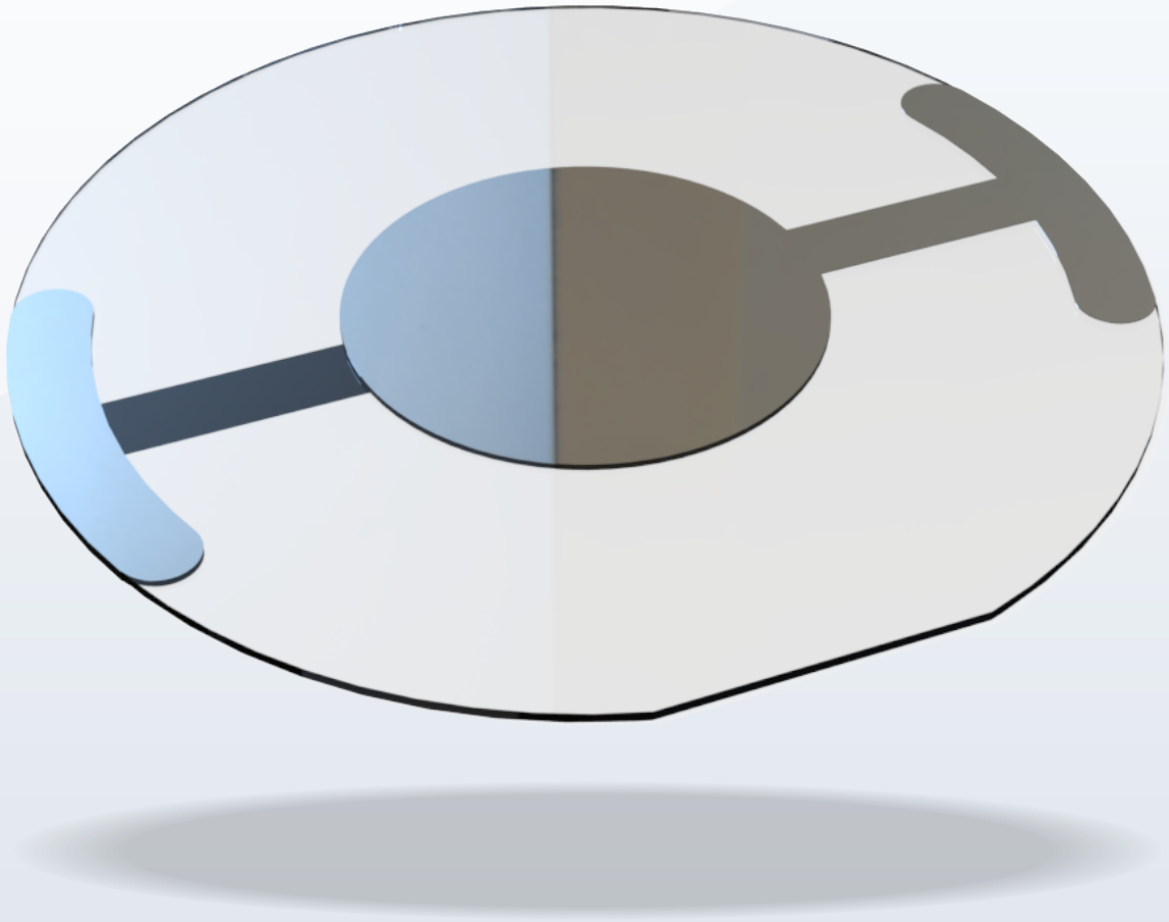
QUARTZ CRYSTAL MICROBALANCE SENSOR

AT10-14-6-PT-WRAP

SPECIFICATIONS, CLEANING AND CARE



10 MHz Quartz Sensors, Platinum, 6 mm electrodes

openQCM devices are released as scientific open hardware instruments, and they are intended solely for use for SCIENTIFIC, RESEARCH and DEVELOPMENT APPLICATION, DEMONSTRATION, OR EVALUATION PURPOSES and are not considered to be finished end-products fit for general consumer use.

openQCM by Novaetech Srl
Piazza Bartolo Longo, 28
80045 Pompei (NA)
Italy
https://openqcm.com

