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Standard Terminology Relating to Metallography[1]

This standard is issued under the fixed designation E7; 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 U.S. Department of Defense.

1. Scope

1.1 This standard covers the definition of terms, acronyms, and symbols used in ASTM documents related to the field of metallography and metallographic testing. Terms that are only relevant to a particular standard or that are adequately defined in a general dictionary are not defined in this terminology standard.

1.2 This standard includes terminology used in metallographic areas, such as, but not limited to: light microscopy, microindentation hardness testing, specimen preparation, x-ray and electron metallography, quantitative metallography, photomicrography, and determination of grain size and inclusion content.

1.3 This standard may be of use to individuals utilizing standards of Committee E04 as well as by those in need of a general reference source for terminology in the field of metallography.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E45 Test Methods for Determining the Inclusion Content of Steel

E80 Recommended Practice for Dilatometric Analysis of Metallic Materials; Replaced by E 228 (Withdrawn 1986)[3]

E112 Test Methods for Determining Average Grain Size

E175 Terminology of Microscopy (Withdrawn 2019)[3]

E1122 Practice for Obtaining JK Inclusion Ratings Using Automatic Image Analysis (Withdrawn 2006)[3]

3. Significance and Use

3.1 Standards of Committee E04 consist of test methods, practices, and guides developed to ensure proper and uniform testing in the field of metallography. In order for one to properly use and interpret these standards, the terminology used in these standards must be understood.

3.2 The terms used in the field of metallography have precise definitions. The terminology and its proper usage must be completely understood in order to adequately communicate in this field. In this respect, this standard is also a general source of terminology relating to the field of metallography facilitating the transfer of information within the field.

4. Terminology

Abbe condenser—see **condenser, Abbe**. **(E175)**

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. **(E175)**

absorption—the decrease in intensity which radiation undergoes during its passage through matter when the ratio of transmitted or reflected luminous flux to incident is less than 1.

absorption coefficient—specific factor characteristic of a substance on which its absorption radiation depends. The rate of decrease of the natural logarithm of the intensity of a parallel beam per unit distance traversed in a substance. For X-rays, the linear absorption coefficient is the natural logarithm of the ratio of the incident intensity of an X-ray beam incident on unit thickness of an absorbing material to the intensity of the beam transmitted. If I_e is the incident intensity of a beam of X-rays, I_t the transmitted intensity, and X the thickness of the absorbing material, then:

$$I_t = I_e exp(-\mu X) \quad (1)$$

Here μ is the linear absorption coefficient. The mass absorption coefficient is given by μ/ρ where ρ is the density.

absorption edge—an abrupt change in absorption coefficient at a particular wavelength. The absorption coefficient is always larger on the short wavelength side of the absorption edge.

absorption limit—See **absorption edge.**

[1] This terminology is under the jurisdiction of ASTM Committee E04 on Metallography and are the direct responsibility of Subcommittee E04.02 on Terminology.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

accelerating potential—a relatively high voltage applied between the cathode and anode of an electron gun to accelerate electrons.

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. See **apochromatic objective**

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

achromatic objective lens—an objective lens with longitudinal chromatic correction for green and blue, and spherical chromatic correction for green. Note—Lens should be used with a green filter.

acid extraction—See **extraction.**

air-lock—an intermediate enclosed chamber of a vacuum or pressure system through which an object may be passed without materially changing the vacuum or pressure of the system.

airy disk—the image of a bright point object, as focused by a lens system.

DISCUSSION—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. **(E175)**

alignment—a mechanical or electrical adjustment of the components of an optical device in such a way that the path of the radiating beam coincides with the optical axis or other predetermined path in the system. In electron optics there are three general types:

(*1*) *magnetic alignment*—an alignment of the electron optical axis of the electron microscope such that the image rotates about a point in the center of the viewing screen when the current flowing through a lens is varied.

(*2*) *mechanical alignment*—a method of aligning the geometrical axis of the electron microscope by relative physical movement of the components, usually as a step preceding either magnetic or voltage alignment.

(*3*) *voltage alignment*—a condition of alignment of an electron microscope such that the image expands or contracts symmetrically about the center of the viewing screen when the accelerating voltage is changed.

allotriomorphic crystal—a crystal whose lattice structure is normal, but whose outward shape is imperfect since it is determined to some extent by the surroundings; the grains in a metallic aggregate are allotriomorphic crystals.

alloy system—a complete series of compositions produced by mixing in all proportions any group of two, or more, components, at least one of which is a metal.

alpha brass—a solid solution phase of one or more alloying elements in copper and having the same crystal lattice as copper.

alpha iron (Fe)—solid phase of pure iron which is stable at temperatures below 910°C and possesses the body-centered cubic lattice. It is ferro-magnetic below 768°C.

amplifier—a negative lens, used in lieu of an eyepiece, to project under magnification the image formed by an objective. The amplifier is especially designed for flatness of field and should be used with an apochromatic objective.

ampliphan eyepiece— See **amplifier.**

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

angle of reflection: (*1*) *reflection* —the angle between the reflected beam and the normal to the reflecting surface.
(*2*) *diffraction*—the angle between the diffracted beam and the diffracting planes.

Angstrom unit (abbreviation) = A,Å , or *A. U*—a unit of length equal to 10^{-8} cm. This is the standard unit of measurement in X-ray crystallography.

angular aperture—See **aperture, optical.**

anisotropic (replaces anisotropy)—having different values for a property, in different directions.

annealing-twin bands— See **twin bands.**

anode aperture—See **aperture.**

anvil—the base on which objects for hardness test are placed.

anvil effect—the effect caused by use of too high a load or when testing the hardness of too thin a specimen, resulting in a bulge or shiny spot on the under side of the specimen.

aperture, angular—the angle between the most divergent rays that can pass through a lens to form the image of an object **(E175)**

aperture, effective—the diameter of the entrance pupil; it is the apparent diameter of the limiting aperture measured from the front. **(E175)**

aperture, electron:—

anode aperture— the opening in the accelerating voltage anode shield of the electron gun through which the electrons must pass to illuminate or irradiate the specimen.

condenser aperture—an opening in the condenser lens controlling the number of electrons entering the lens and the angular aperture of the illuminating beam. The angular aperture can also be controlled by the condenser lens current.

physical objective aperture—a metal diaphragm, centrally pierced with a small hole, used to limit the cone of electrons accepted by the objective lens. This improves image contrast since highly scattered electrons are prevented from arriving at the Gaussian image plane and therefore can not contribute to background fog.

aperture, optical—the working diameter of a lens or a mirror.