How Does a Thin Film Monitor Measure Thickness?

A quartz crystal microbalance or QCM thin film monitor uses the piezoelectric effect to generate oscillations in a quartz crystal.

As mass is added to the crystal, the oscillation frequency decreases and a correlation is made to determine thickness change.

How does a thin film monitor work?

A thin film monitor tracks the quartz crystal oscillation at the resonant frequency of the crystal. This frequency is the natural frequency where the crystal vibrates at the highest amplitude. For thin film crystals, this generally occurs at 6 MHz (or six million times per second). The thin film monitor functions as a frequency counter and constantly tracks this resonant frequency as it decreases with the mass accumulation of a deposited/evaporated material on the crystal surface. This changing resonant frequency is then entered as a variable into the Z-match equation to generate a thickness reading.

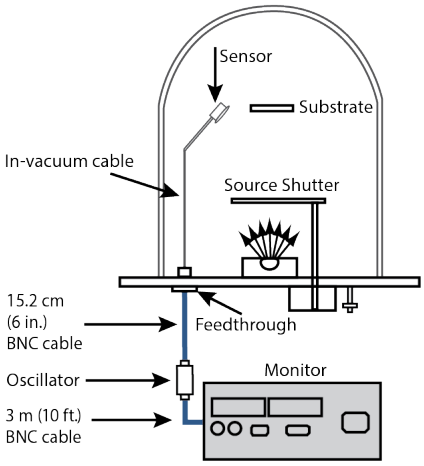
What is an oscillator?

An oscillator is used in a QCM system to drive the crystal at its resonant frequency. The oscillator is located outside the vacuum chamber and is electrically connected to the monitor and the crystal sensor feedthrough. The oscillator applies a quickly changing electrical potential to the crystal, causing the crystal to vibrate. A signal is then sent back to the monitor.

The monitor receives this signal and counts the crystal vibrations each second. This information is relayed to a microprocessor that, using user-defined material properties, calculates:

1. The thickness accumulation rate in Ångström (Å) per second. To give you an idea of the accuracy of this monitor, one hydrogen atom is about 0.5 Å in thickness.
2. The total thickness accumulated since the beginning of the process.
3. The "life" of the crystal. An estimate of how much useful frequency range the crystal has left before the oscillator will no longer be able to drive the crystal due to it becoming too heavily dampened.

The oscillator is a critical part of the QCM system. There are more sophisticated oscillators, such as a ModeLock® Crystal Exchange Unit (XIU), that can provide more features and additional crystal data that can create greater accuracy and longer crystal life.



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