Quartz Crystals Technical Bulletins

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Technical Bulletin No. 1

What Exactly is a Quartz Crystal Sensor?

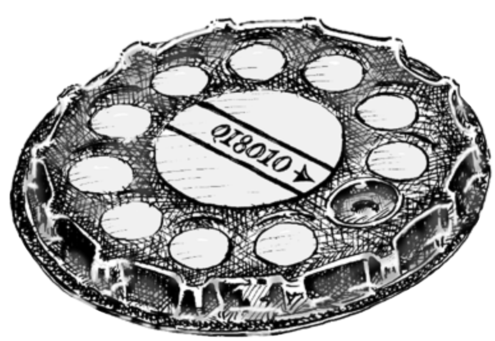
Fil-Tech is a worldwide supplier of replacment quartz crystals for most thin film monitors and controllers.As many film process engineers and operators know, the quartz crystal is the key to a successful deposition run. Quartz crystals open a window on the coating process, reveal the thickness of material deposited on the substrates, and convey the rate, or thickness per second, that is being evaporated. This information is in turn used to control the power supply to the evaporation source allowing precise control of the coating process from beginning to end. When the crystal fails, however, the window abruptly shuts leaving the operator in the dark and potentially terminating the coating run. With such a potentially destructive impact from such a small inconspicuous item, the question must to be asked, "What exactly is a quartz crystal sensor?"

The thin circular crystal that is eventually placed in the sensor head originates as a multifaceted bar of quartz that is shaped like a sparkling six-sided rod. Through a series of machining and milling, the bar is eventually converted to a stack of thin (approximately 10 thousandths of an inch thick) circular wafers. Each wafer is then contoured on one side and cleaned. Finally, the wafer is coated with a thin metal film, edge-to-edge on one side and a pattern on the backside. After final inspection to determine electrical properties, the crystals are packaged in an indexable container and shipped to the end user.

The real mystery, however, is how this thin tiny disc actually works. It was first discovered that certain crystalline materials, like quartz, would develop an electrical charge like a battery, when pressed or squeezed. This property came to be known as the piezoelectric effect (pronounced "pea-a-zo"). Conversely, if a battery were connected to a crystal, the crystal would change by stretching or compressing. If the battery were then turned on and off quickly, in rapid succession, the crystal would vibrate.

In the 1950's, a German scientist named George Sauerbrey, showed that the vibration of a quartz crystal could be slowed down by depositing a thin coating on the crystal's surface. It was found that the change in this vibration or "frequency," was a function of the thickness and the density of the coating. Using sophisticated electronics, this could be calculated many times per second giving a real time measurement of the thickness of coating being deposited on the crystal or any object in its vicinity.

And with that, the thin film monitor was born.



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Technical Bulletin No.2

How Does a Monitor Measure Thickness?

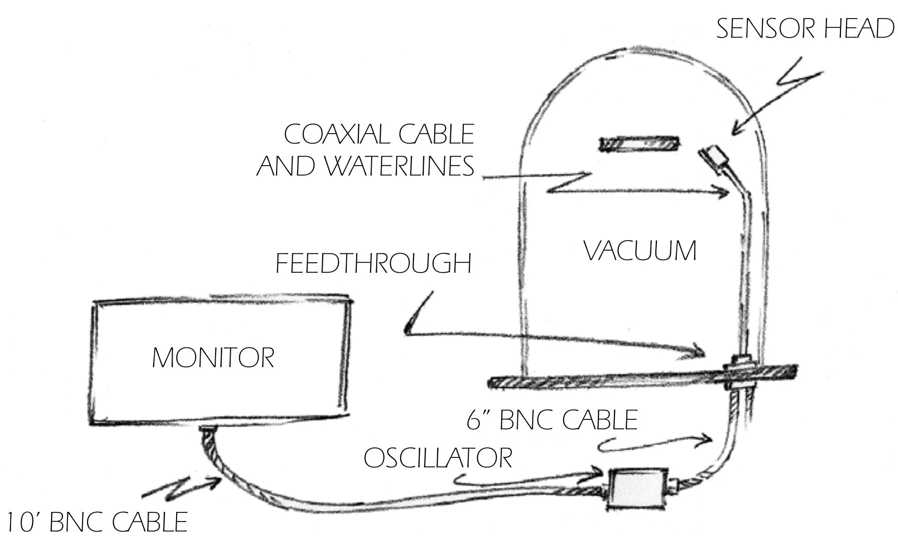
Once a quartz crystal is placed inside a sensor head in a vacuum chamber, the only indication that the crystal is working properly comes from the thin film monitor, or if the process is run automatically, a thin film controller. So, what does a thin film monitor do, anyway?