DATE
11 November 2026

VERSION
1.0

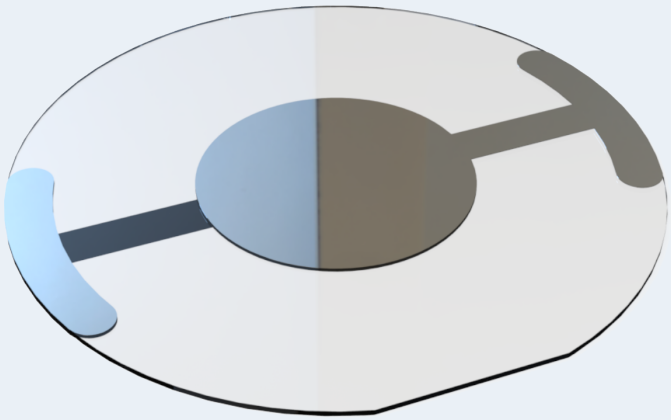
© openQCM by Novaetech Srl

QUARTZ CRYSTAL MICROBALANCE SENSOR

AT10-14-6-PT-WRAP

10 MHz Quartz Sensors, Platinum, 6 mm electrodes

BOX OF 5 PIECES



PT 10 MHZ

FREQUENCY	BLANK DIAMETER	ELECTRODES	SURFACE
10 MHz	14 mm	6 / 6 mm	Pt

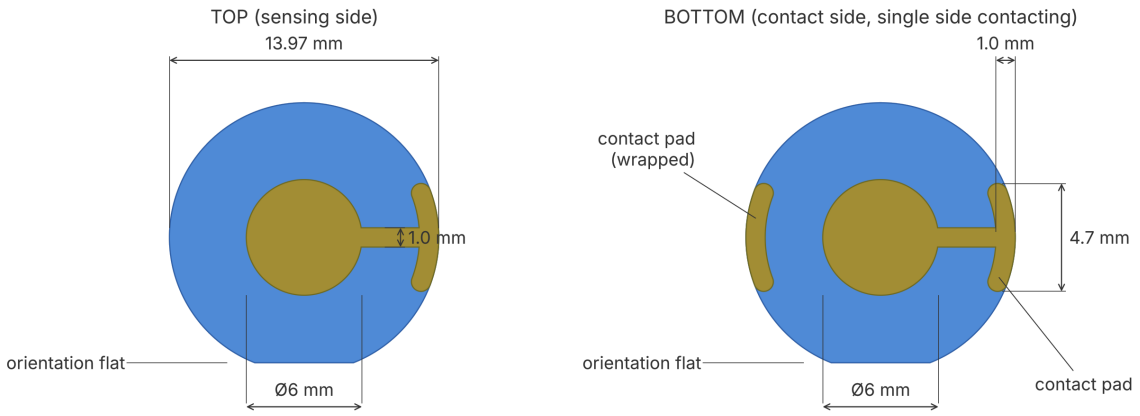
KEY FEATURES

- 10 MHz
- 14.0 MM SENSOR DIAMETER
- 6.0 / 6.0 MM ELECTRODE DIAMETER (SYMMETRIC)
- Pt (platinum) ELECTRODE (with Ti adhesion layer)
- WRAPPED ELECTRODES (SINGLE SIDE CONTACT)
- ORIENTATION FLAT ON THE BLANK
- FOR ELECTROCHEMISTRY, CATALYSIS AND GAS PHASE

