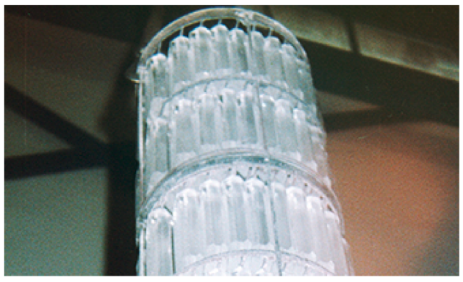
Crystal Industry Innovation

Synthetic Quartz

Introduction



Quartz is a piezoelectric material. A thin wafer of quartz, with electrodes attached to opposing surfaces, vibrates mechanically when voltage is applied to the two electrodes. Frequency of vibration is primarily a function of wafer dimensions. The wafers, called crystal resonators when suitably mounted with electrodes attached, have long been used for controlling frequency of radio transmitters, and it has been an essential component intelecommunication communication equipment where its piezoelectric properties are used in filters, oscillators and other devices. Now quartz crystals time and coordinate signals for microprocessors, computers, programmable controllers, watches, and other digital equipment such as various DSP.

Quartz is a crystalline form of silicon dioxide (SiO_2). It is a hard, brittle, transparent material with a density of 2649kg/m3 and a melting point of 1750° C. Quartz is insoluble in ordinary acids, but soluble in hydrofluoric acid and in hot alkalis. When quartz is heated to 573° C, its crystalline form changes. The stable form above this transition temperature is known as high-quartz or beta-quartz, while the stable form below 573° C is known as low-quartz or alpha-quartz. For resonator applications, only alpha-quartz is of interest and unless stated otherwise the term quartz in the sequel always refers to alpha-quartz. Quartz is an abundant natural material, but considerable labor is required to separate good quality from poor-quality natural quartz. Although silicon (mainly in the form of dioxide, and generally as small quartz crystallites) comprises approximately one third of earth's crust, natural quartz of size and quality suitable for use in devices employing its piezoelectric properties, has been found principally in Brazil. Natural quartz is also costly to process because it occurs in random shapes and sizes.

Moreover, some segments of poor-quality quartz are discovered only after partial processing. And widespread impurities in natural quartz often make cutting of small wafers impractical. The first major step in the development of cultured quartz was in 1936 when the US Army Signal Corps gave a contract to Brush Laboratories under the direction of Drs. Jaffe, Hale, and Sawyer. This was done due to the pending scarcity of natural quartz with good piezoelectric quality, customarily purchased from Brazil.

Today, quartz is now grown artificially to specified dimensions. Crystal orientation is controlled, and purity is uniformly high. Standard sizes reduce the cost of cutting wafers, and impurities are widely dispersed, making possible small

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