

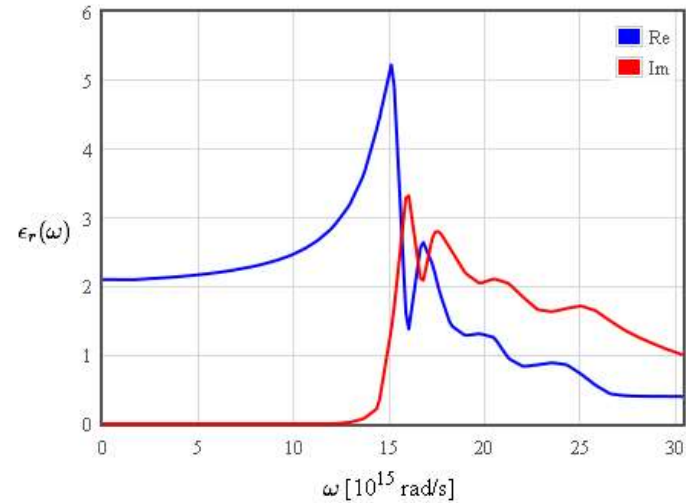
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## The optical properties of SiO<sub>2</sub> (glass)

nanophotonics.csic.es

### Dielectric function

The relative dielectric constant describes the relationship between the electric displacement  $\vec{D}$  and the electric field  $\vec{E}$ ,  $\vec{D} = \epsilon_r \epsilon_0 \vec{E} = \vec{P} + \epsilon_0 \vec{E}$ .



There are two conventions for dielectric function. Either it is assumed that the time dependence of  $\vec{D}$ ,  $\vec{P}$ , and  $\vec{E}$  is  $\exp(-i\omega t)$  and the plot of the dielectric function looks as it is shown above, or it is assumed that the time dependence of  $\vec{D}$ ,  $\vec{P}$ , and  $\vec{E}$  is  $\exp(i\omega t)$  and the imaginary part of the has the opposite sign as in the plot above. Here we will assume a time dependence of  $\exp(-i\omega t)$ .

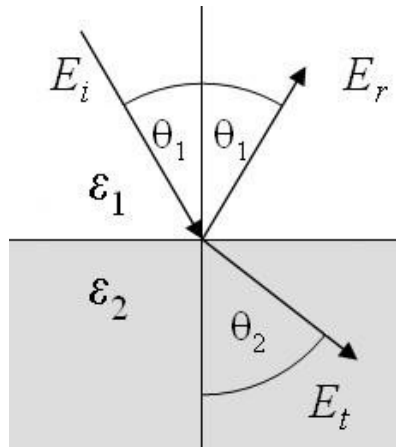
### Electric susceptibility

The electric susceptibility  $\chi_E$  describes the relationship between the polarization  $\vec{P}$  and the electric field  $\vec{E}$ ,  $\vec{P} = \epsilon_0 \chi_E \vec{E}$ .

$$\chi_E = \epsilon_r - 1$$



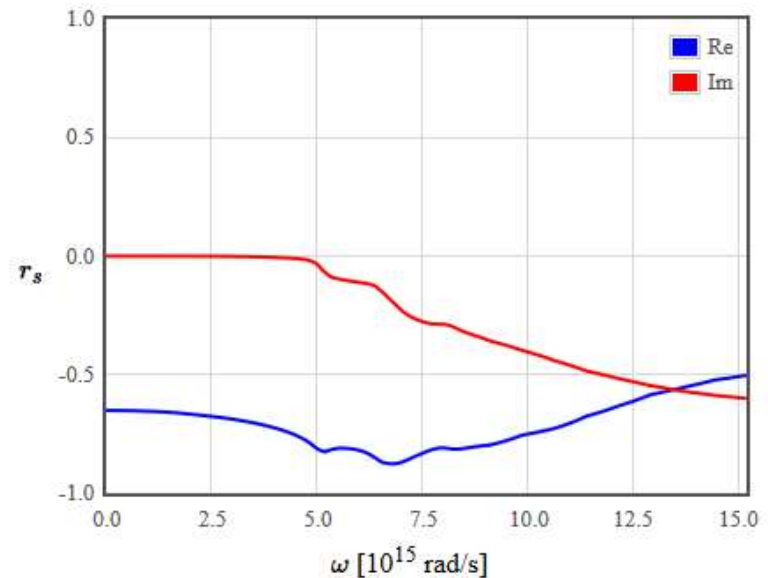
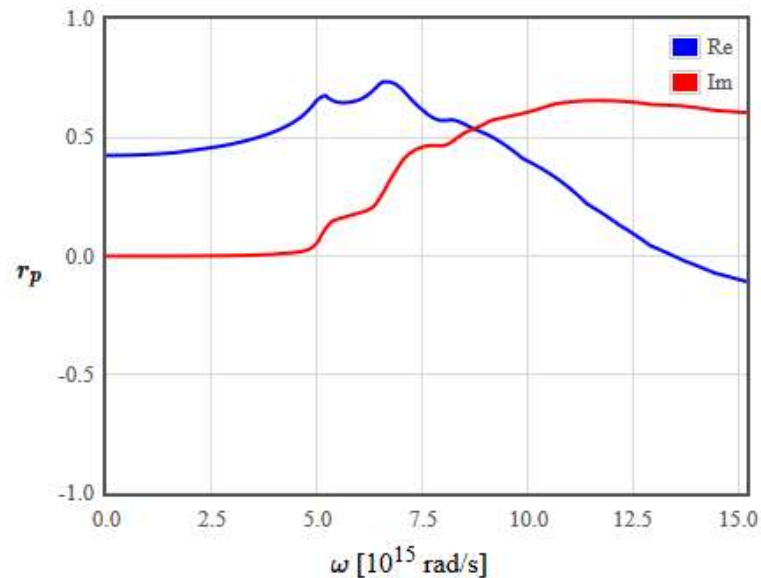
# Ellipsometry



