Designation: E175 – 82 (Reapproved 2005)ε1

Standard Terminology of Microscopy[1]

This standard is issued under the fixed designation E175; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the Department of Defense.

ε[1] NOTE—Terms were added editorially in July 2005.

Abbe condenser—see **condenser, Abbe.**

aberration—any error that results in image degradation. Such errors may be chromatic, spherical, astigmatic, comatic, distortion, or curvature of field; and can result from design or execution, or both.

achromatic—literally, color-free. A lens or prism is said to be achromatic when corrected for two colors. The remaining color seen in an image formed by such a lens is said to be secondary chromatic aberration.

achromatic objective—an objective that is corrected chromatically for two colors, and spherically for one, usually in the yellow-green part of the spectrum.

Airy disk—the image of a bright point object, as focused by a lens system. With monochromatic light, it consists of a central point of maximum intensity surrounded by alternate circles of light and darkness caused by the reinforcement and interference of diffracted rays. The light areas are called maxima and the dark areas minima. The distribution of light from the center to the outer areas of the figure was investigated mathematically by Sir George Airy. The diffraction disk forms a basis for determining the resolving power of an ideal lens system. The diameter of the disk depends largely on the aperture of the lens. The diffraction of light causing the Airy disk is a factor limiting the resolution of a well corrected optical system.

analyzer—an optical device, capable of producing plane polarized light, used for detecting the state of polarization.

ångström unit—a unit of linear measure named after A. J. Ångström. It is 1×10^{-10} metres; 1 μm = 10,000 Å. It is generally abbreviated as A. in the United States; elsewhere, it is variously abbreviatedÅ , A., A.U., Å., or ÅU.

angular aperture—see **aperture, angular.**

aperture, angular—the angle between the most divergent rays that can pass through a lens to form the image of an object.

aperture, effective—the diameter of the entrance pupil; it is the apparent diameter of the limiting aperture measured from the front.

aplanatic—corrected for spherical aberration and coma.

apochromatic objective—a lens system whose secondary chromatic aberrations have been substantially reduced. (See *achromatic*).

axis, optical—the line formed by the coinciding principal axes of a series of optical elements comprising an optical system. It is the line passing through the centers of curvature of the optical surfaces.

axis, optic—the direction, or directions in an anisotropic crystal along which light is not doubly refracted.

balsam, Canada—a resin from the balsam fir *Abies balsamea*. Dissolved in xylene, toluene, or benzene it is used as a mountant for permanent microscopical preparations. Its refractive index may vary from 1.530 to 1.545 and its softening point from room temperature to 100°C, these properties varying with age and solvent content. If impure it discolors with age.

Bertrand lens—see **lens, Bertrand.**

bisectrix, acute—in biaxial crystals, that principal axis of the ellipsoid of indexes which bisects the smaller angle between the optic axes.

bisectrix, obtuse—in biaxial crystals, that principal axis of the ellipsoid of indexes which bisects the larger angle between the optic axes.

calcite—a doubly refracting mineral used in the manufacture of polarizing prisms. It is uniaxial negative and in the trigonal diversion of the hexagonal system of crystals. Its indexes are $\varepsilon = 1.486$, $\omega = 1.658$; its hardness is 3 on the Mohr scale and specific gravity 2.711.

Canada balsam—see **balsam, Canada.**

chromatic aberration—a defect in a lens or lens system as a result of which the lens possesses different focal lengths for radiation of different wavelengths.

collimation—the operation of controlling a beam of radiation so that if the light source were a point, the light rays would become parallel. The total bundle of rays diverge as the source size increases.

[1] This terminology is under the jurisdiction of ASTM Committee E41on Laboratory Apparatus and is the direct responsibility of Subcommittee E41.01 on Apparatus.

