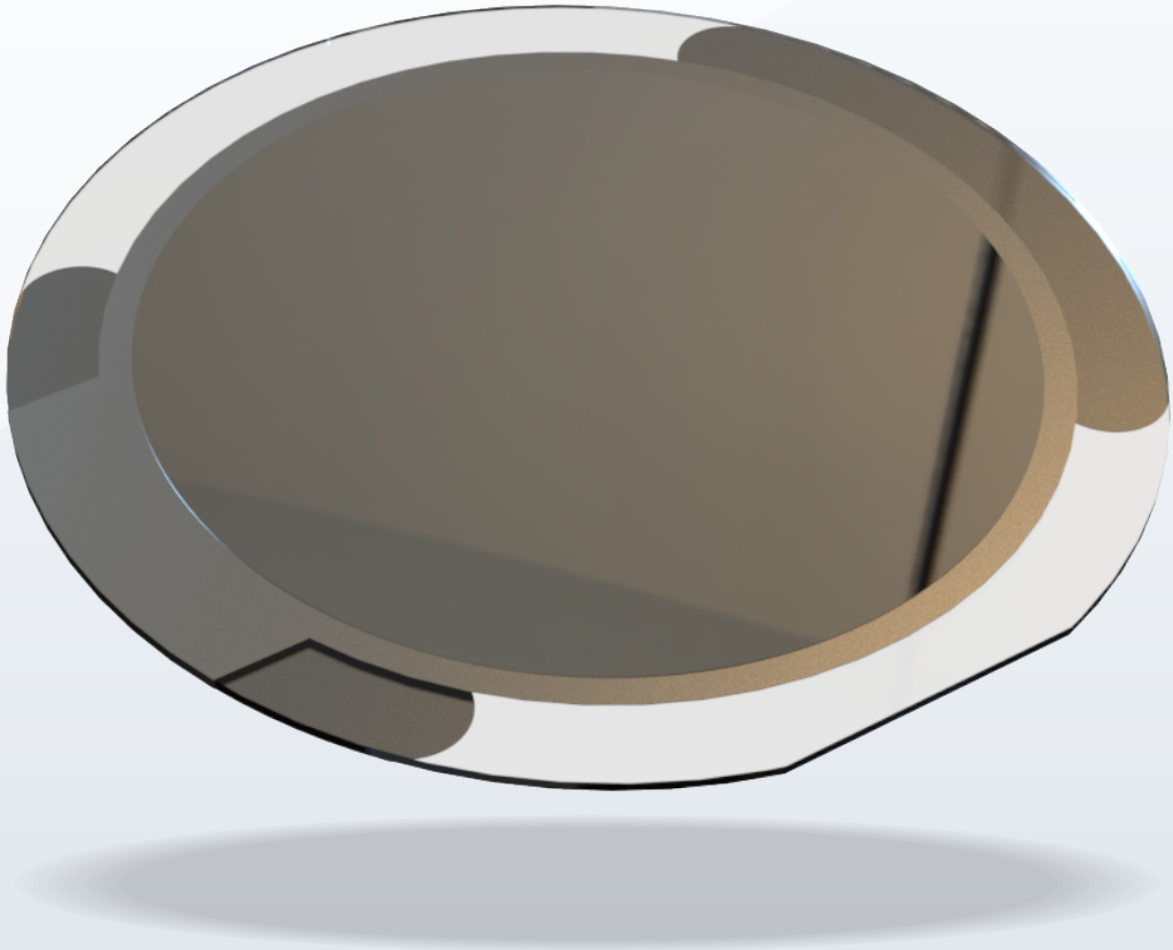
QUARTZ CRYSTAL MICROBALANCE SENSOR

AT5-14-12-SiO2-WRAP

SPECIFICATIONS, CLEANING AND CARE



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DATE
11 November 2026

VERSION
1.0

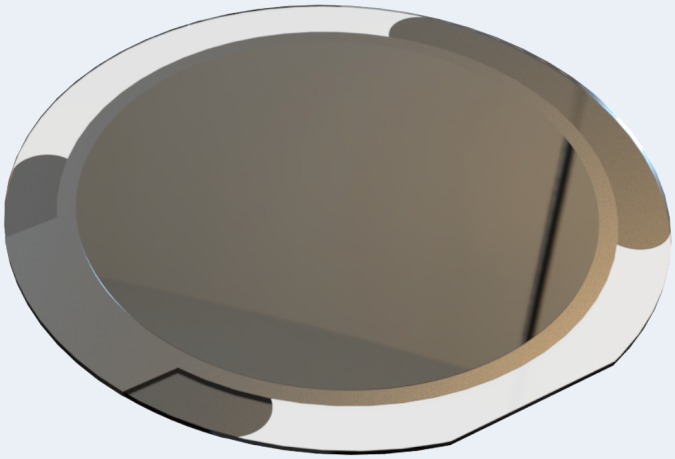
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QUARTZ CRYSTAL MICROBALANCE SENSOR