A thin film monitor uses several electronic components to cause the crystal in the chamber to vibrate at approximately 6 million times per second (or 6 Megahertz), count the change in the number of vibrations per second as the coating deposits on the crystal and, calculate the thickness of the coating from the data it receives. Most monitors can accomplish these tasks many times per second; giving the operator a continuous measurement of how fast the coating is being deposited on the crystal and the substrates in the chamber.

In order to cause the crystal to vibrate at 6 MHz, the monitor uses an "oscillator" which is located outside the vacuum chamber and electrically connected to the monitor and the crystal sensor feedthrough. The oscillator applies a quickly changing electrical charge to the crystal, causing the crystal to vibrate. An electrical signal is then sent back to the monitor.

Circuits inside the monitor receive the electrical signal and count the crystal vibrations each second. This information is relayed to a microprocessor that calculates and displays on the monitor: 1) the coating rate in Angstroms per second; 2) the total thickness coated since the beginning of the process; 3) the "life" of the crystal, a measure of how much the crystal vibrational rate has changed since it was new; and, (4) the total elapsed time since the coating process began. More sophisticated units also show a graphical display of the coating rate versus time, as well as an indication of the film type being deposited.

Many factors can also be programmed into the monitor to allow highly accurate measurement and control of the film coating process. Operators can program: 1) the desired coating thickness or the maximum coating rate; 2) the density of the film being coated; 3) the tooling factor, a correction for the position of the crystal in relation to the position of the parts being coated; and, 4) the "Z" value, or acoustic impedance. (The acoustic impedance only applies when a coating is very thick, more than 10,000 Angstroms, and is a correction for the way the crystal vibrates when a thick film is on it. In most optical coating processes "Z" can be entered as "1".)



TYPICAL SYSTEM

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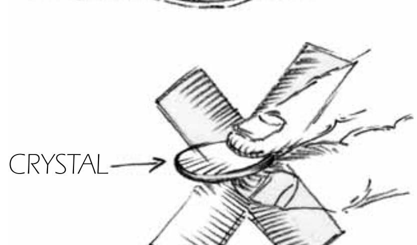
Technical Bulletin No.3

Basic Care and Handling of Quartz Crystals

A quartz crystal is arguably one of the most sensitive electrical devices ever invented. When used for thin film coating measurements, a crystal can detect as little as a picogram or 0.000000000001 gram of deposited material. This corresponds to a coating layer on the order of one atom thick! Quartz is also sensitive to heat, able to respond to temperature changes of less than one-one hundredth of a degree. Furthermore, quartz crystals are sensitive to stress, able to detect the movement when films cool after being deposited on the crystal during a typical optical coating run.

With a device this sensitive operating in high stress coating environments you have to ask, "How can it work?" Our answer is, "Just barely!" A typical antireflective coating with magnesium fluoride, zirconium, or chromium hits the crystal doubly hard with high temperatures in excess of 300 degrees C and high stresses from the film as it cools only the crystal. It is not uncommon to see a crystal act erratically by exhibiting large positive and negative jumps in rate or thickness, after just a few minutes exposure to MgF_2. These materials can also easily destroy a crystal.



NO!

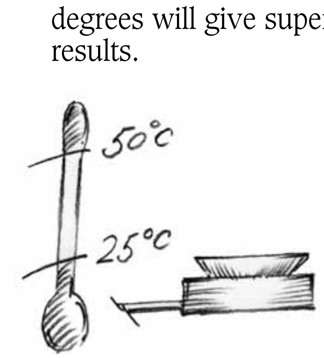
Therefore, in order to get the maximum life out of Fil-Tech's quartz crystals, we recommend the following guidelines:

1) Always use plastic tweezers around the edge of the crystal during handling. Do not touch the center of a crystal, as any oil, dirt, dust or scratches will quickly degrade the ability of the crystal to vibrate.

2) Keep the crystal holder clean. Do not allow flakes of material to come into contact with the center of the crystal, front or back. Any burrs or particulate that come between the crystal and cap will interfere with the electrical contact and develop stress points, affecting the crystal's vibrational pattern.

3) If possible after it is mounted in the cap, blow off the crystal surface with a low-pressure jet of dry, filtered nitrogen or oil-free air. This will remove any dust or flakes of loose coating that may have come in contact with the crystal during installation.

4) In order to promote better film adhesion, maintain the cooling water to the sensor head in the 25 to 50 degree C range. The hotter the deposition, the closer the crystal should run to 50 degrees C. Additionally, whatever your temperature, keeping it stable to within 1-2 degrees will give superior results.



