USER'S MANUAL

BREWSTER'S ANGLE AND REFRACTIVE INDEX

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Introduction:

When light strike the surface of a dielectric (non-conducting) material/or the air-glass interface, a portion of the incident light is reflected and the reminder is transmitted into the material.The refraction of the incident light that is reflected depends on both the angle of incidence and the polarization direction of incident light. The functions that describe the reflection of light polarized parallel and perpendicular to the plane of incidence are called the **"Fresnel Equation"**

Figure 1. shows a graph of the reflectivity for the air-glass interface as a function of the angle of incidence. Notice that even though the glass in transparent ,4% of the light is still reflected. However, as angle of incidence increases, the parallel component drops and perpendicular component rises, until at the Brewster's Angle their value are approximately 0% and 15% of the initial intensity of the light respectively. Fig. 1 also shows that for one angle of incidence, called **Brewster's Angle**, none of the parallel polarization is reflected. At an incident angle of 90^o all the incident light is reflected, so the substance acts as a mirror.

Natural or Randomly polarized light can be represented by components of polarization parallel and perpendicular to the plane of incidence. If natural or randomly polarized light is incident on a glass surface, the Fresnel's equations describe the percent reflection for each of the polarization components. Thus natural light is always at least partially polarized upon reflection.

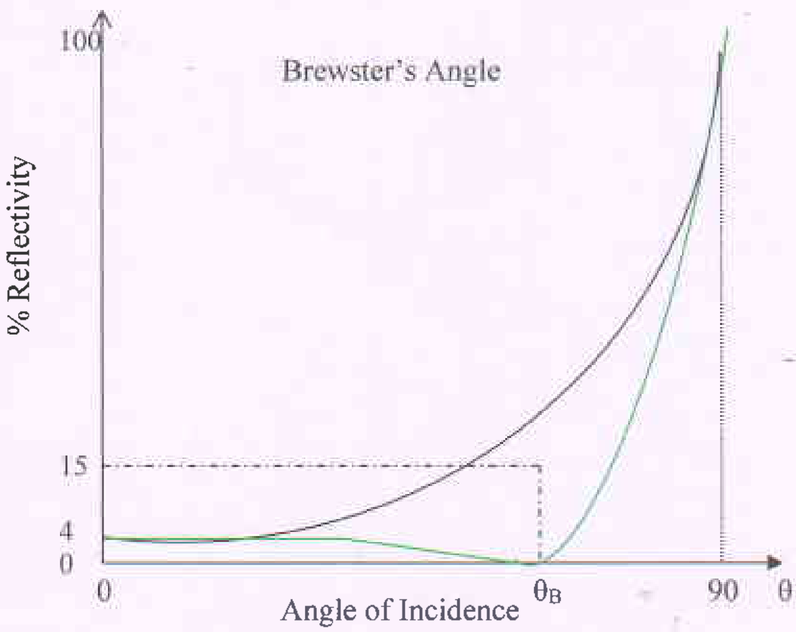

Fig. 1

Theory:

When natural or randomly polarized light reflect off a nonconducting surface, it is partially polarized parallel to the plane of the reflective surface. There is a specific angle called "Brewster angle" at which the light is 100% polarized. This occur if the reflected and refracted beam are perpendicular to one another ($\alpha + \beta = \pi/2$) as shown in Fig. 2, in that case the reflected light beam is polarized.

According to Snell's Law of reflection

When the angle of incident is equal to Brewster's angle.

$$\text{Sin}\,\alpha = \mu\,\text{Sin}\,\beta$$
$$= \mu\,\text{Sin}\,(\pi/2 - \alpha) = \mu\,\text{Cos}\,\alpha$$

Thus $\mu = \tan\alpha$ .... (1)

Where μ is the refractive index of the reflecting material and can be calculated using Eqn.(1)

