(GO1-4) Determination of the Refractive Index of Transparent Solid Materials Using Travelling Microscope

Aim of experiment

Determination of the refractive index of transparent solid materials using travelling microscope.

Apparatus

Travelling Microscope– Block of Glass– Piece of paper, Ink.

Theory of experiment

For visible light, most transparent media have refractive indices between 1 and 2. Gases at atmospheric pressure have refractive indices close to 1 because of their low density. Almost all solids and liquids have refractive indices above 1.3, with aerogel as the clear exception. Aerogel is a very low density solid that can be produced with refractive index in the range from 1.002 to 1.265. Diamond lies at the other end of the range with a refractive index as high as 2.42. Most plastics have refractive indices in the range from 1.3 to 1.7, but some high-refractive-index polymers can have a value as high as 1.76.

Real and Apparent Depth Method

This method can be used for a solid in the form of a rectangular block or for a liquid. In *figure 1*, light from O is refracted on emerging from the glass block at N so that it appears to have come, from point *O* we get Snell's law at a surface

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

By simple geometry

$$M\hat{I}N = \theta_1 \quad \text{and} \quad M\hat{O}N = \theta_2$$

therefore $\quad n_1 \sin M\hat{I}N = n_2 \sin M\hat{O}N$

$$n_1 \frac{MN}{IN} = n_2 \frac{MN}{ON}, \qquad \text{i.e.} \quad \frac{n_2}{n_1} = \frac{ON}{IN}$$

The rays which enter the travelling microscope are confined to a narrow cone, in which case ON≈OM and IN≈IM and therefore $\frac{n_2}{n_1} = \frac{OM}{IM}$

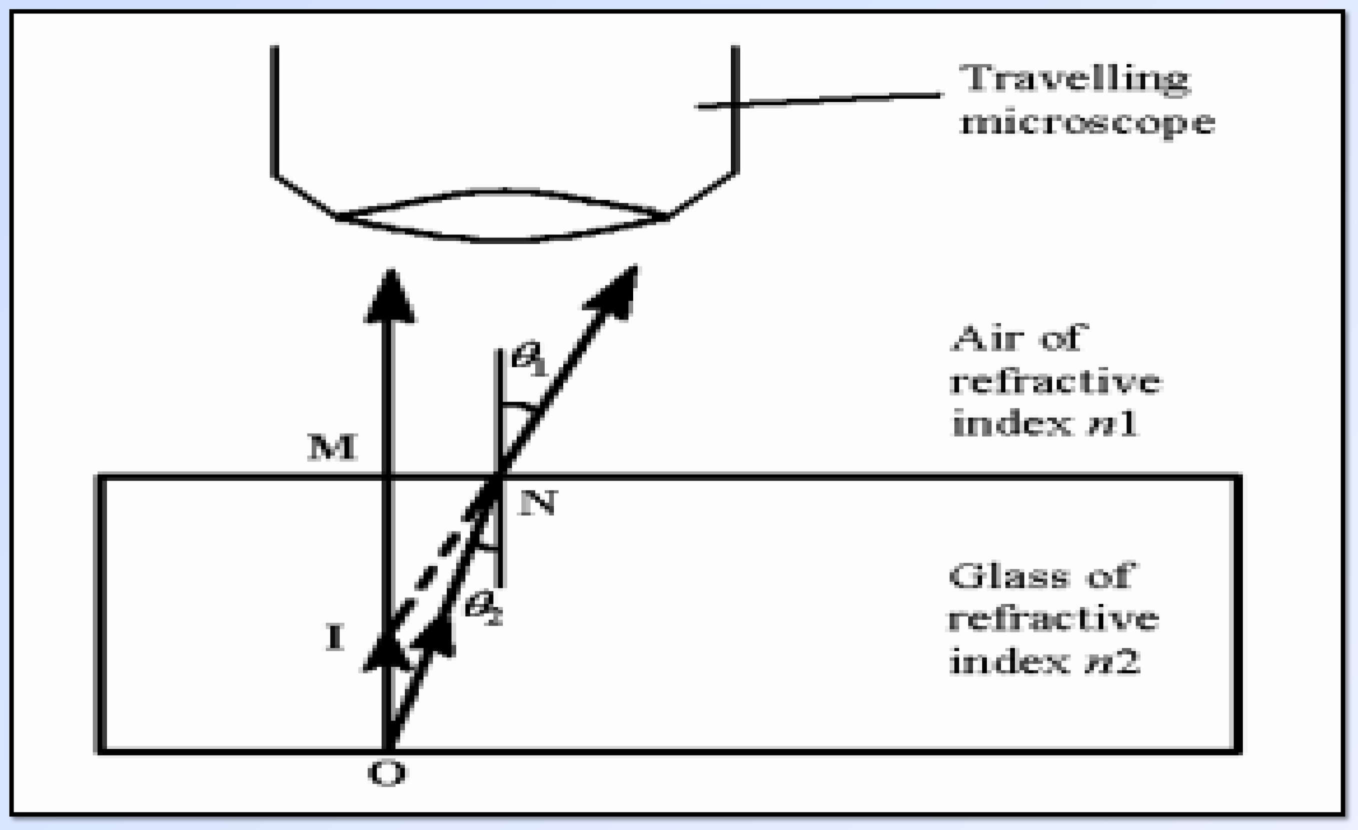

Figure 1. Real and apparent depth method of measuring refractive index

Since n_1 is the refractive index of air, is equal to unity, and therefore the refractive index of a transparent surface is given by;

$$n_2 = \frac{OM}{IM}$$

$$n_2 = \frac{real\ depth}{apparent\ depth} \qquad (1)$$

Procedure

1. Focus the travelling microscope on ***O*** (say an ink mark on a piece of paper) before the glass block has been placed over it. Suppose that the scale position is *(a).*
2. Put the block in position and move the travelling microscope upwards so that it is focused on I, in which case the mark will once again be in focus. Suppose that the scale position is now *(b).*
3. Move the travelling microscope upwards again until the top of the block *(M)* is in focus. Suppose that the scale position is now *(c).*
   Since *OM = (c - a)* and *IM = (c - b)*, equation 1 gives

$$n_2 = \frac{c-a}{c-b}$$

4. Repeat steps 1-3 two more times and get the average value of the refractive index of the transparent medium.

Results

Trial	*a (cm)*	*b (cm)*	*c (cm)*	*(c -a) (cm)*	*(c - b) (cm)*	n_2
1						
2						
3						
					n_{2wav}=	