Calibrating the 3D Printed Rotating Polarizer Mounts

Calibration of the 3D printed rotating polarizer mount involves manually scribing azimuth angle graduations on the circular wall protruding from the gear in which a polarizer is mounted (Fig. 1). The critical polarizer element azimuth angles for use with the 3D printed RAE are $0, +45, 90, \text{and} -45$ degrees relative to the plane of incidence. The plane of incidence is perpendicular or normal to the sample surface, which is vertical when using the 3D printed linear sample mount (Fig. 2). The azimuth angles of 0 and 90 degrees are synonymous with the parallel (*p)* and perpendicular (*s*) polarization planes respectively. The calibration of rotating polarizer mounts is outlined through two methods:

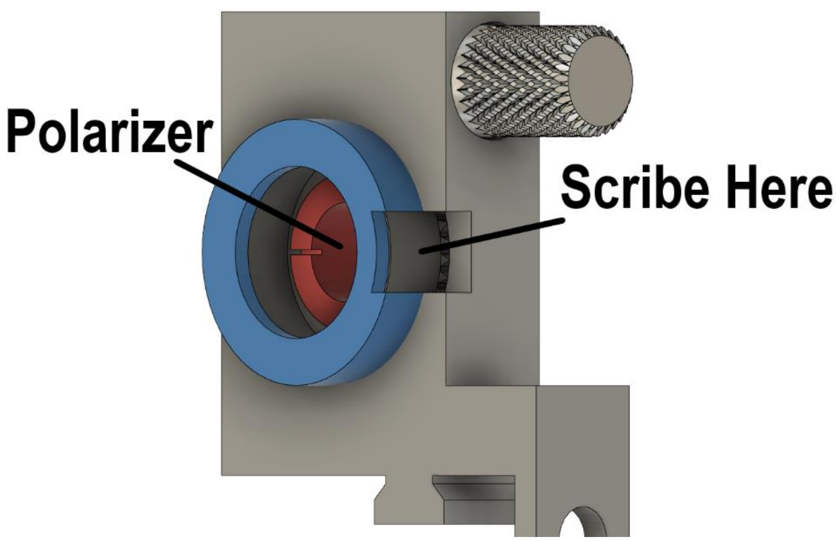

Figure 1 Rotating polarizer mount.

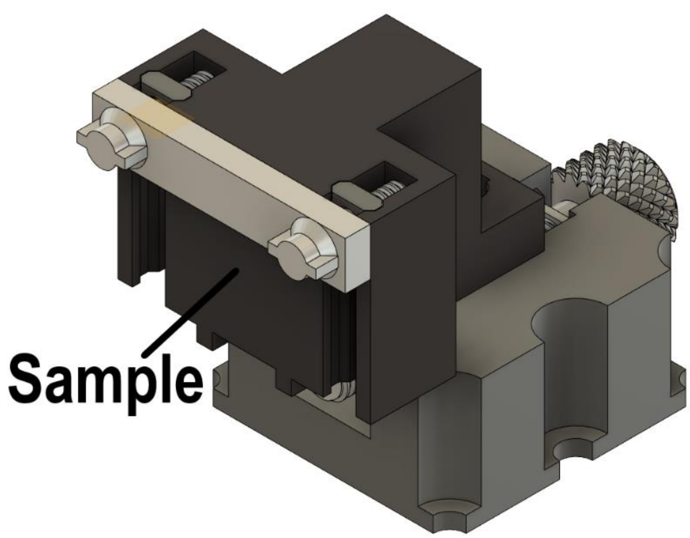

Figure 2. Linear sample mount.

Method 1) Use of a polarizer with known transmission axis:

One can determine the transmission axis of a polarizer by using another polarizer with a known transmission axis in a crossed polarizer configuration. Orient the known polarizer's transmission axis to be parallel (*p*) or perpendicular (*s*) to the instrument plane of incidence, and rotate the unknown polarizer until a null, or minimum light intensity, is measured by eye or a light sensor. At this azimuth angle, the unknown polarizer's axis of transmission is perpendicular to the known polarizer's axis of transmission. Repeat this process to determine both *p* and *s* orientations for the unknown polarizer.

Method 2) Use of a glass slide and the Brewster effect (Fig 3.):

One can calibrate the transmission axis of an unknown polarizer by reflecting light from a glass slide mounted in the linear sample mount of the 3D printed RAE. In this configuration, only one rotating polarizer mount is used in the instrument at a time, either the "polarizer" or "analyzer". Use the indices of refraction for glass (fused/amorphous $\mathrm{SiO_2}$) and the ambient (typically air) at the instrument's incident wavelength to calculate the Brewster angle using eq. 1.

$$\theta_{\mathrm{Brewster}} = \mathrm{atan}\left(\frac{n_{\mathrm{glass}}}{n_{\mathrm{ambient}}}\right)$$

Equation 1. Brewster angle.

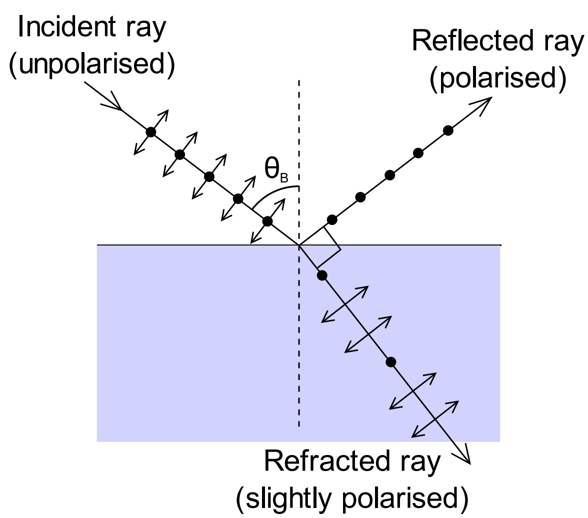

Figure 3. Diagram of the Brewster effect.

Set the RAE angle of incidence to the Brewster angle using the goniometer and reflect the instrument’s light source from the glass slide. Rotate the polarizer element until a null, or minimum light intensity, is measured by eye or a light sensor. At this azimuth angle, the polarizer’s axis of transmission is parallel to the plane of incidence. Repeat these steps with the other rotating polarization mount, and then use them together with method 1 to determine *s* orientations for both polarizers.

The $+45$ and -45 degree polarizer azimuth angles can be estimated by using a protractor indexed against the previously determined *p* (0 degree) and *s* (90 degree) orientations scribed on the rotating mount.

The calibration of both the “polarizer” and “analyzer” elements can be checked against each-other by verifying that transmitted light intensity is minimized under a crossed polarizer configuration for all scribed azimuth angles.