COOLING WATER TO SENSOR HEAD

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Technical Bulletin No.4

Crystal Sensor Head Design and Failure Modes

In order to use a quartz crystal in the coating chamber, a device had to be developed that could be electrically activated to vibrate the crystals in vacuum, allow only a portion of the crystal to be coated with evaporated material, and permit the crystal to be changed easily. Furthermore, the device would have to shield the crystal from the high temperatures inherent in the coating process. Thus, the "sensor head" was created.

In currently available sensor head designs, the crystal rests in the "crystal holder", a metal cap with a hole drilled through the center of the cap. The holder serves as one half of the electrical circuit that causes the crystal to vibrate. This hole allows the evaporating film to coat a circular region of approximately 0.3" diameter (7.6 mm) on the crystal face. The crystal is held in place in the holder by a spring. In some models, the spring is located around the inside of the holder and presses against the crystal edge. In other designs, a "ceramic retainer" with a gold-coated spring in the center presses against the outer back edge of the crystal.

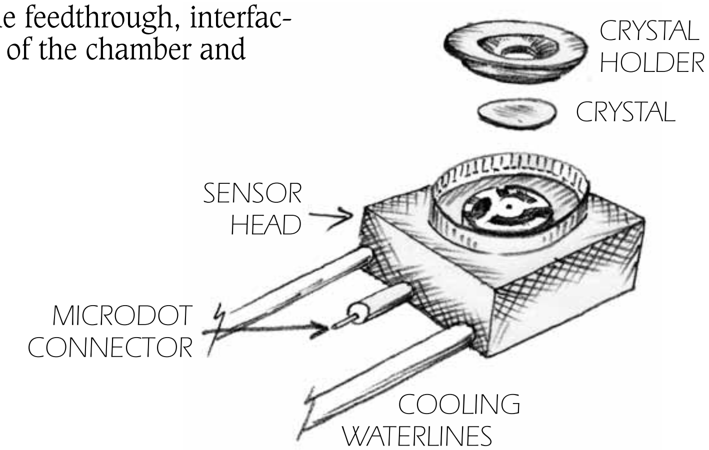
In both designs, the crystal holder is inserted into the sensor head (a small metal block), where a second gold coated spring presses against the back of the crystal or retainer to complete the crystal electrical circuit. The head often contains another spring for holding the crystal holder in place and providing electrical contact between the holder and the head.

On the outside of the sensor head is a screw-on miniature connector, a "Microdot Connector". At this point, a thin microcoaxial (two wires in one body) cable connects the sensor head to the feedthrough, interfacing the inside of the chamber and atmosphere. The feedthrough then connects in atmosphere to the oscillator and on to the thin film monitor.

The sensor head also has two small metal tubes, "water lines", extending from one end to provide water-cooling to the crystal. The water lines feed either an internal passageway drilled through the sensor head or simply connect to a tubing bend that rests in the back of the head. Both water lines connect to the feedthrough.

When new, a sensor head allows easy insertion of the crystal, snug mounting of the crystal holder, uninterrupted electrical connection to the feedthrough, and unimpeded water cooling. After repeated use, however, this system can break down and lead to erratic or failed crystal readings. Several of the most common modes of failure are:

1) The contact springs in the crystal holder or sensor head break or bend sufficiently, interrupting the electrical circuit;
2) The wires inside the sensor head connecting to the microcoaxial cable fitting break, interrupting the electrical circuit;
3) The microcoaxial cable connecting the sensor head to the feedthrough cracks or loosens, interrupting the electrical circuit; or
4) The water lines clog due to high mineral content of the water, causing the sensor head to overheat.



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Technical Bulletin No.5

Effect of Electrode Metal on Quartz Crystal Sensor Performance

The type of metal used for the contact electrode on a quartz crystal has a pronounced effect on the crystal's ability to measure film thickness. As a result, Fil-Tech provides four standard crystal coatings: **Gold, Longer Life Gold, Stress Relieving Alloy, and Silver.**

Gold is the mostly widely known electrode material. It offers low contact resistance, high chemical stability, and is easy to deposit. Typically, gold crystals are used for low-stress metal depositions such as gold, silver, and/or copper. With gold, it is possible to get frequency shifts of up to 1 Megahertz without adverse effects. However, gold electrodes are relatively inflexible, transmitting stresses from deposited films to the underlying quartz. Transmitted stresses may result in frequency jumps and crystal instability.

Stress Relieving Alloy, an aluminum-silver composition, is the best electrode for high-stress material depositions including; silicon monoxide, silicon dioxide, magnesium fluroride, and titatium dioxide. Deposited high-stress materials often cause erratic crystal performance produced by high tensile or compressive stresses. These stresses cause bending of the quartz and subsequent frequency shifts.