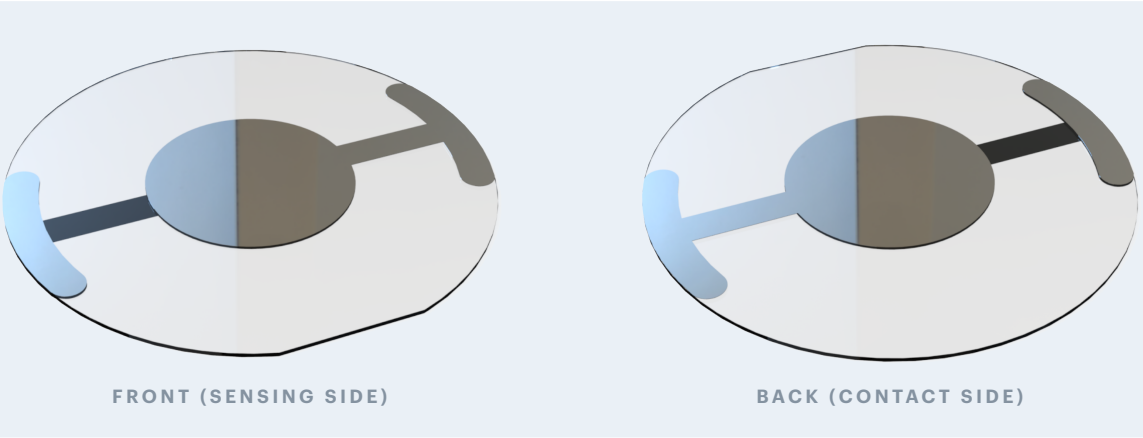
DESCRIPTION

The Quartz Crystal Microbalance (QCM) sensor is a 10 MHz AT-cut crystal with symmetric 6 mm Pt (platinum) electrodes on a titanium adhesion layer. Platinum is chemically inert, withstands oxidizing cleaning and a wide electrochemical potential window, and is the reference surface for electrochemical QCM, catalysis and corrosive gas studies. Both electrodes are wrapped around the edge of the blank to the same side, so the sensor can be contacted from one face only. The quartz blank has an orientation flat marking the crystallographic axes.

2D DIMENSIONS



3D VIEWS



MECHANICAL

Nominal blank diameter	14.0 mm
Nominal blank thickness	≈ 0.17 mm (AT cut, 10 MHz fundamental)
Crystal axes orientation	Yes, orientation flat on the blank edge
Surface appearance	Transparent, polished
Edge bevel	To be confirmed

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 +70 °C
Storage temperature	-40 °C to +125 °C
Compatibility	openQCM™, Q-SENSE™

ELECTRICAL

Nominal frequency	10.000 MHz
Frequency tolerance	± 5 kHz
Resonance resistance	< 10 Ω
Shunt capacitance, C0	6 pF
Q-value	To be confirmed
Mass sensitivity (Sauerbrey, n = 1)	4.42 ng cm^{-2} Hz^{-1}

ELECTRODES

Front electrode diameter	6.0 mm
Front electrode material	Platinum (Pt)
Back electrode diameter	6.0 mm
Back electrode material	Platinum (Pt)
Adhesion layer	Titanium (Ti)
Layer thickness	~10 nm Ti / ~200 nm Pt
Electrode configuration	Both electrodes wrapped, single side contact

PACKAGING & STORAGE

Sensor package type	Box
Storage quantity	5 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.

AT10-14-6-PT-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 PLATINUM ELECTRODES

Platinum withstands strong oxidation, but it is not indestructible: it dissolves slowly under potential cycling, especially above 1.15 V and in the presence of chloride [7, 8], and a dissolved monolayer appears as a frequency drift on the QCM. No cleaning procedure written for platinum QCM sensors has been published, so the steps below adapt methods from platinum electrochemistry and thin film platinum devices [9, 10] to a 200 nm film on quartz. Flame annealing, the classic treatment for platinum bead electrodes, must never be used (see TEMPERATURE). Potentials are given vs the reversible hydrogen electrode (RHE); use a chloride free reference electrode such as Hg/Hg_2SO_4 [8].

LEVEL 1 ROUTINE CLEANING BETWEEN MEASUREMENTS

1. Rinse with the measurement solvent or buffer, then with ultrapure water (18 MΩ cm). For organic solvent or gas phase work rinse with ethanol or isopropanol: these solvents do not etch Pt, Ti or Cr [1].
2. Dry with filtered nitrogen or argon.
3. Electrochemical users: in deaerated 0.5 M H_2SO_4 or 0.1 M $HClO_4$, run 10 to 20 cycles between 0.05 V and 1.20 V at 100 mV/s and stop in the double layer region (0.40 to 0.50 V) on the cathodic sweep. Platinum dissolution is negligible below about 1.05 V and becomes significant above 1.15 V [7].

LEVEL 2 STANDARD PRE-USE CLEANING

1. Immerse in acetone for 10 to 30 min at room temperature [9], rinse with isopropanol and ultrapure water, dry with nitrogen.
2. Optionally treat with UV/ozone for 10 to 20 min, with the sensor a few millimetres from the lamp and at no more than 80 °C [9, 11]. UV/ozone removes the carbon layer that grows on platinum in air [12, 13].
3. Electrochemical activation in 0.5 M H_2SO_4 or 0.1 M $HClO_4$, prepared from high purity acid and purged with nitrogen or argon for at least 15 min: cycle between 0.05 V and 1.40 V (1.25 V if the adhesion layer is chromium) at 200 mV/s until consecutive voltammograms overlap, typically 20 to 200 cycles [9]. Record 3 cycles at 50 mV/s and finish at 0.45 V on the cathodic sweep. The lower limit for chromium follows from its transpassive dissolution [14] and from the loss of resonance of Cr adhered films under anodic polarization [2].
4. Rinse with ultrapure water and dry with nitrogen. Use within a few hours.

