Answer on Question #81221 Physics / Optics

Question. Light of wavelength $5800\ Å$ falling at nearly normal incidence gets reflected from a soap film of refractive index 1.4. what is the least thickness of the film that will appear bright and dark?

Solution.

For bright

$$2dn\cos r \pm \frac{\lambda_0}{2} = 2d\sqrt{n^2 - \sin^2 i} \pm \frac{\lambda_0}{2} = m\lambda_0 (m = 1, 2, \dots).$$

For dark

$$2dn\cos r \pm \frac{\lambda_0}{2} = 2d\sqrt{n^2 - \sin^2 i} \pm \frac{\lambda_0}{2} = (2m+1)\frac{\lambda_0}{2} (m = 1, 2, \dots).$$

In our case $n > n_0$, where $n_0 = 1\ (air)$. So,

For bright

$$2dn\cos r - \frac{\lambda_0}{2} = \lambda_0 \ \rightarrow \ 2dn\cos 0° - \frac{\lambda_0}{2} = \lambda_0 \ \rightarrow \ 2dn = \frac{3}{2}\lambda_0 \ \rightarrow d = \frac{3}{4}\cdot\frac{\lambda_0}{n} =$$

$$= \frac{3}{4}\cdot\frac{5800\cdot 10^{-10}}{1.4} = 3.107\cdot 10^{-7}\ m.$$

For dark

$$2dn\cos r - \frac{\lambda_0}{2} = \frac{\lambda_0}{2} \ \rightarrow \ 2dn\cos 0° - \frac{\lambda_0}{2} = \frac{\lambda_0}{2} \ \rightarrow 2dn = \lambda_0 \ \rightarrow \ d = \frac{\lambda_0}{2n} = \frac{5800\cdot 10^{-10}}{2\cdot 1.4} =$$

$$= 2.07\cdot 10^{-7}\ m.$$

Answer. For bright – $d = 3.107\cdot 10^{-7}\ m$; for dark – $d = 2.07\cdot 10^{-7}\ m$.