Stress Relieving Alloy dissipates the stress of the deposited film by plastic yielding or flowing. Long before the compressive or tensile forces cause the crystal to bend, the electrode will "give," dissipating the stress. This results in a much more stable crystal with a longer period of steady, jump-free oscillation. Laboratory experiments have shown as much as a 400% increase in crystal life with deposited silicon dioxide on Stress Relieving Alloy.

Longer Life Gold crystals are exlcusive to Fil-Tech and offer longer life than standard gold crystals. Fil-Tech's proprietary process for Longer Life Gold combines the low contact resistance and high chemical stability of gold crystals with the plastic yielding qualities of Stress Relieving Alloy crystals to produce a superior, Longer Life Gold crystal. Fil-Tech recommends our Longer Life Gold for anti-reflective coatings and semiconductor processes to dissipate the stresses caused by dielectric and high stress material depositions. Laboratory experiments have shown over 200% increase in crystal life with deposited magnesium fluroride on Longer Life Gold.

Silver is an excellent all-around electrode material. Silver has a low contact resistance and exhibits some degree of plastic yielding. However, silver tends to tarnish in the presence of atmospheric sulfides. Tarnish will increase contact resistance and decrease the adherence of films deposited on the crystal.

RESULTANT STRESS TRANSMITTED BY CRYSTALS TO MONITOR

Gold SILVER STRESS RELIEVING ALLOY

DIELECTRIC AND/OR HIGH-STRESS METAL DEPOSITION

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Technical Bulletin No. 6

Choosing the Best Crystal for Your Coating Process

There are a wide variety of coating technologies available to thin film engineers. In light of this, determining the best crystal for a given process may be difficult. The following is a guideline for the application appropriate crystal:

Fil-Tech Recommends Gold For Low Stress Metalizing

The most common thin film process is the deposition of aluminum, gold, copper, and silver to provide electrical contacts or optical reflectance. These films are relatively free of tensile or compressive stress and are deposited at room temperature. They are soft and easily scratched, but usually do not flake off or damage substrates.

These films can be monitored using gold, Longer Life Gold, silver, or Stress Relieving Alloy electrode crystals. We routinely deposit over 60,000 Angstroms of gold and 500,000 Angstroms of aluminum on 6 MHz crystals before changing to a new crystal. Select the corresponding Fil-Tech crystal for your system:

Fil-Tech Gold	Part No
Inficon	QI8010
Intellemetrics	QI8010F
Sloan	QS3952
Balzers	QB104G

Fil-Tech Recommends Longer Life Gold Or Stress Relieving Alloy For Your High Stress Metalizing

Thin films of nickel, chromium, molybdenum, zirconium, nichrome, titanium, and inconel develop high stresses when deposited. These films often flake or crack at a thickness above 100 Angstroms, and in some instances, can even craze or crack the substrates they are coating. This stress is quickly transmitted to the quartz crystal and manifests as a sudden rate jump or a series of rapidly occurring positive and negative rate spikes. In some processes this can be tolerated, but in others, may negatively impact evaporation source control.

The best choice for these materials is either a Longer Life Gold or Stress Relieving Alloy crystal. The electrode compliance or yielding tends to reduce the film stress and diminish, and often eliminate, the erratic rate changes. Select the corresponding Fil-Tech Longer Life Gold or Stress Relieving Alloy crystals for your system:

Fil-Tech	Longer Life Gold	Stress Relieving Alloy
Inficon	QI8012	QI8008
Intellemetrics	QI8012F	QI8008F
Sloan	QS3952GL	QS3954
Balzers	QB104GL	QB104A

Fil-Tech Recommends Stress Relieving Alloy For Dielectric Material Optical Coating

Dielectric materials, including magnesium fluoride, titanium dioxide, silicon monoxide and dioxide, aluminum oxide, and thorium fluoride, are frequently used for their optical transmission or reflectance properties and are the most difficult to monitor. These films do not adhere well unless the substrate is heated to temperatures of 200 degrees C or more. When deposited on water-cooled crystals, these films exhibit tremendous stress upon condensation and can easily cause crystal failure within the first 1,000 Angstroms of coating.