Current edition approved May 1, 2005 Published July 2005. Originally approved in 1961. Last previous edition approved in 1995 as E175–82(1995). DOI: 10.1520/E0175-82R05E01.

coma—a lens aberration occurring in that part of the image field that is some distance from the principal axis of the system. It results from different magnification in the various lens zones. Extra-axial object points appear as short comet-like images with the brighter small head toward the center of the field (positive coma) or away from the center (negative coma).

compensating eyepieces—those designed for use with objectives such as apochromats in order to correct chromatic aberration.

condenser or condenser lens—a term applied to lenses or mirrors designed to collect, control, and concentrate radiation in an illumination system.

condenser, Abbe—originally a two-lens substage condenser combination designed by Ernst Abbe. It lacks chromatic correction though designed for a minimum of spherical aberration and has only a very low-angle aplanatic cone. It may be rated with a numerical aperture as high as 1.3.

condenser, darkfield—a condenser forming a hollow cone of light with its apex (or focal point) in the plane of the specimen. When used with an objective having a numerical aperture lower than the minimum numerical aperture of the hollow cone, only light deviated by the specimen enters the objective. Objects are seen as bright images against a dark background.

condenser, darkfield, bispheric—a darkfield condenser consisting of a convex spherical reflector mounted concentric with a larger concave reflector. The rays are formed into a diverging cone by the convex reflector. The annular concave reflector then forms a hollow converging cone which is focused on the subject. See **condenser, darkfield.**

condenser, darkfield, paraboloid—a darkfield condenser consisting of a reflecting surface in the form of a segment of a paraboloid of revolution. Parallel rays entering the condenser around the periphery of the central stop are reflected from the curved surfaces and converge at the focus of the paraboloid. See **condenser, darkfield.**

condenser, variable-focus—essentially an Abbe condenser in which the upper lens element is fixed and the lower movable. The lower lens may be used to focus the illumination between the elements so that it emerges from the stationary lens as a large diameter parallel bundle. The field of low-power objectives may thus be filled without removing the top element. At the opposite extreme it can be adjusted to have a numerical aperture as high as 1.3.

critical illumination—see **illumination, critical.**

crystal, birefringent—a pertaining to the use of a microscope.

curvature of field—a property of lens that causes the image of a plane to be focused into a curved surface instead of a plane.

darkfield condenser—see **condenser, darkfield**.

density. optical—logarithm to the vase 10 of the reciprocal of transmittance.

depth of field—the depth or thickness of the object space that is simultaneously in acceptable focus.

depth of focus—the depth or thickness of the image space that simultaneously in acceptable focus.

diaphragm—a fixed or adjustable aperture in an optical system. Diaphragms are used to intercept scattered light, to limit field angles, or to limit image-forming bundles or rays.

disk, Airy—see **Airy disk**.

distance, interpupillary—see **interpupillary distance**.

dry objective—any microscope objective designed for use without immersion liquids.

electromagnetic lens—an electromagnet designed to produce a suitably shaped magnetic field for the focusing and deflection of electrons or other charged particles in electron-optical instrumentation.

electron microscope—see **microscope, electron**.

electron optics—the science that deals with propagation of electrons, as light optics deals with that of light and its phenomena.

eye lens—see **lens, eye**.

eyepiece—the lens system used in an optical for magnification of the image formed by the objective.

eyepiece, parfocal—eyepieces with common focal planes so that they are interchangeable without refocusing.

eyepiece, positive—an eyepiece in which the real image of the object is formed below the lower lens elements of the eyepiece.

filar micrometer or filar eyepiece—an eyepiece equipped with a fiducial line in its focal plane, that is movable by means of a calibrated micrometer screw, in order to make accurate measurements of length.

focus, principal—the point at which a lens focuses an axial object pint. Synonymous with *focal point*.

illumination, critical—the formation of an image of the light source in the object field. (Also known as Nelson illumination)

illumination, Köhler—a method of microscopical illumination, first described by A. Köhler, in which an image of the source is focused in the lower focal plane of the condenser, and the field diaphragm is focused in the specimen plane.

illumination, oblique—illumination from light inclined at an oblique angle to the optical axis.

image—a representation of an object produced by means of radiation usually with a lens or mirror system.

immersion objective—an objective in which a medium of high refractive index is used in the object space to increase the numerical aperture and hence the resolving power of the lens.

interpupillary distance—the distance between the centers of the pupils of the eye. The binocular microscope tubes must be adjustable for this distance.

Köhler illumination—see **illumination, Köhler**.

lens—a transparent optical element, so constructed that it serves to change the degree of convergence or divergence of the transmitted rays.

lens, Bertrand—a small convergent lens placed between objectives and eyepiece. The lens focuses an image of the upper focal plane of the objective on the focal plane of the eyepiece. It is chiefly used with polarized light for inspecting the interference figure. It is also convenient for quickly