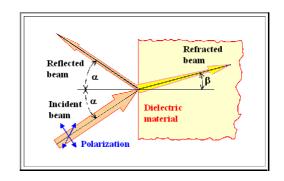
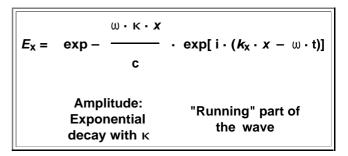
## 3.7.4 Summary to: Dielectrics and Optics

- 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:
  - How large is the fraction R that is reflected? 1 R then will be going in the material.
  - 2. How large is the angle  $\beta$ , i.e. how large is the refraction of the material?
  - 3. How is the light in the material absorped, i.e. how large is the absorption coefficient?
  - Of course, we want to know that as a function of the wave length  $\lambda$  or the frequency  $v = c/\lambda$ , the angle  $\alpha$ , 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 = (∈ <sub>r</sub> ) <sup>1/2</sup>	Basic definition of "normal" index of refraction <i>n</i>
$n^* = n + i \cdot \kappa$	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 <i>n</i> *

- 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 ⇒



- Knowing the dielectric function of a dielectric material (with the imaginary part expressed as conductivity  $\sigma_{DK}$ ), we have (simple) optics completely covered!
  - If we would look at the tensor properties of ∈, 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.

$$n^{2} = \frac{1}{2} \left( \epsilon' + \left( \epsilon'^{2} + \frac{\sigma_{DK}^{2}}{4\epsilon_{0}^{2}\omega^{2}} \right)^{\frac{1}{2}} \right)$$

$$\kappa^{2} = \frac{1}{2} \left( -\epsilon' + \left( \epsilon'^{2} + \frac{\sigma_{DK}^{2}}{4\epsilon_{0}^{2}\omega^{2}} \right)^{\frac{1}{2}} \right)$$

## **Questionaire**

Multiple Choice questions to all of 3.7