$$r_p = \frac{E_{rp}}{E_{ip}} = \frac{\sqrt{\epsilon_2} \cos \theta_1 - \sqrt{\epsilon_1} \cos \theta_2}{\sqrt{\epsilon_2} \cos \theta_1 + \sqrt{\epsilon_1} \cos \theta_2}$$

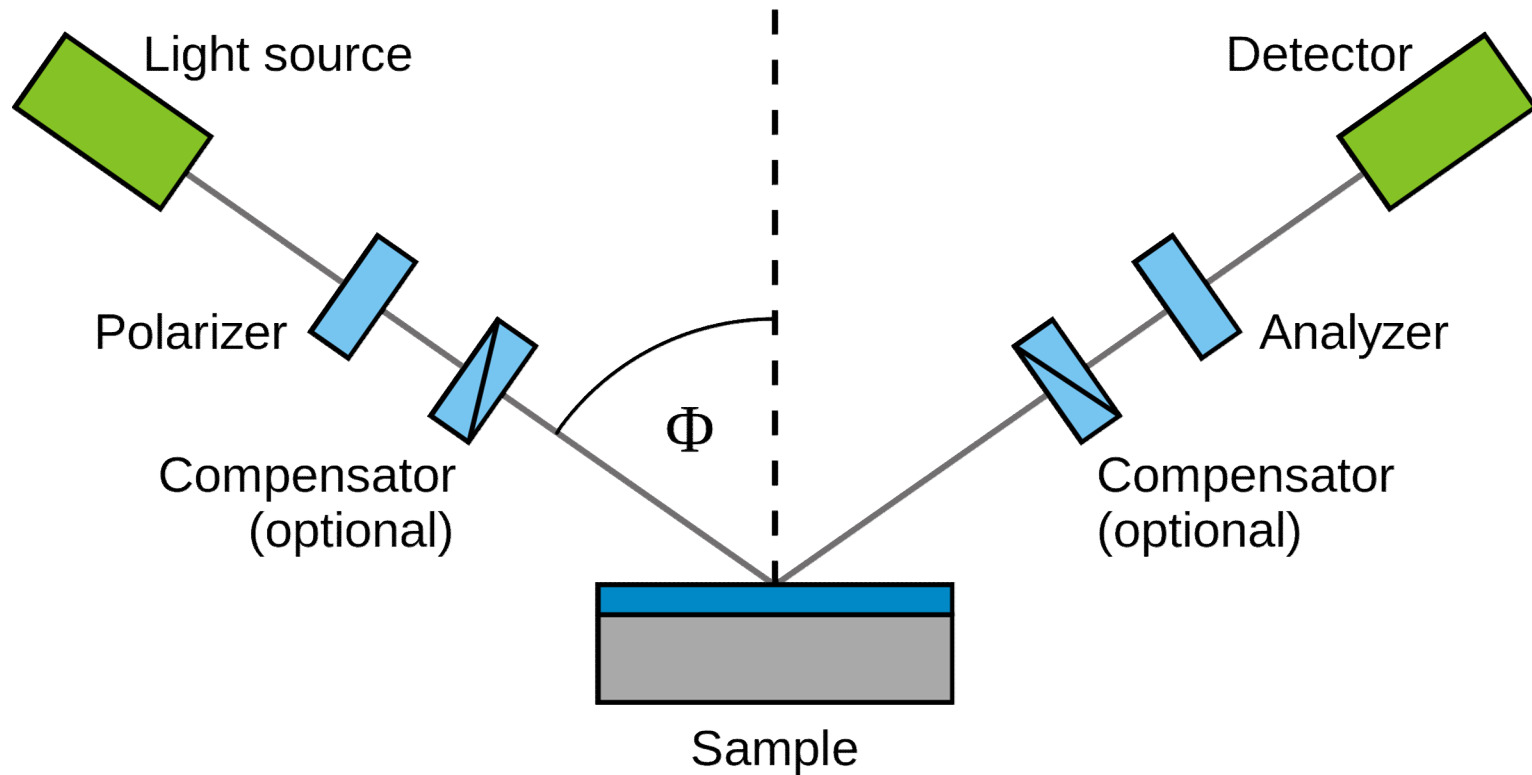
$$r_s = \frac{E_{sr}}{E_{si}} = \frac{\sqrt{\epsilon_2} \cos \theta_2 - \sqrt{\epsilon_1} \cos \theta_1}{\sqrt{\epsilon_1} \cos \theta_1 + \sqrt{\epsilon_2} \cos \theta_2}$$

