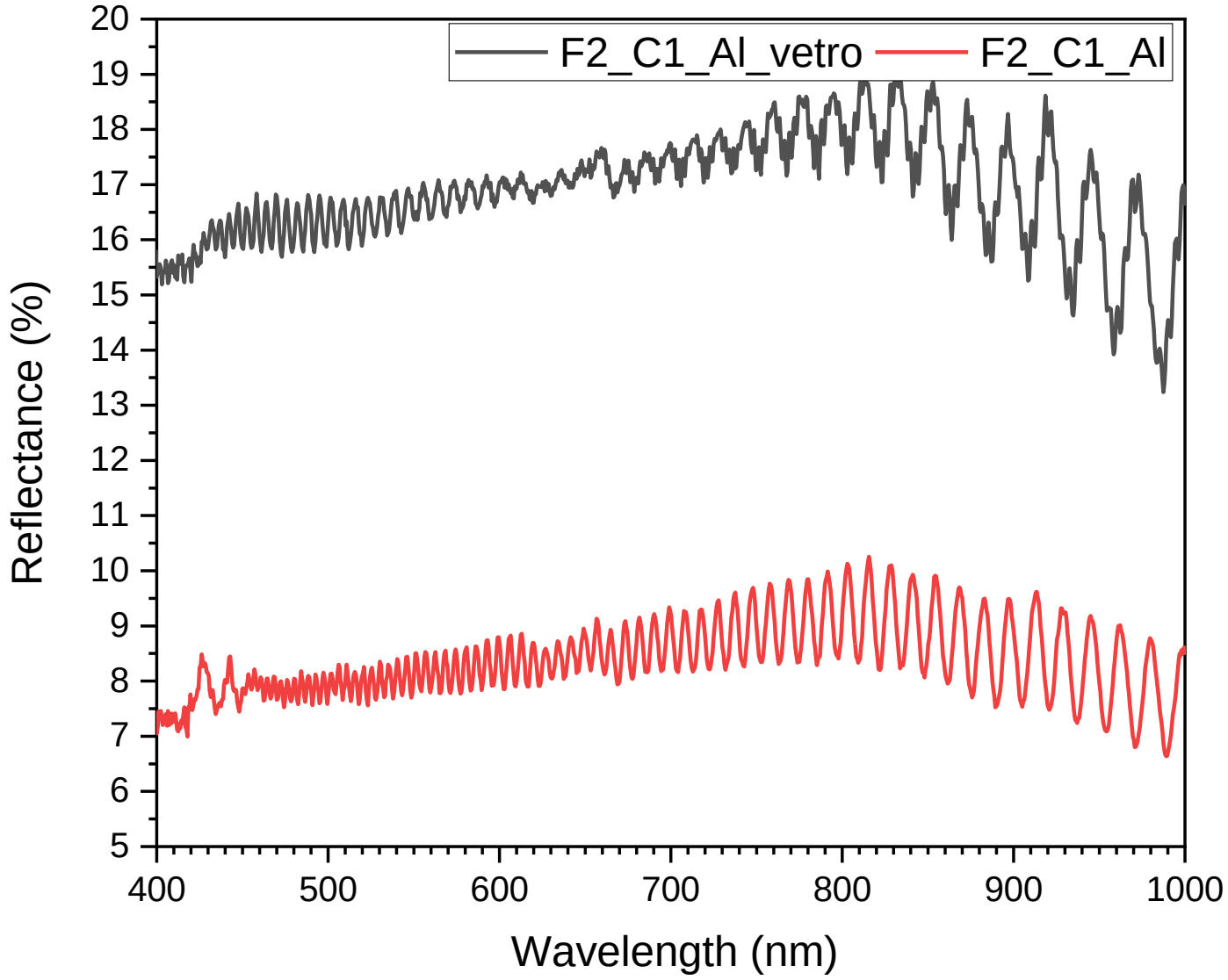
Frazione 1_A


F1_A _Ag
F1_A _Ag % (3)
Reflectance (%)
9
8
7
750 775 800 825 850 875 900 925 950 975 1000
Wavelength (nm)

Frazione 1_C


F1_C _Ag_vetro
F1_C _Ag1
F1_C _Ag2
F1_C _Ag3
Reflectance (%)
Wavelength (nm)
15
14
13
12
11
10
9
8
7
6
5
800
825
850
875
900
925
950
975
1000

Frazione 2_C con riferimento Al



Frazione 2_C con riferimento Ag