INTRODUCTION

The first part of this chapter concerns the general properties of interference figures common to both uniaxial and biaxial crystals. The second part deals solely with uniaxial interference figures. Biaxial figures are treated separately in Chapter 11. Photographs of interference figures can be seen in Figs. 8-1 and 11-2, for example.

An interference figure, also called a “directions image,” is obtained with conoscopic illumination. This utilizes the upper (swing-out) converging lens of the condenser system, and either the Bertrand lens or a direct view of the back focal plane of the objective. The interference figure is the image seen at the back focal plane when the strongly convergent light passes through a birefringent crystal between crossed polars. The vibration directions at the center of the figure are due to light traveling normal to the plane of the object slide, and therefore correspond to the vibration directions in the crystal under orthoscopic observation. All other parts of the interference figure are illuminated by the strongly convergent light passing obliquely through the crystal, and vibration directions in these parts of the figure are therefore associated with oblique wave normals. Specifically, these vibration directions are projections of the vibration directions encountered by each wave normal as it passes through the crystal.

In obtaining an interference figure, an objective of large numerical aperture (equation 2-1) is used, so that a wide-angle cone of oblique rays can enter. This is commonly a high-power objective of 40× or 50× magnification with N.A. = 0.85. The image of the back focal plane is observed either unmagnified, by removing the eyepiece, or magnified, by inserting the Bertrand lens. A pinhole ocular may be used to center the observer’s eye in the former case; a pinhole diaphragm may be used to restrict the image to a small grain in the latter.
case. The conoscopic field may need to be filled by slightly raising the focus from that of the orthoscopic image.

Emile Bertrand in 1878 was the first to use a lens in the tube of the polarizing microscope to see and measure interference figures, although such a lens had been advocated for the independent conoscope by Amici as early as 1844. The trick of seeing an interference figure by merely removing the eyepiece is due to Lasaulx (also in 1878) and is often called the Lasaulx method. Historical references to the study of interference figures may be found in Johannsen (1918).

GENERAL PROPERTIES OF INTERFERENCE FIGURES

Isogyres

All interference figures consist of one or more black bars, which are known as isogyres. The remaining area of the field is colored by interference colors, very often gray or white. The isogyres are bands of extinction in the interference figure. They are formed where the vibration directions in the figure are parallel to those of the polars, which are usually set N–S and E–W. The form and position of the isogyres in the interference figure depend upon the orientation and axial character of the grain. Rotation of the grain (with the stage) usually changes the form of the isogyres, because in almost all instances such rotation changes the orientation of the vibration directions in the grain relative to those of the polars.

Color Curves

With crystals of sufficiently large thickness or birefringence, the interference colors seen in the interference figure are higher than white or gray, and these may form color curves (isochromatic curves, color bands, isochromes). The color at each point in a color curve is the result of the retardation (phase difference) of the two plane polarized components that are propagated along the same oblique path. Any one curve is the locus of all points, in the figure, of equal retardation. The form and position of the color curves usually change on stage rotation, just as do those of the isogyres.

The origin of isogyres and color curves is discussed more fully below, in connection with the specific types of interference figures to be encountered.