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Standard Terminology Relating to Thermophysical Properties¹

This standard is issued under the fixed designation E 1142; 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.

1. Scope

1.1 This is a compilation of terms and corresponding definitions commonly used in the study of thermophysical properties. Terms that are generally understood or defined adequately in other readily available sources are either not included or their sources identified.

1.2 A definition is a single sentence with additional information included in a *Discussion*. It is reviewed every five years, and the year of the last review or revision is appended.

1.3 Definitions identical to those published by another standards organization or ASTM Committee are identified with the abbreviation of the name of the organization or the identifying document and ASTM Committee; for example, ICTA is the International Confederation for Thermal Analysis.

1.4 Definitions of terms specific to a particular field (such as *dynamic mechanical measurements*) are identified with an italicized introductory phrase.

2. Referenced Documents

2.1 ASTM Standards:

D 2160 Test Method for Thermal Stability of Hydraulic Fluids²

D 4092 Terminology Relating to Dynamic Mechanical Measurements on Plastics³

E 7 Terminology Relating to Metallography⁴

E 473 Terminology Relating to Thermal Analysis⁵

3. Terminology

3.1 Terms and Definitions:

admittance, Y— the reciprocal of impedance.

alpha (α) loss peak—*in dynamic mechanical measurement*, first peak in the damping curve below the melt, in order of

decreasing temperature or increasing frequency, (D 4092, D-20), (1988).

angular frequency, ω—the number of radians per second traversed by a rotating vector that represents any periodically varying quantity.

DISCUSSION—Angular frequency, ω, is equal to two π times the frequency, f.

arrhenius equation—a mathematical relationship between the specific reaction rate and the temperature given as

$$k = Ae^{-E/RT} \quad (1)$$

where:

k is the reaction rate constant, *A* is the frequency factor, *E* is the energy of activation, *R* is the gas constant, and *T* is the absolute temperature, (1990).

beta (β) loss peak—*in dynamic mechanical measurement*, second discrete peak in damping curve below the melt, in order of decreasing temperature or increasing frequency, (D 4092, D-20), (1988).

boiling pressure—at a specific temperature, the value of the vapor pressure of the liquid at which it is equal to the external pressure, (1988).

boiling temperature—at a specific pressure, the temperature at which the vapor pressure of the liquid is equal to the external pressure, (1988).

capacitance—that property of a system of conductors and dielectrics that permits the storage of electrical charge when a potential difference exists between the conductors.

DISCUSSION—Capacitance is the ratio of a quantity of electric charge, *Q*, to a potential difference, *V*. A capacitance value is always positive. The unit of capacitance is the farad, F, which is equivalent to one coulomb per volt.

Celsius—designation of the degree on the International Practical Temperature Scale; also used for the name of the scale, as “Celsius Temperature Scale.” Formerly (prior to 1948) called “Centigrade.” The Celsius temperature scale is related to the International Kelvin Temperature Scale by the equation $T_c = T - 273.15\text{K}$, (1988).

Centigrade—see **Celsius**.

coefficient of expansion— see **coefficient of linear thermal expansion**.

¹ This terminology is under the jurisdiction of ASTM Committee E37 on Thermal Measurements and are the direct responsibility of Subcommittee E37.03 on Nomenclature and Definitions.

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² *Annual Book of ASTM Standards*, Vol 05.01.

³ *Annual Book of ASTM Standards*, Vol 08.02.

⁴ *Annual Book of ASTM Standards*, Vol 03.01.

⁵ *Annual Book of ASTM Standards*, Vol 14.02.



coefficient of linear thermal expansion, α —change in length, relative to the length of the specimen, accompanying a unit change of temperature, at a specified temperature, (1988).

coefficient of volume thermal expansion α_v —for a solid or liquid, the change in volume, relative to the volume of the specimen, accompanying a change of temperature at a specified temperature, (1988).

color temperature—temperature in degrees Kelvin (K) at which a black body must be operated to give a color equal to that of the source in question, (1988).

complex modulus, E^* , G^* , or K^* —ratio of the stress to strain where each is a factor that may be represented by a complex number as follows: $E^* = E' + iE''$, $G^* = G' + iG''$, and $K^* = K' + iK''$.

where:

E^* = complex modulus, measured in tension or flexure,

E' = storage modulus, measured in tension or flexure,

E'' = loss modulus, measured in tension or flexure,

G^* = complex modulus, measured in shear,

G' = storage modulus, measured in shear,

G'' = loss modulus, measured in shear,

K^* = complex modulus, measured in compression,

K' = storage modulus, measured in compression

K'' = loss modulus, measured in compression, and

$i = \sqrt{-1}$, measured in compression.

