10.6: Example- Copper

The real and imaginary parts $(n_{\theta}+i\kappa_{\theta})=\sqrt{\epsilon_{r}-\sin^{2}\theta}$ have been plotted in Figure (10.6.8) as a function of the angle of incidence, θ, for room temperature copper and for a wavelength of λ= 0.5145 microns (see Table(10.1)). As can be seen from the figure, the angular dependence of the indices n_{θ}, κ_{θ} is not very pronounced. For a lossy material such as copper that has a complex dielectric constant the reflectivity, E_R/E_0, is complex; that is, the phase shift between the incident wave and reflected wave electric vectors is neither 0° (in phase) nor 180° (out of phase). The real and imaginary parts of the reflectivity have been plotted in Figure (10.6.9) as a function of the angle of incidence for S-polarized 0.5145 micron light incident on room temperature copper; the absolute value of the reflectivity has been plotted in Figure (10.6.10).

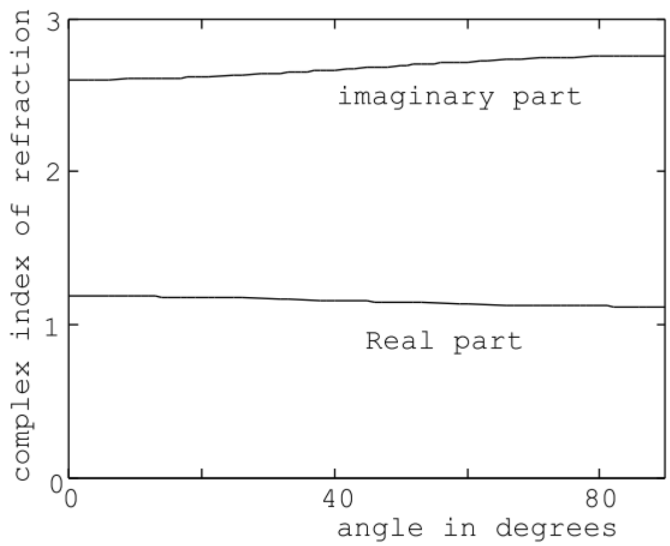

Figure 10.6.8: The dependence of the complex index of refraction, n_{θ} + iκ_{θ}, upon angle of incidence of the incident wave calculated for copper at room temperature and for an incident wavelength of λ = 0.5145 μm. The normal component of the wave-vector in copper is given by $k_{z}=\left(\frac{\omega}{c}\right)(n_{\theta}+i\kappa_{\theta})$. At this wavelength the relative dielectric constant for copper is ϵ_r= (-5.34+i6.19), n=1.19, and κ=2.60.

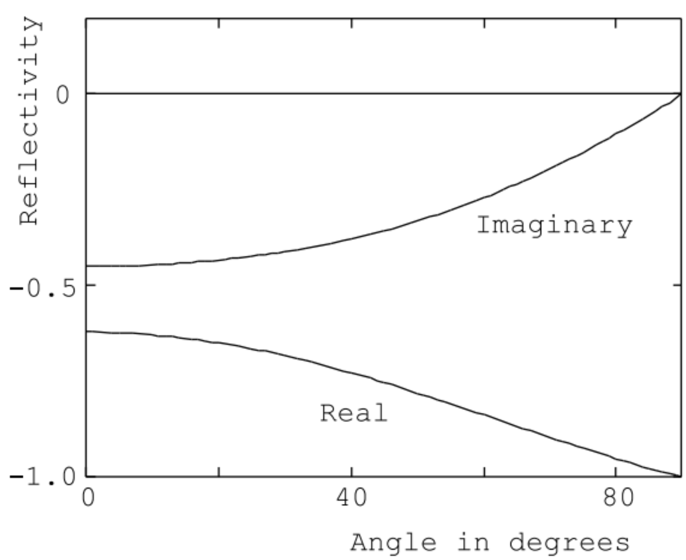

Figure 10.6.9: The real and imaginary part of the reflectivity of copper, E_R/E_0, as a function of angle of incidence for a wavelength λ= 0.5145 μm and S-polarized radiation. Copper at room temperature; ϵ_r= (-5.34 + i6.19), n=1.19, and κ=2.60.

