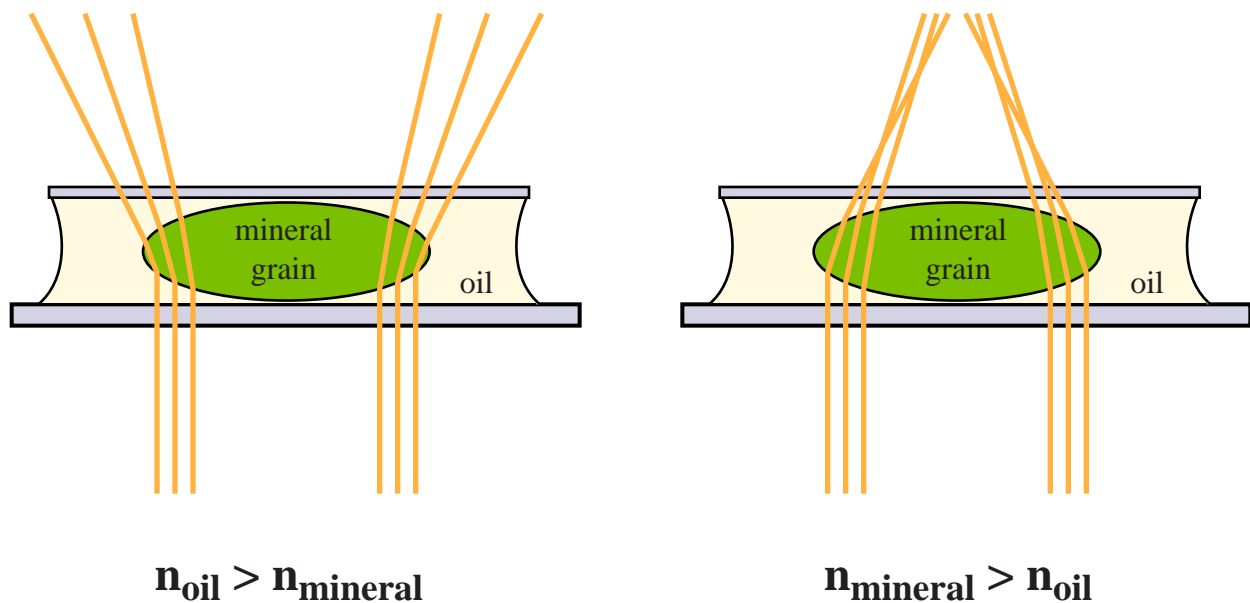


Lecture Notes - Optics 2: Becke Lines, Dispersion

- The refractive index of a cubic (system) crystal or a homogeneous non-crystalline material (such as glass or a fluid) does not vary with the direction of light propagation. Therefore, these substances are **isotropic** with respect to the propagation of light. The single refractive index **n** of an isotropic solid may be determined by observing refraction effects when small grains of the solid are placed in liquids of known refractive indices.
- When small grains of an isotropic solid are placed in a drop of oil under a cover slip on a glass slide, refraction and reflection at the edge of the grains focus the light locally to form a bright **Becke Line** around the mineral grain (see Nesse, Figs. 3.4 and 3.5). Becke lines are most easily seen with the medium power objective of a microscope and with the substage diaphragm mostly closed. The greater the difference in refractive index between the oil and the mineral, the brighter the Becke line and the greater the relief of the mineral. **Relief** is a qualitative measure of the contrast (shadows and Becke lines) between the mineral and the oil caused by refraction and reflection at their interface. When the mineral and oil have the same refractive index, the mineral will be almost invisible in the oil (very low relief) and the Becke line(s) will be faint and colored.
- If the microscope stage is **lowered**, the Becke line will appear to move toward the medium (mineral or oil) that has the higher refractive index. Shadows and bright areas due to **oblique illumination** may also be used to determine relative refractive indices. The refractive index of the isometric mineral is determined by repeated tests using different oils until a refractive index match is obtained.



- The refractive index of most materials varies with the wavelength of light, a property called **dispersion**. Generally, the index of refraction is higher for shorter wavelengths (higher frequencies) of light and decreases monotonically with increasing wavelength. However, some highly colored minerals exhibit **abnormal dispersion** for those wavelengths of light that are strongly absorbed (see Nesse, Fig. 1.11). The coefficient of dispersion is defined as the difference ($n_F - n_C$) between the refractive indices for the F (486 nm) and C (656 nm) Fraunhofer lines (prominent wavelengths in a sunlight spectrum).
- Because the coefficient of dispersion is typically lower for the mineral than for the oil, it is not possible to get a match of refractive indices for all the wavelengths of light simultaneously. When the oil has refractive indices near to those of the mineral, Becke lines for shorter wavelengths (blues) will move into the oil while Becke lines for longer wavelengths (reds) will move into the mineral, as the stage is lowered. This problem can be avoided if monochromatic light source such as a sodium lamp is used. If white light is used, then one tries to find the match for yellow light (n_D where $D = 589$ nm). In this case, a yellowish-orange Becke line will move into the mineral and a pale blue line will move into the oil, as the stage is lowered. See Table 3.1 in Nesse for more information.