The best choice for dielectric materials is a Stress Relieving Alloy electrode crystal. Positive and negative rate spikes can be reduced dramatically. Laboratory results have also shown a usable life increase of 100% for magnesium fluroride and silicon dioxide. In most cases crystal life can also be extended approximately 50% by raising the sensor head cooling water termparture to 50 degrees C (from the normal 25 degrees C). Select the corresponding Fil-Tech Stress Relieving Alloy crystal for your system:

Fil-Tech Stress RelievingAlloy	Part No.
Inficon	QI8008
Intellemeterics	QI8008F
Sloan	QS3954
Balzers	QB104A

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Technical Bulletin No. 7

Specifications for Fil-Tech QI8010 Gold Quartz Crystals

Fil-Tech's quartz crystals are designed to exactly replace original equipment manufacturers' crystals to insure trouble-free operation. In spite of this, Fil-Tech will often tighten the OEM's specification to enhance crystal performance. The following specifications are used in evaluating a crystal:

A) Physical Characteristics	Fil-Tech QI8010
1) Sensor material	Single crystal Alpha Quartz
2) Angle of Cut[1]	35°15' (AT)
3) Contour	3 +/-0.5 diopter Plano-Convex
4) Surface Roughness	10 micron
5) Diameter	0.550" (13.97 mm)
6) Electrode	Gold/Chromium
B) Electrical Characteristics[2]	
1) Resonant Frequency (MHz)	5.975-5.993
2) Resistance at Resonance	<15 Ohms
3) Contact Resistance	<15 Ohms

1. The true angle of cut varies as a function of the contour. The true angle for this configuration crystal is actually 35 degrees 16 minutes.
2. Fil-Tech values are actual quality assurance specifications. Fil-Tech 100% inspects all crystals using 10 electrical parameters and cosmetic criteria. A detailed histogram of Fil-Tech lot measurements is also available upon request.

Note: Fil-Tech believes that high-level inspections are required to maintain the high quality crystal production demanded by our end users. In addition to the electrical and physical parameters listed above, Fil-Tech also measures motional capacitance and inductance, spurious resonance separation, and static capacitance to help track subtle changes in incoming quartz quality and in the production process.

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Technical Bulletin No.8

Specifications for Fil-Tech QI8008 Stress Relieving Alloy Quartz Crystals

Fil-Tech's has developed a Stress Relieving Alloy® crystal to facilitate the difficult process of deposition of dielectric and high stress materials. The Stress Relieving Alloy crystals are fabricated from the same raw crystal materialused for our gold and silver crystals. Fil-Tech Stress Relieving Alloy crystals are identical to our gold and silver except for the electrode coating. The following are the specifications for Stress Relieving Alloy crystals:

A) Physical Characteristics	Fil-Tech QI8008
1) Sensor material	Single crystal Alpha Quartz
2) Angle of Cut[1]	35° 15' (AT)
3) Contour	3 +/-0.5 diopter Plano-Convex
4) Surface Roughness	10 micron
5) Diameter	0.550" (13.97 mm)
6) Electrode	Silver Aluminum Alloy/Chromium
B) Electrical Characteristics[2]	
1) Resonant Frequency (MHz)	5.975-5.993
2) Resistance at Resonance	<15 Ohms
3) Contact Resistance	<15 Ohms

1. The true angle of cut varies as a function of the contour. The true angle for this configuration crystal is actually-35 degrees 16 minutes.

2. Fil-Tech values are actual quality assurance specifications. Fil-Tech 100% inspects all crystals using 10 electrical parameters and cosmetic criteria. A detailed histogram of Fil-Tech lot measurements is also available upon request.

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Technical Bulletin No. 9

Fil-Tech Quality Crystals 100% Testing and Inspection

Fil-Tech 100% tests and inspects all crystals to insure they are in accordance with our specifications. In order to insure our customer the finest Quality Crystals®, and insure long crystal life, Fil-Tech measures the following for each crystal. We use sophisticated test equipment to measure the electrical parameters and cosmetic criteria below. All tests are based on physical measurements - they are not derived.

Electrical Inspection:

1. Frequency;
2. Contact Resistance;
3. Activity - equivalent series resistance (ESR), which is a function of film adhesion and surface roughness;
4. Capacitence;
5. Inductance; and
6. Parallel Resonance Frequency.

Cosmetic Inspection:

1. Electrode pattern must be centered;
2. Electrode pattern must be clear of distortions;
3. Surface must be free of dust particles, fingerprints, metallic splatters, and other visible surface contamination;
4. Quartz must be free of twinning; and
5. Surface must be free of scratches, chips and markings.

Fil-Tech also employs a unique data logging system and lot number program that records the complete history of our deposition process. With this log, we can trace, via lot number, the deposition process on a real time basis for every crystal produced and shipped.

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Technical Bulletin No.10

Shelf Life & Storage of Quartz Crystals

Fil-Tech suggests the following guidelines regarding the "shelf life" of quartz crystal sensors and the environmental conditions required for storing quartz crystals. Shelf life refers to the time a device can be safely stored without harmful effects to its performance.