Similarly, the real and the imaginary parts of the ratio H_R/H_0 have been plotted in Figure (10.6.11) as a function of the angle of incidence for P-polarized 0.5145 micron light incident on copper; the absolute value of this ratio is shown in Figure (10.6.12). The reflection coefficient for P-polarized radiation is given by $R_P = E_R/E_0$ but this is very closely related to the ratio H_R/H_0 because $E_0 = Z_0H_0$ and $E_R = -Z_0H_R$, where Z_0= 377 Ohms, the impedance of free space. Notice that the real part of the reflectivity for P-polarized light vanishes at an angle of incidence of approximately 69° ; the phase of the reflected light at that angle is shifted by 90° relative to the incident light. The phase shift between reflected and incident light is much less pronounced for S-polarized light; approximately 15° for an angle of incidence of 69° .

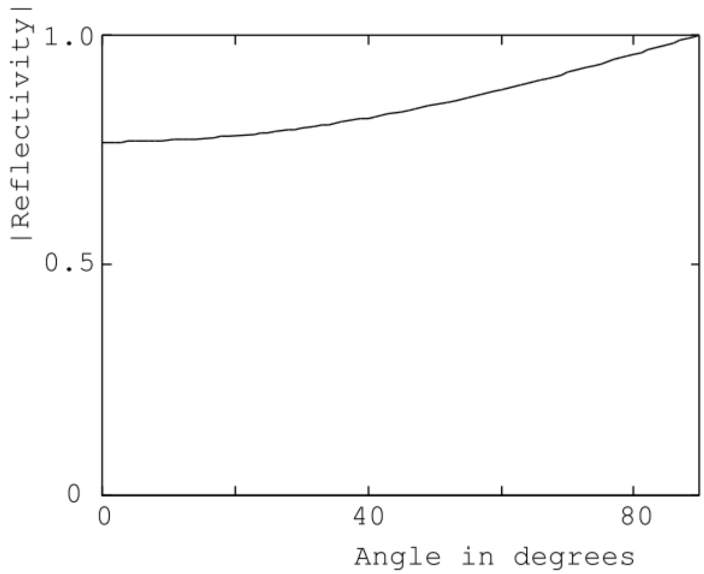

Figure 10.6.10: The absolute value of the reflectivity of copper, | E_R/E_0 |, as a function of angle of incidence for a wavelength λ= 0.5145 μm and S-polarized radiation. Copper at room temperature; ϵ_r=(-5.34 + i6.19), n=1.19, and κ=2.60.

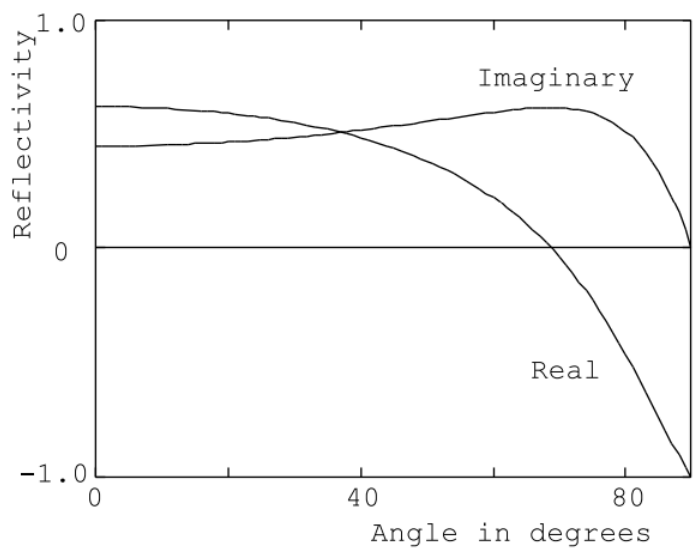

Figure 10.6.11: The real and imaginary parts of the complex ratio HR/H0 for copper as a function of angle of incidence for a wavelength λ= 0.5145 μm and for P-polarized radiation. Copper at room temperature; ϵ_r=(-5.34 + i6.19), n=1.19, and κ=2.60.