AT5-14-12-SiO2-WRAP

5 MHz Quartz Sensors, Silicon Dioxide

BOX OF 10 PIECES



SiO2 5 MHz

FREQUENCY	BLANK DIAMETER	ELECTRODES	SURFACE
5 MHz	14 mm	12 / 5 mm	SiO_2

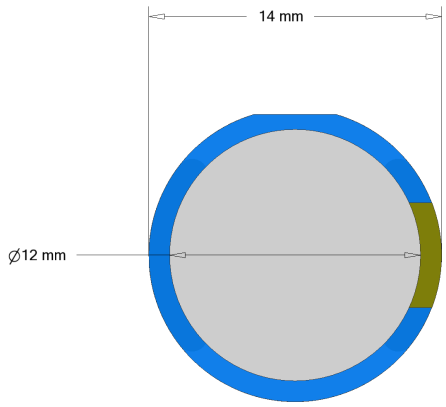
KEY FEATURES

- 5 MHz
- 14.0 MM SENSOR DIAMETER
- 12.0 / 5.0 MM ELECTRODE DIAMETER
- SiO_2 (silicon dioxide) TOP LAYER on Ti/Au ELECTRODE
- WRAPPED ELECTRODES (SINGLE SIDE CONTACT)
- FOR LIPID BILAYERS, POLYMERS AND SILICA SURFACE STUDIES

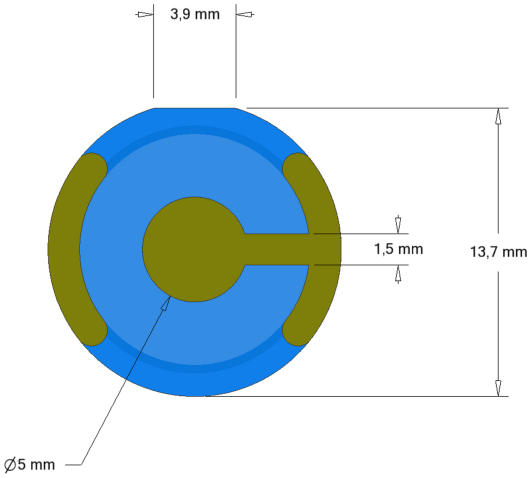
DESCRIPTION

The Quartz Crystal Microbalance (QCM) sensor is a 5 MHz AT-cut crystal whose gold front electrode is covered by a thin silicon dioxide layer. The silica surface is hydrophilic after activation and reproduces glass and oxidized silicon, the standard substrates for supported lipid bilayers, vesicle adsorption, polyelectrolytes, surfactants and protein adsorption. The underlying Ti/Au electrode provides the electrical contact. The front electrode is wrapped around the edge of the blank, so both electrodes are contacted from the back face only.

2D DIMENSIONS

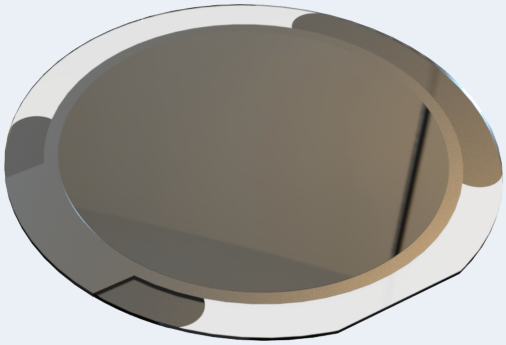


FRONT (SENSING SIDE)

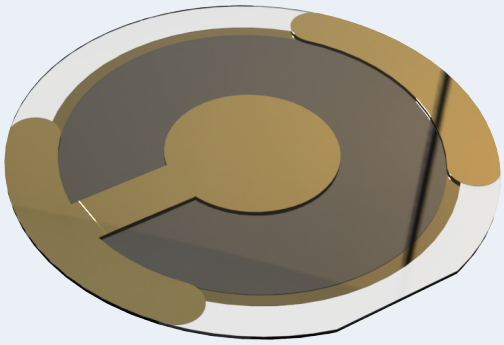


BACK (CONTACT SIDE)