The complex modulus may be measured in tension or flexure, (E^*), compression, (K^*), or in shear, (G^*), (D 4092, D-20), (1988).

complex shear compliance, J^* —reciprocal of complex shear modulus, where $J^* = 1/G^*$, (D 4092, D-20), (1988).

complex tensile compliance, D^* —reciprocal of complex tensile modulus, where $D^* = 1/E^*$, (D 4092, D-20), (1988).

composition—quantity of the components of a mixture; usually expressed in terms of the weight percentage, or the atomic percentage of each of the components in the mixture, (E 7, E-4), (1988).

conductivity, electrical (volume), σ —the ratio of the current density ($A \cdot cm^{-2}$) through a specimen to the potential gradient (V/cm) in the same direction as the current.

DISCUSSION—Conductivity is normally expressed in units ($ohm \cdot cm$)⁻¹, but the correct SI units are Siemen-m.

congruent phases—those states of matter of unique composition that co-exist at equilibrium at a single point in temperature and pressure; for example, the two coexisting phases of a two-phase equilibrium (E 7, E-4), (1988).

congruent transformation—an isothermal, or isobaric, phase change in which both of the phases concerned have the same composition throughout the process; the order of a system becomes unary at a composition of congruency, (E 7, E-4), (1988).

constitutional diagram—graphical representation of the compositions, temperatures, pressures, or combinations thereof at which the heterogeneous equilibria of a system occur, (1988).

cooling curve—graphical representation of specimen temperature or temperature change as a function of time or decreasing environment temperature, (1988).

cooling rate—average slope of the time-temperature curve taken over a specific time and temperature interval as the temperature is decreased, (1988).

critical curve—in a binary, or higher order, phase diagram, a locus of points along which two or more phases exist in stable thermodynamic equilibrium.

critical point—in a binary phase diagram, that specific value of composition, temperature, pressure, or combinations thereof at which the phases of a heterogeneous equilibrium become identical, (1989).

critical pressure—that pressure at the critical point; (1990).

critical surface—in a ternary or higher order phase diagram, the area upon which the phases in equilibrium become identical, (E 7, E-4), (1988).

critical temperature—that temperature at the critical point, (1990).

crystal—solid composed of atoms, ions, or molecules, arranged in a pattern which is periodic in three dimensions, (E 7, E-4), (1988).

crystallinity—regular arrangement of the atoms of a solid in space, (1988).

DISCUSSION—In most materials, this state is usually imperfectly achieved. The crystalline regions (ordered regions) are submicroscopic volumes in which there is more or less regularity of arrangement of the component molecules.

crystallite—crystalline grain not bounded by habit planes, (E 7, E-4), (1988).

crystallization—arrangement of previously disordered material segments of repeating patterns into geometric symmetry, (1988).

crystallization temperature—that temperature at which a specimen undergoes crystallization upon cooling, (1988).

Curie point—see **Curie temperature**.

Curie temperature—temperature above which a ferromagnetic or ferroelectric material becomes paramagnetic, or paraelectric, respectively (1997).

DISCUSSION—There may be more than one if there are multiple materials.

damping—loss in energy, dissipated as heat, that results when a material or material system is subjected to an oscillatory load or displacement, (D 4092, D-20), (1988).

devitrification—crystallization of an amorphous substance, (E 7, E-4), (1988).

dielectric constant— see **permittivity, relative**.

dielectric dissipation factor, D —the ratio of the loss factor, ϵ'' , to the absolute permittivity, ϵ' , or

$$D = \epsilon''/\epsilon' \quad (2)$$

DISCUSSION—The dielectric dissipation factor is numerically equal to the tangent of the dielectric loss angle and may be referred to as the loss tangent, $\tan \delta$, or the cotangent of the phase angle, θ .

dielectric loss angle—the angle whose tangent is the dissipation factor or $\arctan \epsilon''/\epsilon'$.

DISCUSSION—It is also the difference between 90 degrees and the phase angle.

differential thermocouple— see **differential thermopile**.

differential thermopile—a number of



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