

APPENDIX 5

GLOSSARY

Every field of human endeavor has its own specialized vocabulary. Common words are often used in a sense which is unfamiliar to those outside the field of specialization. Much of the difficulty of learning a new subject is due to the unfamiliar vocabulary. This is especially true for those not familiar with the language who must rely upon a dictionary which is usually of little help.

The definitions below explain the meaning of the words or terms as they are used in the field of applied piezoelectricity.

activity — A qualitative measure of the amplitude of the vibration of the quartz resonator when operated in a particular oscillator circuit.

activity dip — A decrease in the activity associated with a change of temperature of a crystal unit.

amplitude-frequency effect (also AF effect) — The change in the frequency of a quartz crystal unit with the amplitude of the drive level.

AT-cut — A plate cut from a crystal of quartz in such a way that the plate contains the *X*-axis and makes an angle of about $35\frac{1}{4}^{\circ}$ with the optic axis on the *r* side.

aging — The change of frequency or other characteristics of a quartz crystal unit with the passage of time.

alpha quartz — The crystalline form of SiO_2 at temperatures below 573°C .

antiresonance — The frequency at which a parallel combination of reactive elements presents a reactance of zero. The impedance at the antiresonant frequency is usually quite large.

axis — A direction (not a line) in a crystal. The axes are chosen arbitrarily in such a way as to make the description of the physical properties of the crystal as simple as possible.

b mode — The mode of vibration in a doubly rotated crystal plate such as the IT- or SC-cut in which the primary displacement is normal to the face of the plate.

beta quartz — The crystalline form of SiO_2 at temperatures above 573°C .

blank — A plate of quartz usually cut at certain specified angles with respect to the crystalline axes and intended for use in fabricating a quartz resonator.

BT-cut — A plate cut from the quartz crystal in such a way that the plate contains the *X*-axis and makes an angle of about 49° with respect to the optic axis on the *R* side.

c mode — (see *b* mode) The mode of vibration in a doubly rotated crystal plate such as the IT- or SC-cut in which the primary displacement is parallel to the surface of the plate. The frequency of the *c* mode is lower than that of the *b* mode.

contour — (v.) The process of generating spherical surfaces on quartz plates.

(n.) The surface curvature; usually expressed in dipoters.

crystal — A solid body composed of atoms, molecules, or ions arranged in a regular three-dimensional array. (The term is often used interchangeably with *quartz crystal unit*.)

crystal unit — An electric component consisting of a quartz piezoid, electrodes, and a protective cover.

cultured quartz — Crystalline SiO_2 produced in a factory as opposed to natural quartz provided by nature.

Curie temperature — The temperature at which quartz changes from the alpha to the beta phase. The temperature is 573°C at atmospheric pressure.

cutoff frequency — The lowest frequency which can be transmitted by a wave in a given wave guide or acoustic structure.

dimensioning — The process of fabricating a piezoid to a precisely determined set of dimensions for the purpose of avoiding activity dips. Also predimensioning.

dioptr — A term used in the optical industry to measure the magnifying power of a lens. The laps used to generate spherical surfaces on lenses are marked in diopters. The diopter rating of a lens is the reciprocal of its focal length which, for a planoconvex lens, is given by $D = 1/f = (n - 1)(1/R)$. If *R* is the radius of curvature and $n = 1.5$, which is typical for glass, then $D = 1/2R$, where *R* is measured in meters.

energy trapping — A term applied to the application of the cutoff phenomenon in wave guides to suppress undesired modes of vibration in quartz crystal units.

face — One of the natural surfaces which develop on a crystal during the growth process. Also *natural face*.

face shear — A mode of strain in which a square plate is distorted into the shape of a rhombus.

frequency — The number of mechanical vibrations executed in 1 sec measured in Hertz (Hz) = 1 cycle/sec; kilohertz (kHz) = 10^3 Hz; megahertz (MHz) = 10^6 Hz.

IT-cut — A doubly rotated quartz plate in which $\theta \doteq 34^\circ 20'$ and $\phi = 19^\circ 6'$. See Fig. 11.10.

lumbered (bar) — A crystal of (cultured) quartz on which have been cut surfaces which are accurately oriented with respect to the crystallographic axes.

piezoid — A body of some special shape cut from a crystal having piezoelectric properties and used as an electromechanical transducer.

plate-back (v.) The process of reducing the frequency of a piezoid to the desired or nominal frequency by depositing electrodes on its surfaces. plate-back (n.) The amount by which the frequency is reduced.

quartz — Crystalline SiO_2 . Usually refers to alpha quartz.

r face — One of the three smaller faces which occur at the ends of the natural quartz crystal.

R face — One of the three larger faces which occur at the ends of the quartz crystal.

reference edge — The edge of a blank or wafer identified for use in orienting the blank or wafer on the x-ray chuck for making orientation measurements.

reference flat — A flat edge on an otherwise circular blank for use as a reference edge. Called an *X*-flat when perpendicular to the *X*-axis.

resonator — A piece of quartz cut in such a way that it can be excited into mechanical vibration at a certain frequency.

resonator frequency — (1) The frequency of one of the normal modes of a vibrating system; an eigenfrequency. (2) The frequency at which a series combination of reactive elements has a zero reactance. The impedance of a series-resonant circuit is usually low.

rhomb face — One of the *r* or *R* faces on the crystal of quartz.

SC-cut — A doubly rotated quartz plate in which $\theta \doteq 34^\circ 7'$ and $\phi \doteq 21^\circ 56'$. See Fig. 11.10. Also TTC-cut and TS-cut.

seed crystal — The plate or bar on which the crystal of cultured quartz is grown.

spurious mode — One of the undesired modes of vibration of a piezoid. Usually refers to one of the inharmonic overtone modes.

spur — Contraction of *spurious mode*.

swept quartz — Quartz from which certain impurities have been removed by the use of an electric field.

test set — A standardized oscillator used for measuring the parameters of a crystal unit.

twinning — The reversal of the direction of some physical property of a crystal. Optical twinning in quartz occurs when the plane of polarization of light is rotated in opposite directions in parts of the same crystal. Electrical twinning occurs when the direction of the polar axis is reversed in different parts of the same crystal.

wafer — A slab of quartz sawed from the crystal but not yet shaped to form a blank or a resonator.

X-cut — A surface sawed perpendicular to the *X*-axis. Also a plate or wafer cut perpendicular to the *X*-axis.

Y-bar — A cultured crystal of quartz grown in such a way that its long dimension is parallel to the *Y*-axis. Used for cutting AT-, BT-, and SC-cut wafers.

Y-cut — See *X*-cut.

Z-cut — See *X*-cut.

ZZ' angle — The angle between the plane of the blank and the optic axis in quartz.