Quartz crystals are surface active and frequency based devices. Their self life generally applies to any changes in their electrode chemical composition and resonant frequency. Therefore, the storage environment of crystals will dictate the shelf life of the sensors. By following the guidelines below, quartz crystals can be stored almost indefinitely depending on the electrode material selected. The QI8010 gold crystal is the most stable due to the inert nature of the gold electrode. The QI8008 and QI8009 are slightly more sensitive to chemical exposure and moisture due to their respective Stress Relieving Alloy ® and silver electrodes.

Temperature:
Standard room temperature between 20 and 24 degrees C.

Humidity:
Standard room humidity between 40% and 60%.

Chemical Exposure:
Do not store crystals in the presence of volatile materials, oils, sulfur, halides, ozone, iodine and oxidizing agents.

Particulate Exposure:
Do not store crystals in particulate laden environments. If this can not be avoided seal containers properly.

Mechanical Exposure:
Do not store crystals in areas with excessive mechanical vibrations.

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Technical Bulletin No.11

How to Improve Crystal Performance

Fil-Tech recommends the following guidelines for improving crystal performance:

1) Keep the crystal surface clean. Avoid any physical contact with the center of the crystal during handling and blow off any particulates using dry and filtered air or dry nitrogen. Keeping the crystal surface clean lowers resistance and improves film adhesion.

2) Maintain good electrical contact with the crystal. Keep cables in good condition and snug to the sensor and feedthrough. Periodically inspect the finger spring contacts in the sensor head and adjust or replace when necessary.

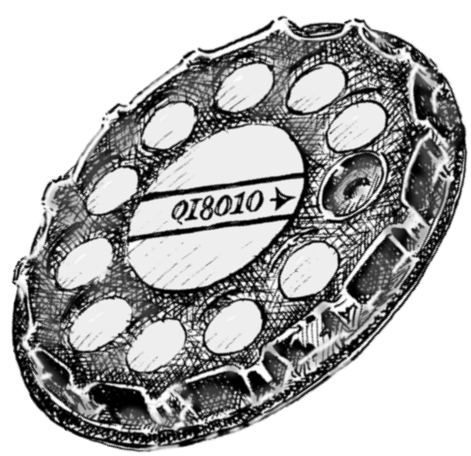
3) Keep the sensor head cap clean. Material buildup around the opening can cause mechanical coupling and damping if it contacts the crystal.

4) Maintain the crystal sensor water temperature at a minimum of 25°C. When using a circulating chiller with heating capability, run the sensor at 50°C for high stress coatings. The higher temperature reduces stress as the coating deposits and also improves film/crystal adhesion.

5) Use Stress Relieving Alloy crystals in place of Gold for high stress material depositions. Stress Relieving Alloy electrodes yields, dissipating film stress before it reaches the crystal surface.

6) Shield the crystal from direct exposure to radiant heat sources or glow.

7) Minimize source "spitting" during evaporation, as "splatters" (large pieces of evaporant) dramatically increase the resistance of the crystal and lead to erratic rate function or early failure. Reduce early failure with proper source rate control, proper distance from the crystal to the source, and proper source type (e.g. Drumheller type for Silicon Monoxide).



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Technical Bulletin No.12

Quartz Crystals Reveal Hidden Process Problems

When process problems occur, crystals are often the first and only ingredient in the coating process that gets the blame. Rate spikes or crystal failures do not always indicate crystal problems, they may actually reveal other hidden process issues. By focusing on the crystal, you may be overlooking other more significant process problems.

Fil-Tech recommends the following:

1) Do not touch crystals with fingers or hands. Use tweezers to handle crystals. Store unused crystals in a clean area.

2) Use Stress Relieving Alloy® or Longer Life Gold crystals instead of Gold when depositing SiO2, Magnesium Fluoride, and similar dielectric materials. Stress Relieving Alloy and Longer Life Gold electrodes yield, dissipating film stresses before they reach the crystal surface.

3) Move the sensor head away from deposition splatter. Shield the crystal from direct exposure to radiant heat sources.

4) Frequently inspect the finger spring contacts in the sensor head and adjust or replace when necessary. Keep the sensor head cap clean. Keep cables in good condition and snug to the sensor and feedthrough.

5) Maintain the crystal sensor water temperature at a constant between 25° C and 50° C.

Help solve your process problems with crystal analysis. Send us your "problem" crystal and we will help find your process problems with Scanning Electron Microscope(SEM) analysis. SEM analysis will examine the crystal and identify evaporant splatter, fingerprints, and other causes of crystal failures. We will analyze your crystal and send you a SEM Report with our findings.