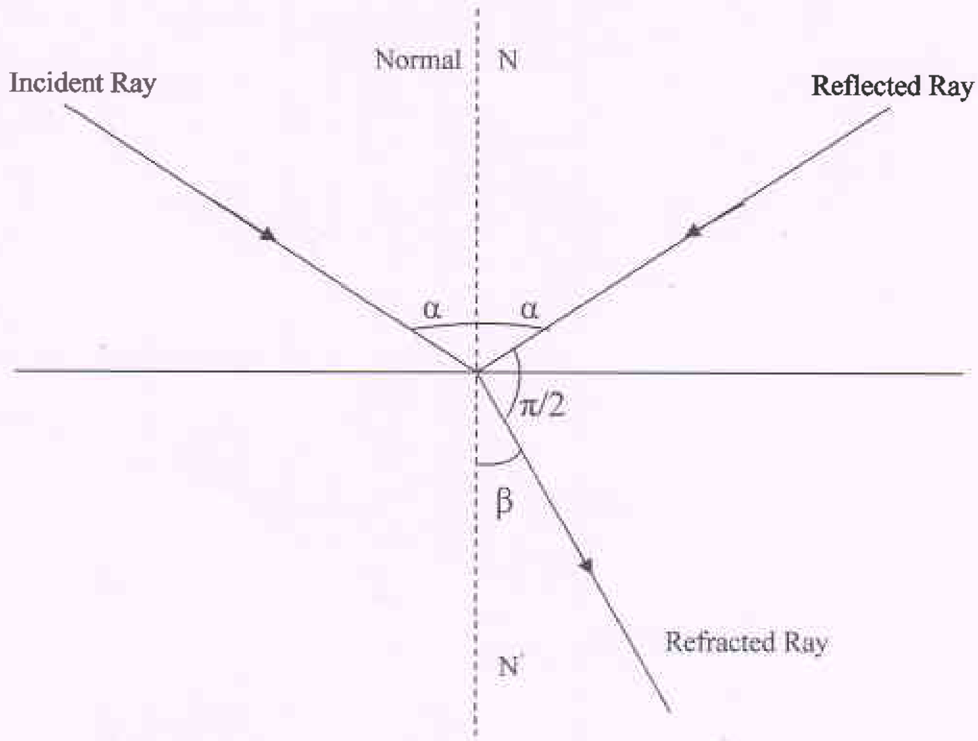

Fig. 2

OBJECT: To determine the Brewster angle/Polarizing angle of a light beam reflected from glass and to determine the reflecting index of the glass plate.

Equipments Used: Rotational circular table fitted with optical rail on movable arm with one post and one X-Z stage , Analyzer , Detector , Prism table , Glass plate/Mica plate and holder, Randomly polarized Helium Neon Laser with stand, digital microameter,

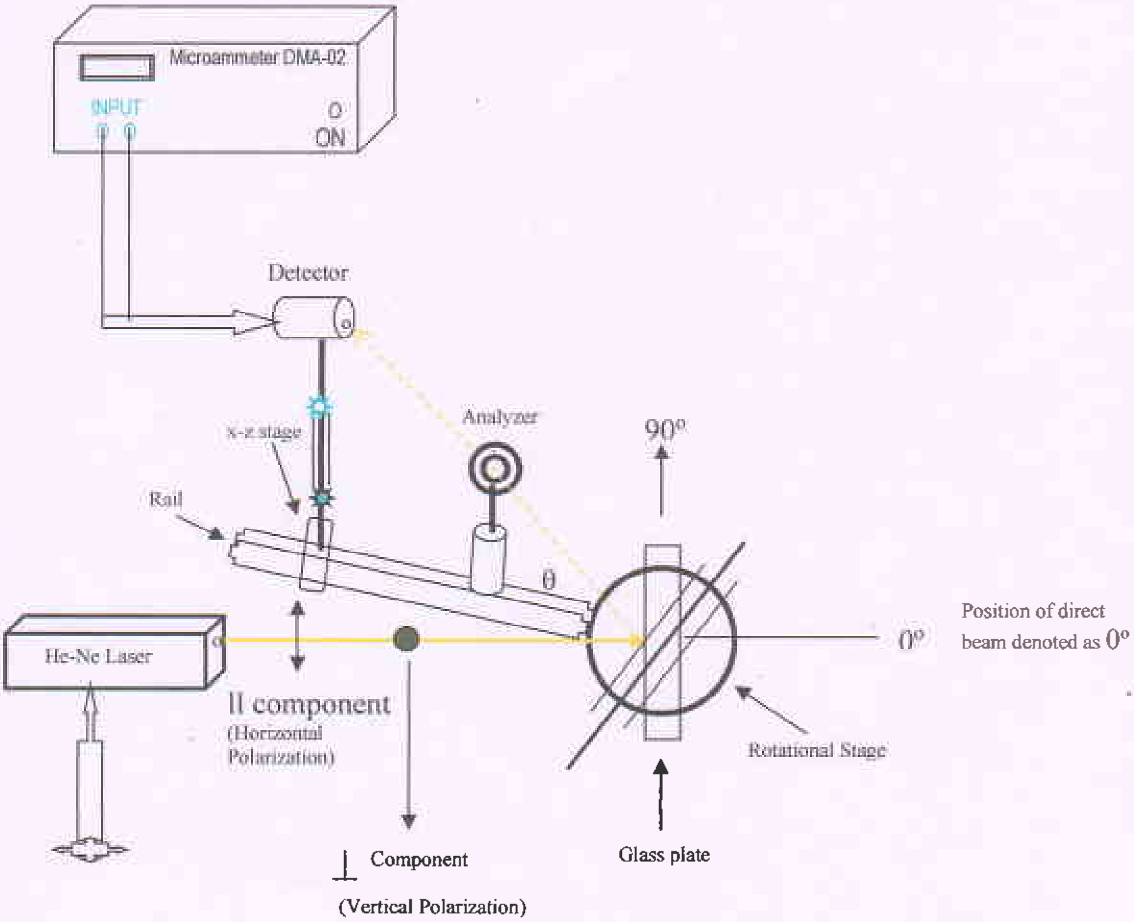

Fig. 1 Set-up To Measure Brewster's Angle

Method:

1. Set-up the system as shown in Fig.1 keeping the rail at 180° from the laser beam i.e. in-front of direct laser beam. Put glass plate on the prism table and be sure the glass or reflecting plate is vertical and centered over the axis of rotation of the rotation stage. Align laser beam, polarizer and detector to get the maximum deflection in the microammeter in this position the laser beam strike the reflecting material at normal incidence, so the reflecting beam goes back into the laser aperture. Read the position of rotation stage and denote it as 0° and note the microammeter reading.

