

# Reflection From a Dielectric

The intensity of the light reflected from the surface of a dielectric depends upon the index of refraction of the material, the polarization of the light, and the angle of incidence. Your goals are to measure the index of refraction of a sample of plastic by determining Brewster's angle, to measure the reflection coefficients for the TE and TM polarizations as a function of the angle of incidence, and to compare these latter data to theoretical predictions.

## Before You Come to Lab

Review the theoretical treatment of reflection and transmission at oblique incidence in Griffiths, Section 9.3.3.

### I) Apparatus

The apparatus consists of a diode laser, a rotating Polaroid filter, a rotating table supporting a slab of black plastic, and a rotating arm carrying a photodiode for making the measurements of the reflected light. The output current from the photodiode (which is proportional to the corresponding light intensity) is converted to a voltage by a "transimpedance" amplifier, and the voltage signal is measured using a digital multimeter.

This lab will allow you to acquire very precise data if you are careful. Alignment of the apparatus is critical, but some components, especially the diode laser, are prone to move around -- be very careful not to bump anything once you have started to take data. The photodiode will saturate if it is exposed to too much light.

The laser, rotating table, and the plastic slab must be adjusted so the laser beam goes neatly through both the entrance slit ahead of the plastic and the aperture in front of the detector, regardless of the detector angle.

### II) Brewster's Angle

Find Brewster's angle by adjusting the angle of rotation of the Polaroid to get the TM mode and the angle of the detector to get minimum intensity. You may find it helpful to use an iterative process in which you minimize the intensity by alternately adjusting the angle of incidence and the plane of polarization until the reflection is as close to zero as possible. This process of finding Brewster's angle also results in setting the angle of the Polaroid in one of the two directions that you need for the reflection coefficient measurements.

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### III) Reflection Coefficient Measurements

Check the zero point on the digital meters, and remember to re-check if you change scales. Measure the reflected intensity for the first polarization over as large a range of angles as possible. Then rotate the Polaroid to the other polarization and take the other set of data. (Can you think of a clever and accurate way to make this rotation? Hint: You have a second Polaroid.)

### IV) Comparison with Theory

Calculate the theoretical values of the reflection coefficients  $R_{TE}$  and  $R_{TM}$  using Fresnel's equations (below) and make plots showing your data and the corresponding theoretical curves. You may find it easiest to use Microsoft Excel for your plotting and analysis. You should normalize your experimental results in order to obtain the best possible agreement with the theoretical curves.

$$R_{TE} = \left[ \frac{\cos \theta - \sqrt{n^2 - \sin^2 \theta}}{\cos \theta + \sqrt{n^2 - \sin^2 \theta}} \right]^2$$

$$R_{TM} = \left[ \frac{-n^2 \cos \theta + \sqrt{n^2 - \sin^2 \theta}}{n^2 \cos \theta + \sqrt{n^2 - \sin^2 \theta}} \right]^2$$

R.R.C. 2/26/83

S.J.H. rev. 1/16/91

R.R.C. rev. 3/9/94

C.E.C. rev. 5/19/95