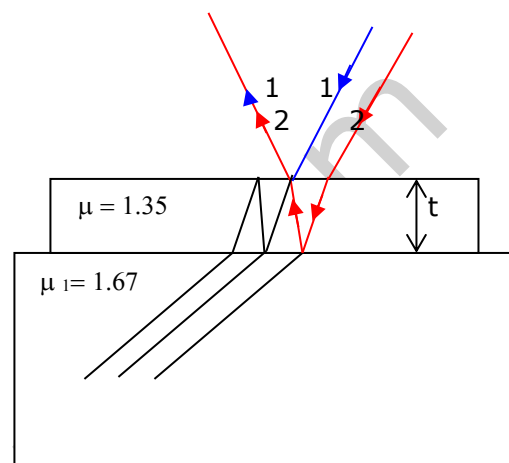


Q- A thin film of index of refraction of 1.35 is placed over a glass plate of refractive index 1.67. White light incident on the film and it is noticed that only two visible brightest colors in the reflected light are 400 and 525 nm. Determine the thickness of the film.

The question is based on the concept of the interference through thin films. When light incident on a thin film of a transparent media a part is directly reflected from the upper surface of the film and comes back (blue) while the rest part is refracted and after reflection from the lower surface of the film again refracted and comes back to the same medium (red). These two beams are having a path difference and hence interfere with each other.



Let the thickness of the film is t . If the incidence is near normal the additional path traveled by the light coming after refraction reflection and refraction is $2t$ in the film and hence equivalent path difference will be $2\mu t$.

As both reflections are from the denser medium there will be no additional phase difference or path difference is to be considered. For the interference to be constructive, this path difference must be equal to $n\lambda$ where n is an integer and λ is the wavelength of the light.

Let for the light of wavelength $\lambda_1 = 400$ nm the interference is corresponding to maxima of order n_1 then we have

$$n_1\lambda_1 = 2\mu t \quad \text{----- (1)}$$

for the second light for the same thickness of the film the order of the maxima will be different and let it be n_2 then we have

$$n_2\lambda_2 = 2\mu t \quad \text{----- (2)}$$

Equating from the two equations we have

$$n_1\lambda_1 = n_2\lambda_2$$

$$\text{Or } \frac{n_1}{n_2} = \frac{\lambda_2}{\lambda_1} = \frac{525}{400} = \frac{21}{16}$$

As the order of maxima cannot be a fraction the thickness of the film is such that $n_1 = 21$ and $n_2 = 16$

Substituting the value of n_1 in equation 1 the thickness of the film is given by

$$t = \frac{n_1\lambda_1}{2\mu} = \frac{21 \cdot 400 \cdot 10^{-9}}{2 \cdot 1.35} = 3.11 \cdot 10^{-6} \text{m}$$

For the second wave we have the same thickness again as

$$t = \frac{n_2\lambda_2}{2\mu} = \frac{16 \cdot 525 \cdot 10^{-9}}{2 \cdot 1.35} = 3.11 \cdot 10^{-6} \text{m}$$

This is the minimum thickness. Other thicknesses will be with the ratio 42/32 and so on.
