Identification of Uniaxial Crystals

PROPERTIES USED IN IDENTIFICATION

The properties of uniaxial crystals discussed in this chapter are of two kinds, optical and crystallographic. Chief among the optical properties used in identification in immersion mounts are those related to refractive index, optic sign, and color. In thin section, the most useful optical properties are relief, birefringence, and optic sign. Crystallographic properties that are most useful include those related to crystal habit, cleavage, and twinning.

AXIAL CHARACTER

Uniaxial crystals have one optic axis, one direction along which light travels with the same velocity. Crystals of the tetragonal and hexagonal systems are uniaxial. In Winchell and Winchell’s tables of artificial inorganic crystals (1964) about 25 percent of the entries are uniaxial. Larsen and Berman (1934) found that about 21 percent of the 1,700 entries in their tables on nonopaque minerals were uniaxial. In the newer tables of Fleischer et al. (1984), about 23 percent of the 3,300 entries are uniaxial, about 15 percent negative and 8 percent positive. Important rock-forming minerals included in the uniaxial class are quartz, the rhombohedral carbonates, some of the feldspathoids, and many of the accessory minerals in rocks such as zircon, apatite, rutile, corundum, and tourmaline. Some members of the chlorite group are uniaxial and some biotite is uniaxial.¹

¹ Uniaxial crystals may be considered as a group of biaxial crystals in which the angle between the two optic axes is zero for all wavelengths. Chlorite and biotite are normally biaxial, but at some compositions they degenerate to uniaxial character for certain wavelengths.
The uniaxial character of a grain is indicated unequivocally by certain interference figures. The only uniaxial figures that could not be mistaken for biaxial figures are those in which the isogyres form a cross, the center of which remains within the field throughout a complete rotation of the stage. This is a centered or nearly centered optic axis figure. The grains that should be chosen in the search for these typically uniaxial figures can be recognized in an assemblage of diversely oriented grains viewed orthoscopically between crossed polars. They remain dark or almost evenly lighted at all positions of rotation, or have very low interference colors compared with other grains of the same substance of similar thickness.

COLOR, ABSORPTION, AND PLEOCHROISM

Most colored uniaxial crystals show differential absorption of transmitted light related to vibration directions associated with $\epsilon$ and $\omega$. If a different amount of some wavelengths of light is absorbed in different directions of transmission and vibration then the intensity of light in these directions is different. The difference in intensity of light in the two principal directions of vibration is absorption. Absorption is reported by a formula that indicates which vibration direction, $O$ or $E$, has the greater absorption (i.e., transmits the least light). The absorption formula is either $O > E$ or $O < E$. For example, in dravite, the brown magnesian tourmaline, the absorption formula is $O > E$.

If different wavelengths are absorbed in the $O$ vibration direction than in $E$, the color of the crystal will be different when each of these vibration directions is observed separately. The difference in wavelength and intensity of color related to the different vibration directions is pleochroism. Along vibration directions corresponding to values of $\epsilon'$ intermediate between $\epsilon$ and $\omega$ the color is intermediate because the color changes continuously from $O$ to $E$. In uniaxial crystals there are two principal vibration directions and hence in pleochroic uniaxial crystals there are two principal associated colors, so that instead of the general term pleochroism the more restrictive term dichroism is sometimes employed. It is customary to express pleochroism as formulas relating color to the vibration directions associated with the two refractive indices. In dravite, for example, the pleochroism is $O =$ brown, $E =$ light brown.

Recognition of absorption and pleochroic colors depends upon the intensity of the color, which in turn depends upon the thickness of the section and the strength of illumination. Data for minerals usually