

**OHD L-13
METHOD OF TEST FOR
DETERMINING REFRACTIVE INDEX OF GLASS BEADS**

- I. **SCOPE.** This method covers the procedure and equipment used to determine the refractive index of glass beads by the Becke Line method.
- II. **APPARATUS.** The apparatus shall consist of the following:
- A. **Microscope.**
 - B. **Microscope Slide**, of medium thickness glass, having spherical concavities which are ground and polished and with approximate dimensions of 0.71 in. (18 mm) in diameter and 0.03 in. (0.8 mm) deep.
 - C. **Microscope Illuminator**, with iris diaphragm.
 - D. **Set of Certified Refractive Index Liquids**, covering the refractive index range of beads under examination.
- III. **DISCUSSION.** This test utilizes the principle of light being bent as it passes from a medium with one index of refraction to another medium with a different index of refraction. This bending is not apparent if the different mediums have the same index of refraction.

Three (3) situations are possible when determining the index of refraction of glass beads by the liquid immersion method. They are: Using a refractive index liquid that is too high; using a refractive index liquid that is too low; and using the correct refractive index liquid (i.e., a liquid having the same index as the beads). The following procedure includes descriptions of each of the possible situations listed above.

Chemical microscopists are familiar with a phenomenon that mimics the Sabatier border line. If a tiny crystal is immersed in a liquid and examined under a not-sharply-focussed microscope, a thin band of light outlines the crystal. This band is called the Becke line. The narrow bright halo moves toward the medium of higher refractive index if the focus is raised, and toward the medium of lower refractive index if the focus is lowered. This effect, caused by the refraction of light, is the basis of the Becke line method for determining the refractive indices of microscopic crystals.

- IV. **PROCEDURE.**
1. A small quantity of beads (enough to cover an area about $\frac{1}{8}$ " (3 mm) in diameter with a single layer) is placed in the concavity of the glass slide.
 2. A liquid whose refractive index is known and is near the suspected index of the beads selected. One drop of this liquid is placed in the concavity so as to completely cover the beads.
 3. The light from the microscope illuminator is adjusted so that a limited portion of the bead covered area is illuminated by a dim light from below.
 4. The microscope is initially focused on the beads. The focus is then varied slowly, first one direction, then the other, while closely observing the appearance of individual beads through the microscope. If while adjusting the focus in such a direction so as to decrease the distance between the microscope stage and

the objective lens, a dark ring appears on the circumference of a bead and light concentrates in the center, the liquid used has an index of refraction higher than that of the bead. Adjustment of the focus in the opposite direction shows the bead becoming blurred with no ring and a bright center spot appearing. When this situation is present, the slide is removed and the liquid and beads wiped off.

5. Another layer of beads is placed in the slide concavity and a lower refractive index liquid is used. The microscope is again initially focused on the beads and varied slowly as described in the preceding step. If, in this case, a dark ring and bright center spot appear when the distance between the microscope stage and objective lens is increased, then the liquid used has an index of refraction lower than that of the beads.
6. This evaluation and selection of liquids with different indices of refraction is continued until the correct one is found. When the correct liquid is used, the beads will be almost invisible when perfectly focused and will have a blurred outline when the focus is moved in either direction.

RELIEF

The Becke line results from the concentration of light either inside or outside of the image of the particle, depending on whether the particle or the medium has the larger index of refraction. This refraction of light at the boundaries creates an optical halo perceived as the Becke line. This halo is caused by the concentration of refracted light rays along the edge of the particle. The Becke line will move toward the region with higher index of refraction.

$$n_{\text{glass}} > n_{\text{medium}}$$

$$n_{\text{medium}} = 1.525$$

$$n_{\text{glass}} = 1.60$$

$$n_{\text{glass}} < n_{\text{medium}}$$

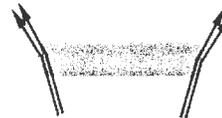
$$n_{\text{medium}} = 1.525$$

$$n_{\text{glass}} = 1.34$$

Becke Line Phenomena



- Glass has higher refractive index
- Becke line seen inside
- Rays converge



- Glass has lower refractive index
- Becke line seen outside
- Rays diverge