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$



# Ellipsometry

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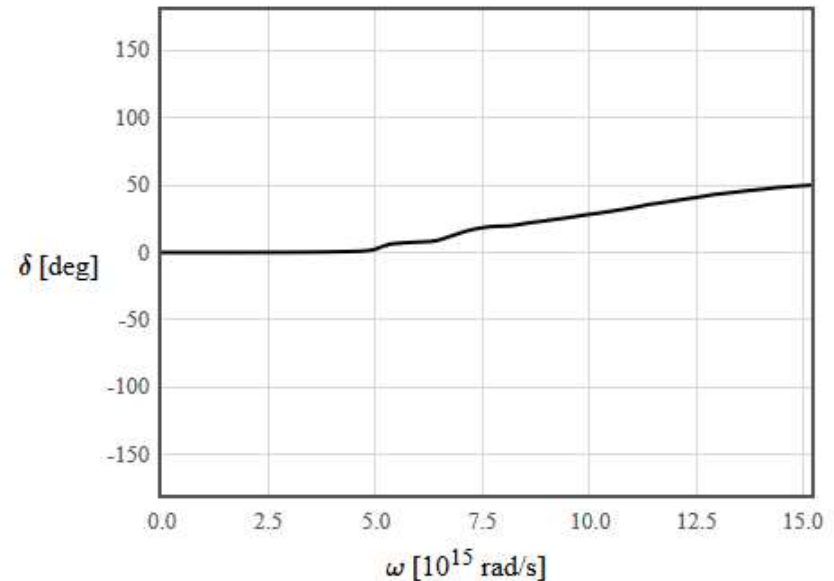
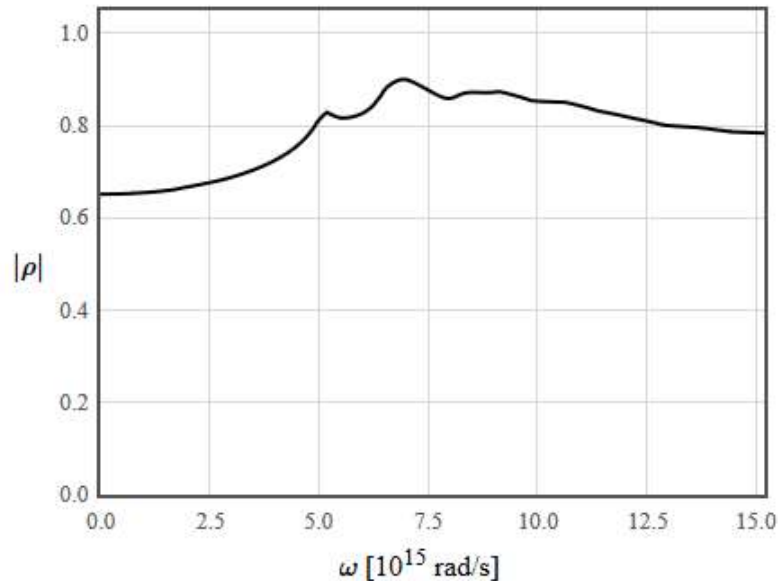
Ellipsometry measures the change of polarization upon reflection. The measured signal depends on the thickness and the dielectric constant.

<http://en.wikipedia.org/wiki/Ellipsometry>

# Ellipsometry

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$$\rho = \frac{r_p}{r_s} = |\rho|e^{i\delta}$$



The ratio of the two reflected polarizations is insensitive to instabilities of light source or atmospheric absorption.