3D VIEWS



FRONT (SENSING SIDE)



BACK (CONTACT SIDE)

MECHANICAL

Nominal blank diameter	14.0 mm (13.97 ± 0.03 mm)
Nominal blank thickness	≈ 0.33 mm (AT cut, 5 MHz fundamental)
Crystal axes orientation	Yes, orientation flat on the blank edge
Surface appearance	Transparent, polished
Edge bevel	Yes

GENERAL

Sensor design	Plano-Plano
Angle of cut	AT, 35° 15′ ± 3′
Oscillation mode	Fundamental
Frequency vs Temp stability	< ± 15 ppm (0 to +50 °C)
Operating temperature	-20 °C to +125 °C
Storage temperature	-40 °C to +125 °C
Compatibility	openQCM™, Q-SENSE™

ELECTRICAL

Nominal frequency	5.000 MHz
Frequency tolerance	± 5 kHz @ 25 °C
Resonance resistance	< 15 Ω
Shunt capacitance, C0	< 7 pF
Q-value	> 100 000
Mass sensitivity (Sauerbrey, n = 1)	17.7 ng cm^{-2} Hz^{-1}

ELECTRODES

Front electrode diameter	12.0 mm
Front electrode material	Silicon dioxide (SiO_2) on Ti/Au
Back electrode diameter	5.0 mm
Back electrode material	Gold (Au)
Adhesion layer	Titanium (Ti)
Layer thickness	~10 nm Ti / ~200 nm Au / ~50 nm SiO_2
Electrode configuration	Wrapped front electrode, single side contact

PACKAGING & STORAGE

Sensor package type	Box
Storage quantity	10 pieces
Package protection	Package is protected with a vacuum sealed plastic bag
Storage recommendation	After opening plastic vacuum bag preferably store in dust free dry Air or Nitrogen @ room temperature.

AT5-14-12-SiO2-WRAP

CLEANING AND CARE

BEFORE YOU START

The sensing film is only about 200 nm thick and sits on a 10 nm titanium adhesion layer. Titanium and chromium are the two adhesion metals used for thin film electrodes on quartz, and they fail in different ways: titanium is attacked by fluoride, hot alkali and piranha, chromium by peroxide, ceric ammonium nitrate and anodic polarization [1, 2]. Along the edge of the electrodes and on the wrapped contact the adhesion layer is exposed, so a reagent that only attacks the adhesion metal can still undercut and lift the electrode. The procedures below were chosen to be safe for both adhesion metals and for the quartz substrate. Where no procedure written for QCM sensors is published, methods developed for the same surface in other fields (electrochemistry, microfabrication, surface science, food processing) were adapted to these limits, and the source of each step is given.

HANDLING AND MOUNTING

- Hold the sensor only at the outer edge of the quartz, with clean plastic tipped tweezers and powder free nitrile gloves. Never touch or wipe the electrodes or the wrapped contact area.
- Dry with a gentle stream of filtered, oil free nitrogen blown from the center outwards. Do not let droplets evaporate on the electrode: they leave rings of residue [3].
- Mount the sensor with the sensing face towards the measurement chamber and tighten the holder finger tight only. Clamping force shifts the resonance frequency: three point clamping changed the frequency of 10 MHz crystals by up to 3 ppm [4], and the force-frequency effect of AT-cut quartz is described in [5].
- After mounting, wait for the frequency to stabilize in the measurement medium before taking the baseline. Swelling O-rings and contact pressure cause slow drift in the first minutes.
- Do not use ultrasonic baths. No study quantifies cavitation damage on thin film QCM electrodes, but cavitation is itself used as a delamination test for sub-micrometre coatings, so we treat it as a risk for the film and for the thin blank.
- Use one fixed pretreatment for a whole series of measurements. Different cleaning methods give different surface states and therefore different sensor responses [6].

CLEANING PROCEDURES FOR SILICON DIOXIDE SURFACES

The silica layer is only about 50 nm thick and is deposited, not grown: it is consumed quickly by fluoride and by hot alkali, and the gold and adhesion metal underneath are exposed at the edges and at any pinhole. A loss of 1 nm of silica corresponds to about +12 Hz on this sensor [7]. The procedures below combine a published QCM protocol for silica sensors based on an alkaline detergent [8] with cleaning methods for glass and silica used in supported lipid bilayer research [9, 10] and with etch rate data from microfabrication [1]. Use ultrapure water (18 MΩ cm) and filtered nitrogen throughout.

