

## 12.108 Lab#14:

### Optics II - Determination of Refractive Index for Isotropic Materials

The purpose of this lab is to learn to use refractive index as a determinative tool. Refer to Chapter 5 in Bloss for detailed information on the Becke line method and how Becke lines are produced.

**Note: the immersion oils that you will be using are toxic and must be handled with care. Be sure to wash your hands with soap and water when you are finished.**

1. Refractive index of halite: The Becke line method can be used in conjunction with oils of variable refractive index to determine the refractive index of halite (NaCl). For each question a) through c) below, place a few grains of halite ( $n=1.544$ ) on a glass slide in an immersion oil which has the refractive index ( $n$ ) indicated.

a) Place some halite grains in an immersion oil with  $n=1.50$  ( $n_{\text{oil}} < n_{\text{grain}}$ ).

Describe the movement of the Becke line as you move the stage away from the objective lens, changing to a higher plane of focus. Make a diagram which illustrates the interaction of light with the grain/immersion oil interface, in terms of refraction and reflection, to form the Becke line that you see.

b) Now place some halite grains in an immersion oil with  $n=1.60$  ( $n_{\text{oil}} > n_{\text{grain}}$ ).

Describe the movement of the Becke line as you move the stage away from the objective lens, changing to a higher plane of focus. Make a diagram which illustrates the interaction of light with the grain/immersion oil interface, in terms of refraction and reflection, to form the Becke line that you see.

c) Finally, place some halite grains in an immersion oil with  $n=1.544$  ( $n_{\text{oil}} = n_{\text{grain}}$ ).

Describe the movement of the Becke line as you move the stage away from the objective lens, changing to a higher plane of focus. Make a diagram which illustrates the interaction of light with the grain/immersion oil interface, in terms of refraction and reflection, to form the Becke line that you see.

d) Finish this generalized statement (and memorize it) about the Becke line method:

*“As the stage is moved away from the objective lens, the Becke line always moves toward the medium with the .....refractive index.”*

2. Relief scale: The relief scale consists of a glass slide on which minerals with different refractive indices are mounted in Canada Balsam ( $n=1.540$ ).

a) Draw pictures of all the minerals in the relief scale, emphasizing the relief of each. State the relative relief of each (i.e., high, low, moderate).

b) Using the Becke line method estimate the refractive index for each of the following minerals.

apatite:            orthoclase:            quartz:

beryl:                fluorite:                garnet:

d) Observe each of the minerals under crossed polars. What if anything, happens when you rotate the stage? Which minerals are isotropic, how and why could you tell?

apatite:

orthoclase:

quartz:

beryl:

fluorite:

garnet:

3. Identification of isotropic unknown:

a) Using an immersion oil with  $n=1.5$ , determine whether the sample has a refractive index higher or lower than 1.5.

b) Determine the refractive index of the sample using the Becke line techniques.

c) comment on the morphology of the grains- i.e, random, cleavage, crystal faces; if there is an angular relationship, what is it?

4) Thin sections: This thin section contains garnet, which you observed in the relief scale.

a) what distinctive characteristics help you recognize the garnets in this sample?

c) estimate what percentage of the thin section is garnet.

## Methods for determination of refractive index

**Mounting sample grains:** Sprinkle a very small number of grains onto a clean glass slide. Place a small coverglass on the grains and apply a drop or two of immersion oil to the edge, allowing the liquid to be drawn under the glass by capillary action. Use a wooden stick to push gently on the coverglass, as required to disperse the grains within the liquid.

1. *Relief:* Examples of minerals showing varying amounts of relief, as well as fracture and cleavage. (A) Conchoidal fracture; (B) Cubic cleavage  $\{100\}$ ; (C) Octahedral cleavage  $\{111\}$ ; (D) Rhombohedral cleavage  $\{110\}$  or other oblique cleavage.

2. *Becke line:* Set the microscope at high magnification, with aperture diaphragm closed about halfway, plane-polarized light. Focus image of mounted grains, being careful to avoid a collision between the objective lens and the coverglass. The Becke line is a bright line parallel to the margin of the grain. Use the fine vertical stage adjustment to lower the stage very slowly. Observe movement and color splitting (if any) of the Becke line.