Note: Visual inspection of quartz crystals will not determine whether they will perform in your chamber.Quartz crystals have natural shadings from their base quartz layer. When coated, crystal will reproduce and reflect the quartz's natural shadings. The color and look of a crystal are not a specification for manufacture. The only tests to determine a crystal's performance are frequency and resistance at resonance. We manufacture in a class 100 clean room and package at cleanstations.We 100% inspect each crystal prior to shipment.

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Interpretation of Crystal Life Data from Thickness Monitors

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This Technical Bulletin provides general guidelines about Crystal Life or Health Data commonly seen on thickness monitors. If interpreted correctly, this data can be helpful in signaling when to replace the quartz crystal sensor.

What Does Crystal Life or Health Mean?

When a quartz crystal sensor is coated with material from the thin film evaporation process the frequency becomes lower or "shifts". This frequency shift is used to calculate the thickness of the evaporated material and the Crystal Life or Health. Crystal Life or Health is generally given as percentage of a 1.50 MHz shift of the crystal's resonant frequency. How the Crystal Life or Health is represented varies with different monitors, some starting with a value of 100% for a new crystal and others at 0%. A new crystal is generally defined as one with a frequency between 5.970-6.000 MHz. Typically a 1% decrease (or increase depending on the representation) of life is equal to approximately 0.015 MHz or 15,000 Hz shift over the 1.50 MHz range.

What Impacts the Crystal Life or Health Data?

Crystal Life or Health reading is impacted by the following major factors:

1) The types of materials being evaporated;
2) The density of material and the ultimate thickness of the film desired; and,
3) Physical conditions.

1) In high tensile or compressive stress materials such as: silicone dioxide, zirconium, titanium, chromium, magnesium fluoride, and titanium dioxide, mechanical forces can be transmitted through the electrode to the crystal plate causing frequency shifts. These stresses can deform the crystal plate and briefly halt the piezoelectric effect. This results in a sudden crystal failure regardless of the Crystal Life or Health.

2) Materials with high density such as silver cause a greater frequency shift than lower density material such as aluminum, and result in accelerated change in the Crystal Life or Health. Additionally, the amount of material being applied directly impacts Crystal Life or Health since mass build-up dampens vibration and ultimately causes crystal failure.

3) Physical conditions like chamber cleanliness, sensor head temperature, and location of the sensor head will also impact Crystal Life or Health. Temperature increases can cause geometric changes in the crystal structure causing the mode of vibration to change from shear wave and inducing frequency jumps. At temperatures above 120° C the temperature coefficient for an AT cut quartz crystal becomes heavily positive and results in frequency jumps. A sensor head too close to the source will be vulnerable to splattering of material. Splatter and large amounts of material added to the crystal surface and can lead to mass loading failure and at a minimum, a large change in the Crystal Life or Health. Similar effects can be seen when particulates from a dirty sensor head cap or chamber fall on a crystal.

When Do I Change the Crystal?

Fil-Tech suggests performing several test runs and recording the Crystal Life or Health when the evaporation rate becomes unstable. Next, record the Crystal Health or Life when the crystal fails. Finally, back off in 1-5% increments, correlating the onset of instability with the failure. The operator will now have a general replacement point as long as all basic quartz crystal sensor care and handling practices have been followed.

Technical Bulletin No.14

Interpretation of Crystal Activity Data from Thickness Monitors

This Technical Bulletin provides general guidelines regarding "Crystal Activity Data" seen on thickness monitors, specifically, what "Activity" means and how it should be interpreted. Operators use Activity Data as an indicator if a new quartz crystal sensor is "good or bad". However, as explained below, Activity Data is a more useful tool for showing problems with crystal hardware.

What Does Crystal Activity Mean?

The true Activity of a quartz crystal is its amplitude of oscillation. The amplitude of oscillation is correlated to the resistance at resonance measurement that we use at Fil-Tech to determine if a crystal works properly.

The Activity specified on thin film monitors is the ability of the crystal measurement circuit to conduct current. The crystal measurement circuit includes the quartz crystal, sensor head, feedthrough, and cables. If there is poor contact between any of theses components the Activity reading will be low. The Activity can range from the best value of 650 to a minimum of 0 which would indicate a dead crystal. Typically, a new crystal will register from 400 - 550, depending on the state of the sensor head and other associated hardware.

Diagnosing and Solving Activity Problems

The use of the Activity reading as an indicator of whether a new crystal is defective is marginal. Activity is a more useful tool for showing problems with crystal hardware. If you are replacing multiple crystals in order to get a high Activity reading, the odds are that the crystal is not the problem, but rather something else in the "circuit" is faulty. Because the Activity is related to current flow, and based on Ohm's Law, any additional resistance to the circuit would adversely impact the Activity value. A short list of culprits includes heavily coated sensor heads, damaged cables, electrical shorts of the feedthrough, dirty contacts, and contact misalignment.