2. Darken the room as much as possible. If there is measurable ambient light, you will need to subtract the ambient light power from each measurement.

3. Starting at normal incidence, slowly rotate the glass plate from 0° to 90° and measure and record the microameter reading of the reflected beam (P ll) at 5° intervals. As it is not possible to measure the reflection at 0° ,but measure the reflection at as small as incident angle is possible. Take measurement at a interval of 2° between the angles of 50° to 70° . these readings in table as shown below. You should notice that at a certain anble there will be little or no reflected light. Note reading carefully " Brewster angle"

4. Plot graph between light intensity in terms of uA and angle AS SHOWN IN Fig. 5. The curve exhibits a significant minimum at angle $\varphi = 68°$.

Observations and Tabulations Table-1

S. No.	Rotation table readings in degrees	Microammeter readings for minimum Intensity in uA.
1.	0.0 (Direct reading)	200
2.	10	...
3.	20	...
4.	30	44
5.	40	26
6.	50	8.6
7.	60	2.6
8.	70	0.18
9.	80	1.2
10.	90	2.4
11.	100	3.5
12.	110	6.0
13.	120	8.0
14.	140	12.0
15.	150	14.0

Calculation:

From graph the minimum intensity is at about 68°

Hence	φ	$= 68^\circ$
And polarizing angle	α	$= (90 - \varphi/2)$
		$= (90 - 68/2)$
		$= (90 - 34)$
		$= 56^\circ$
Hence the refractive index	μ	$= \tan \alpha$
		$= \tan 56$
		$= 1.48$

RESULTS:

1. The polarizing angle as obtained from graph is = 56°
2. The refractive index of the material of glass used = 1.48

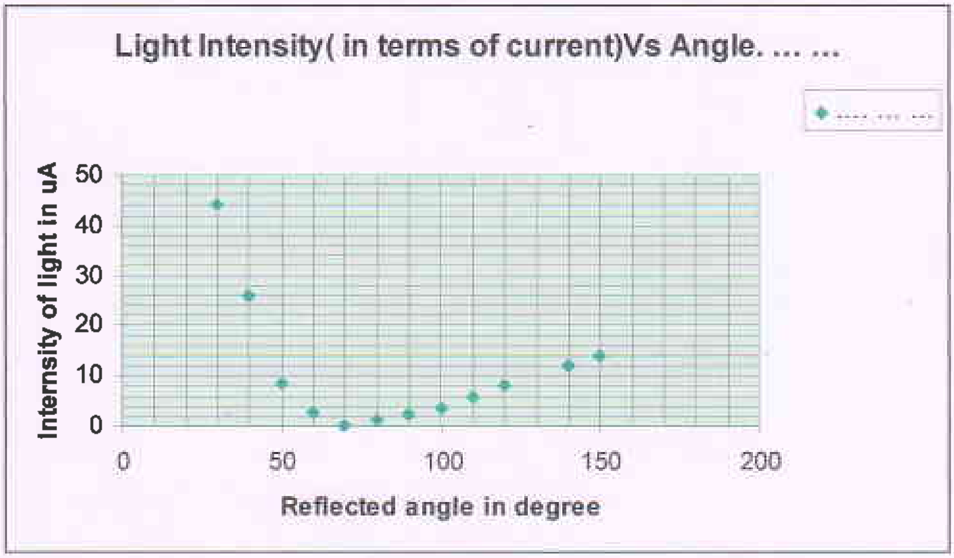

Fig. 5

Brewster's Angle Set-up

Observations and Tabulations Table-1

S. No.	Rotation table readings in degrees	Microammeter readings for minimum Intensity in uA.
1.	**0.0 (Direct reading)**	**180**
2.	10	...
3.	20	...
4.	30	99
5.	40	317
6.	50	62
7.	60	243
8.	70	205
9.	80	140
10.	85	102
11.	90	80
12.	95	60
13.	100	32
14.	105	11
15.	110	1.7
16.	115	09
17.	120	40
18.	125	115
19.	130	203
20.	140	331
21.	150	368

Calculation:

From graph the minimum intensity is at about 70° (180°-110°)
(Direct beam position – Minimum beam Intensity Position)

Hence $\varphi = 70^\circ$

And polarizing angle $\alpha = (90 - \varphi/2)$
$= (90-70/2)$
$= (90-35)$
$= 55^\circ$

Hence the refractive index $\mu = \text{Tan } \alpha$
$= \text{Tan } 55$

= 1.43

RESULTS:

1. The polarizing angle as obtained from graph is = 55°
2. The refractive index of the material of glass used = 1.43