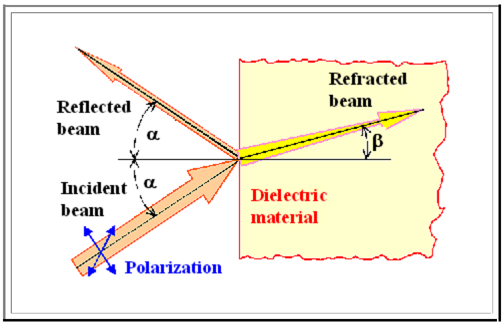
3.7.4 Summary to: Dielectrics and Optics

The basic questions one would like to answer with respect to the optical behaviour of materials and with respect to the simple situation as illustrated are:

1. How large is the fraction ***R*** that is reflected? **1 – *R*** then will be going in the material.
2. How large is the angle β, i.e. how large is the refraction of the material?
3. How is the light in the material absorbed, i.e. how large is the absorption coefficient?

Of course, we want to know that as a function of the wave length λ or the frequency **ν = *c*/λ**, the angle α, and the two basic directions of the polarization (



All the information listed above is contained in the complex index of refraction ***n****** as given ⇒

$n = (\epsilon_r)^{1/2}$	Basic definition of "normal" index of refraction ***n***
$n^* = n + i \cdot \kappa$	Terms used for complex index of refaction ***n**** ***n*** = real part κ = imaginary part
$n^{*2} = (n + i\kappa)^2 = \epsilon' + i \cdot \epsilon''$	Straight forward definition of ***n****

Working out the details gives the basic result that

- Knowing ***n*** = real part allows to answer question **1** and **2** from above via "Fresnel laws" (and "Snellius' law", a much simpler special version).
- Knowing κ = imaginary part allows to answer question **3** ⇒

$$E_x = \exp -\frac{\omega \cdot \kappa \cdot x}{c} \cdot \exp[\, i \cdot (k_x \cdot x - \omega \cdot t)]$$

Amplitude: Exponential decay with κ	**"Running" part of the wave**

- Knowing the dielectric function of a dielectric material (with the imaginary part expressed as conductivity σ_{DK}), we have (simple) optics completely covered!
  - If we would look at the tensor properties of ϵ, we would also have crystal optics (= anisotropic behaviour; things like birefringence) covered.
  - We must, however, dig deeper for e.g. non-linear optics ("red in - green (double frequency) out"), or new disciplines like quantum optics.

$$n^2 = \frac{1}{2}\left(\epsilon' + \left(\epsilon'^{\,2} + \frac{\sigma_{DK}{}^2}{4\epsilon_0{}^2\omega^2}\right)^{½}\right)$$

$$\kappa^2 = \frac{1}{2}\left(-\,\epsilon' + \left(\epsilon'^{\,2} + \frac{\sigma_{DK}{}^2}{4\epsilon_0{}^2\omega^2}\right)^{½}\right)$$

Questionaire
Multiple Choice questions to all of 3.7