The two most troublesome and most common culprits causing low Activity readings are contact misalignment of the double anchor electrode pattern with the contact spring and flattened crystal contacts springs from normal wear and tear, causing high contact resistance. It has been our experience that crystal Activity can vary from crystal failure to 500 with a twist of the sensor head cap (rotating the crystal around the spring contact) even with very low resistance crystal of 10 Ohms. This behavior suggests that the contacts were not mating properly with the electrode pattern of the crystal.

To determine if contact misalignment or flattened contact springs, any of the other aforementioned components are the source of your Activity problems, follow Fil-Tech's Flowchart, Technical Bulletin 15.

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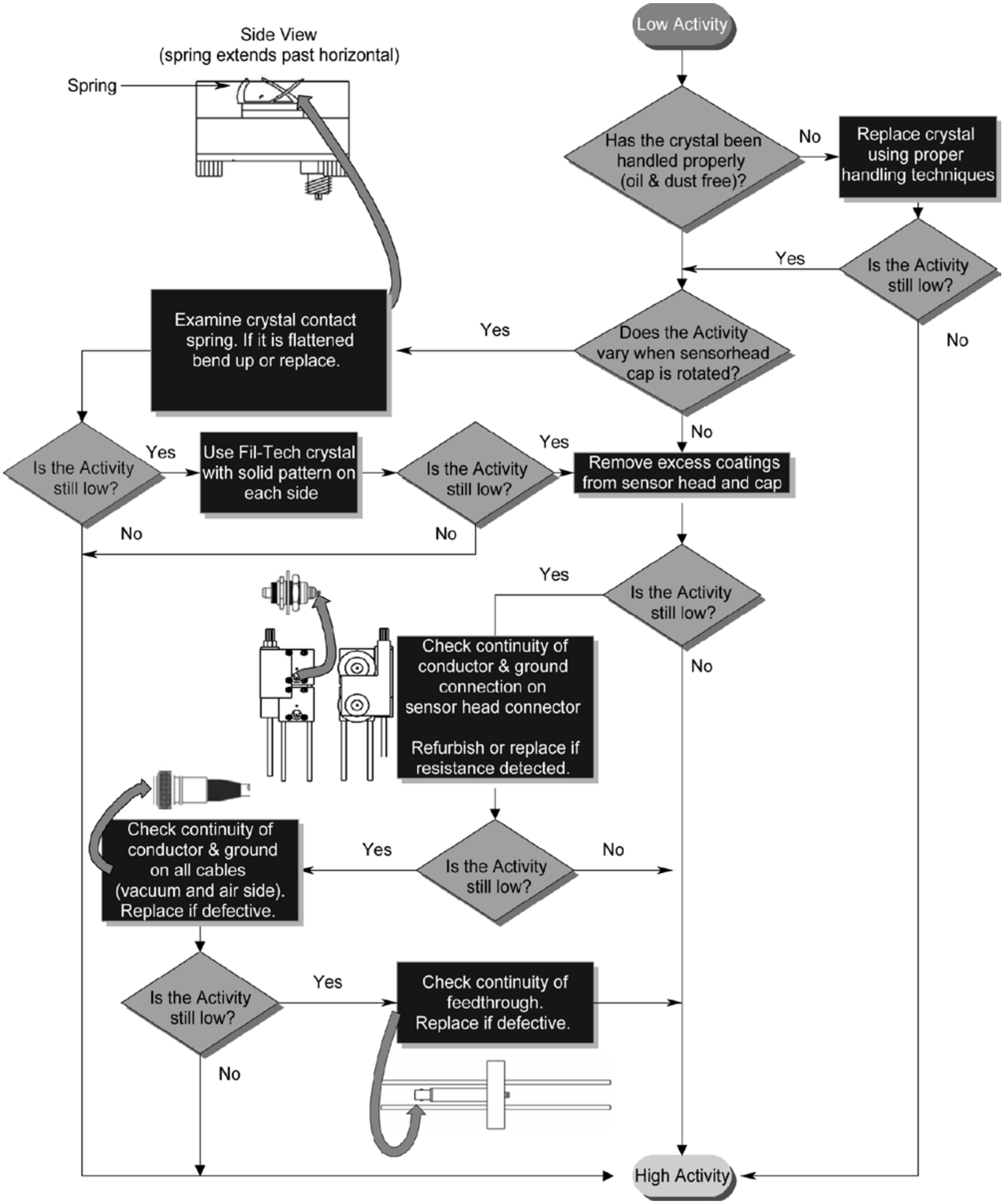
Technical Bulletin No.15

Low Activity Diagnostic Flowchart



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