LEVEL 1 ROUTINE CLEANING BETWEEN MEASUREMENTS

1. Flush the buffer out with ultrapure water before any detergent, to avoid salt and calcium phosphate precipitates.
2. To remove a lipid layer, flush either 2 % (v/v) Hellmanex III at 20 to 25 °C for 10 min [8] or ethanol or isopropanol for 5 to 10 min: phospholipids dissolve in these alcohols [11].
3. Flush ultrapure water for at least 10 min.
4. Remove the sensor, rinse with ultrapure water and absolute ethanol, dry with nitrogen [8].
5. Before forming a new bilayer, activate the surface again as in Level 2, steps 5 and 6.

LEVEL 2 STANDARD PRE-USE CLEANING AND ACTIVATION

1. Inspect the sensor with oblique light. Reject it if the silica is scratched across the active area, delaminated, or if the edges are discolored.
2. Rinse with ethanol or isopropanol, then ultrapure water, dry with nitrogen. These solvents do not etch silica, titanium or chromium [1].
3. Immerse in 2 % (v/v) Hellmanex III in ultrapure water at 20 to 35 °C for 10 to 30 min, without ultrasound [8, 12]. The detergent maker allows higher temperatures only for fused quartz glass [12], and deposited silica dissolves in alkali about twice as fast as fused quartz [1], so do not exceed 35 °C.
4. Rinse thoroughly on both faces with running ultrapure water, then ethanol, dry with nitrogen.
5. Activate with oxygen or air plasma for 1 to 2 min at low to medium power, or with UV/ozone for 10 to 20 min a few millimetres from the lamp [8, 13, 14]. Oxygen plasma removes organics without etching the oxide [1].
6. Use within 30 to 60 min or keep the sensor under ultrapure water: in laboratory air the water contact angle of plasma cleaned silica rises from about 0° to about 25° within one day [13].

LEVEL 3 DEEP CLEANING AND REGENERATION

- **Lipids and heavy contamination.** Repeat Level 2 with Hellmanex at 30 to 35 °C for 30 min [12], then 3 to 5 min of plasma or 30 min of UV/ozone [14].
- **Proteins.** Soak 30 to 60 min in a 1 to 2 % enzymatic laboratory detergent at room temperature, rinse, then 2 % Hellmanex for 10 min and rinse again. A short rinse in 10 to 100 mM HCl (1 to 5 min) can follow, adapted from glass cleaning before silanization [10]; keep it short because the adhesion metal at the edges is not protected by the silica. Finish with plasma or UV/ozone.
- **Polymers.** Soak 10 to 30 min in a good solvent for the polymer, rinse with isopropanol and water, then 5 to 10 min of oxygen plasma [1].

- **Piranha is not recommended.** It does not etch silica or gold, but etches titanium at 240 nm/min and chromium at more than 16 nm/min [1], undercutting the electrode at edges and pinholes. Prefer longer plasma or UV/ozone treatments.

CHEMICAL COMPATIBILITY

RATING	AGENT	WHY
SAFE	**Ultrapure water, ethanol, isopropanol, acetone, methanol**	No etching of silica, Ti, Cr or Au [1]
SAFE	**Oxygen or air plasma, UV/ozone**	Remove organics, do not etch the oxide [1, 14]
SAFE	**Hellmanex III up to 2 % at no more than 35 °C, no ultrasound**	Compatible [8, 12]
SAFE	**Neutral buffers (Tris, HEPES, NaCl, Ca^{2+})**	Standard media for bilayers on silica [15]
CAUTION	**Warm, long or dried on detergent**	High pH damages glass [12]
CAUTION	**Dilute non oxidizing acids, short**	Do not etch silica; exposed adhesion metal at the edges
CAUTION	**Ultrasonic bath**	Cavitation damages polished surfaces [12]
AVOID	**Piranha, NH_4OH/H_2O_2 mixtures**	Undercut Ti and Cr at the edges [1]
NEVER	**HF at any dilution**	10:1 HF removes 50 nm of silica in about 2 min, Ti 1100 nm/min [1]
NEVER	**Buffered oxide etch, fluorides**	Deposited silica is removed in seconds [1]
NEVER	**Hot or concentrated NaOH and KOH**	30 % KOH at 80 °C removes 50 nm of deposited silica in a few minutes [1]
NEVER	**Aqua regia, KI/I_2**	Dissolve the gold underneath through pinholes and edges [1]
NEVER	**Chromium etchants (ceric ammonium nitrate)**	Cr 170 nm/min [1]

