Sensors

Sensors of Langasite can be fabricated as bulk wave (BAW) or SAW devices. Tuning fork style sensors allow a very small size. The sensors can be used to measure various physical parameters such as temperature, force, pressure, viscosity, flow, micro-mass etc. up to temperatures of 900 °C or even more.

Please contact AXTAL for your specific requirements.

Oscillators

AXTAL offers Voltage Controlled Crystal Oscillators (VCXO) with a high pulling range of up to ±1500 ppm. For more details please consult the AXIS30 datasheet www.axtal.com.

Low phase noise miniature OCXO are currently under development.

Filters

Discrete wideband filters with Langasite can offer very wide pass bandwidth values of more than 200 kHz. Monolithic LGS filters as two-pole, 4-pole and 6-pole filters with up to 200 kHz bandwidth are available e.g. for GSM and 3G base stations at 71 MHz.
See www.fomos-t.ru for the details.

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AXTAL ADVANCED XTAL PRODUCTS

Buchfinkenweg 8
74931 Lobbach
Germany

Phone + 49 (0) 62 26 - 97 19 689
Fax + 49 (0) 62 26 - 97 01 33
info@axtal.com
www.axtal.com

Technical Information about

Langasite

(LGS)

AXTAL ADVANCED XTAL PRODUCTS

General

Recent progress in the industrial production of new piezoelectric materials such as Langasite („LGS", Lanthanum-Gallium Silicate $La_3Ga_5SiO_{14}$) allows the manufacturing of resonators with interesting properties, which can overcome the limits of quartz crystals in many applications. LGS resonators as well as LGS-based Frequency Control Products are now commercially available from AXTAL as the exclusive representative of FOMOS, the leading manufacturer of Langasite crystal material.

Langasite is grown synthetically by the Czochralski method. The growth time is only a few weeks. Wafers are available with 3" and 4" diameter. LGS crystals can be manufactured in large quantities and at much lower cost than other alternative piezoelectric materials such as $GaPO_4$.

Crystal Properties

Langasite has a significantly higher electromechanical coupling factor k than quartz:

Langasite: $k = 15{,}8\ \%$
Quartz: $k = 7{,}0\ \%$

As the capacitance ratio between motional and static capacitance is proportional to the square of the piezoelectric coupling factor, higher k means much better pullability.

While quartz has a phase transition at 573 °C (Curie temperature), above which it is no longer piezoelectric, LGS does not show any phase transition up to more than 1000 °C, which enables it to be used e.g. as a sensor material in high temperature applications.

Resonators (Bulk wave, BAW)

The most widely used cut for bulk wave resonators is a rotated Y-cut.

The thickness – frequency relationship for thickness-shear mode resonators is

$$t = \frac{N}{f}$$

where t = thickness in mm, f = frequency in kHz. The value of the frequency constant N for Langasite is approximately 1380 kHz·mm, whereas N ≈ 1660 kHz·mm for AT quartz.

Therefore LGS resonators can be realized at lower frequency in smaller size.

However the highest fundamental mode frequency for conventional resonators is lower than for quartz. For a minimum blank thickness of 50 μm, the frequency is about 27 MHz, while it is about 33 MHz for quartz. High Frequency Fundamental (HFF) resonators up to 160 MHz using inverted mesa technology are currently under development.

The frequency vs. temperature response of rotated Y-cut resonators has the shape of a second order parabola

$$\frac{\Delta f}{f} = a_2 \cdot (T - T_{TO})^2$$

where the position of the apex or turn-over temperature T_{TO} can be controlled by the cutting angle and is set to $T_{TO} \approx 25$°C for most applications. The coefficient is $a_2 \approx -0{,}055$ ppm/K^2.

The chart on the right shows the total frequency excursing in ppm for various operating temperature ranges. The lowest curve is the best achievable value at the physical limits. The center curve is for ±1K tolerance of the T_{TO}, and the upper curve is for at T_{TO} tolerance of ±2K, which is more cost effective.

Surface Acoustic Wave (SAW) devices

LGS has already been applied commercially for SAW devices in which wafers of up to 100 mm in diameter are used (see www.fomos-t.ru/English/wafers_e.htm), while materials such as $GaPO_4$ are used only in laboratory scale, due to the lack of available large wafers and due to high material cost.

SAW resonators offer high pullability, which is more than sufficient to compensate the f(T) deviation with still a fairly large margin for the absolute pull range (APR).

As the SAW velocity of LGS is about 14 % smaller than that of quartz, devices at lower frequency are possible at a given size. The temperature coefficient is similar to quartz, while a_2 is about the double.

With the electromechanical coupling for SAW waves being more than twice the value of quartz, SAW filters with wide bandwidth and good temperature stability can be realized.