VERIFYING CLEANLINESS

- **Water contact angle.** Measured right after activation it should be below 10°; plasma cleaned silica is fully wetted [9, 13]. Values of 20 to 30° show that organics have adsorbed again [13].
- **Baseline.** Compare the frequency in water or in dry air with the value of the new sensor. An increase of about 12 Hz per nanometre indicates that the silica is getting thinner.
- **Functional test, vesicle fusion.** Small unilamellar POPC or DOPC vesicles should adsorb, rupture and form a bilayer with the typical two step kinetics [16–18], ending at about −25 Hz (frequency shift divided by the overtone number) with a dissipation change below 0.2×10^{-6} [15]. Intact vesicles (large frequency shift and high dissipation) indicate contamination, loss of silanol groups, or exposed gold, on which vesicles adsorb without rupturing [16, 17].
- **Surface charge.** Silica is negatively charged at neutral pH, with an isoelectric point of about 2 to 3 [19]. Negatively charged vesicles fuse at high ionic strength and low pH [20]; calcium promotes bilayer formation [18]. Check these conditions before concluding that a sensor is contaminated.

TEMPERATURE AND STORAGE

Keep wet cleaning at or below 35 °C and never anneal. Heating removes the silanol groups that make the surface hydrophilic: bilayers on glass baked at 450 °C showed a 2.3 times lower lipid diffusion coefficient [9, 21], and the surface must be reactivated with plasma or UV/ozone after any thermal step. For short storage (hours to one day) keep the sensor under ultrapure water, which keeps the surface hydrophilic [13]; never store it in alkaline solutions. For long storage rinse, dry with nitrogen and keep the sensor in a clean closed container, then activate it again before use.

TEMPERATURE

The operating and storage temperature ranges of this sensor are listed in the GENERAL table. Within those ranges please consider the following.

- **Frequency vs temperature.** The resonance frequency of AT-cut quartz follows a cubic function of temperature whose shape depends on the cut angle [5, 22]. The cut of this sensor keeps the intrinsic drift small around room temperature, but over wide temperature ranges the frequency change is much larger than the mass signals of interest.
- **Measurements in liquid.** The viscosity and density of the liquid change with temperature and shift the frequency [23]. In water near 25 °C the shift is about +8 Hz/°C at 5 MHz (calculated from the Kanazawa-Gordon equation with the viscosity of water [24]). Control the temperature of the measurement chamber to better than 0.1 °C and let it settle after every liquid change [3].
- **Cleaning temperature.** Wet cleaning steps in this datasheet are performed at room temperature or slightly above, never above the limit given for each step. Never flame anneal, oven anneal or quench the sensor.
- **Adhesion layer.** Titanium diffuses along the grain boundaries of gold and reaches the surface from about 250 to 300 °C [25, 26]; chromium does the same and oxidizes at the surface at about 300 °C [27, 28]. The surface chemistry and the adhesion of the electrode change long before the quartz is damaged.
- **Quartz.** The resonator quality degrades above about 300 °C [29], cooling stresses between 200 and 550 °C create Dauphiné twins that ruin the resonator [30], and at 573 °C quartz goes through the alpha to beta transition with a sharp change of thermal expansion [31].

WHEN TO REPLACE THE SENSOR

Every cleaning cycle removes a little material and changes the surface. On openQCM 10 MHz gold sensors three regeneration cycles reduced the sensor performance by 7 % with electrochemical cleaning, 16 % with oxygen plasma and 25 % with piranha [32]. Replace the sensor when one of the following occurs [3]:

- cracks or chips on the edge of the quartz, scratches or holes in the electrode;
- peeling of the electrode, visible from the contact side, or permanent discoloration;
- noisy or unstable baseline, higher motional resistance (lower Q, higher dissipation);
- the frequency in air drifts from cycle to cycle, showing that the film is being consumed;
- the cleanliness test of this datasheet no longer passes after a deep cleaning.

Record the resonance frequency in air of every new sensor and after each deep cleaning: comparing the values

is the simplest way to follow the condition of the electrode.

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