Perform the activation before recording the baseline, never during a measurement: 200 cycles up to 1.5 V can dissolve about 0.4 µg cm^{-2} of platinum [7], equivalent to about 90 Hz on this sensor.

LEVEL 3 DEEP CLEANING AND REGENERATION

- **Organic films and proteins.** Solvent soak (acetone, then ethanol or isopropanol) for up to 1 h, then UV/ozone 2 to 3 times for 10 min with a water rinse in between [11, 13], then 20 to 50 cycles between 0.05 V and 1.50 V (1.30 V for chromium) at 200 mV/s.
- **Carbon monoxide.** Purge the cell with argon or nitrogen for at least 20 min, then sweep from 0.05 V to 1.0 to 1.2 V: adsorbed CO is oxidized in the first anodic sweep. Repeat 3 to 5 cycles until the hydrogen adsorption peaks are back [10].
- **Sulfur (H_2S, SO_2, thiols).** Adsorbed sulfur is oxidized to soluble sulfate only above 1.3 V [15]: run 50 to 100 cycles between 0.05 V and 1.50 V and replace the electrolyte every 20 to 30 cycles. Recovery may be

incomplete.

- **Metal adatoms (Cu, Ag, Pb, Bi).** Strip anodically at 1.2 to 1.4 V in fresh acid.
- If the voltammetric fingerprint does not recover, replace the sensor: no chemical treatment stronger than these is compatible with the film and the quartz.

CHEMICAL COMPATIBILITY

RATING	AGENT	WHY
SAFE	**Ultrapure water, ethanol, isopropanol, acetone, methanol**	No measurable etching of Pt, Ti or Cr [1]
SAFE	**0.05 to 0.5 M H_2SO_4, 0.1 M $HClO_4$ at room temperature**	Compatible within the potential limits above [9, 10]
SAFE	**UV/ozone at no more than 80 °C**	Compatible [9, 11]
CAUTION	**Upper potential above 1.15 V**	Platinum dissolves, mostly on the cathodic sweep [7]
CAUTION	**Chloride media (PBS, NaCl, KCl) with anodic polarization**	Chloride traces increase platinum dissolution [8]
CAUTION	**Dilute NaOH or KOH, short contact**	Alkali dissolves quartz faster at higher pH and temperature [1, 16]
CAUTION	**H_2O_2, especially warm**	Etches chromium at 110 nm/min at 50 °C [1]
CAUTION	**Oxygen or argon plasma**	Forms platinum oxide or roughens the surface
NEVER	**Aqua regia, also diluted**	Etches platinum at 3.6 nm/min at 30 °C, faster when hot [1]
NEVER	**Hot HCl with oxidants (Cl_2, H_2O_2, HNO_3)**	Dissolves platinum [17]
NEVER	**HF, buffered HF, fluorides**	Ti 1100 nm/min in 10:1 HF, etches quartz [1]
NEVER	**Piranha (H_2SO_4/H_2O_2)**	Ti 240 nm/min, undercuts the adhesion layer [1]
NEVER	**Chromium etchants (ceric ammonium nitrate)**	Cr 170 nm/min [1]
NEVER	**Flame, torch or furnace annealing**	See TEMPERATURE [18–20]

VERIFYING CLEANLINESS

- **Voltammetric fingerprint.** In deaerated 0.5 M H_2SO_4 at 50 mV/s between 0.05 V and 1.40 V a clean surface shows sharp hydrogen adsorption and desorption peaks between 0.05 and 0.40 V, a flat double layer between 0.40 and 0.70 V, oxide formation from about 0.8 V, one oxide reduction peak, and overlapping cycles [10, 21, 22]. Contamination suppresses or smears the hydrogen peaks.
- **Electrochemical surface area.** The hydrogen desorption charge divided by 210 µC cm^{-2} gives the real area [10, 23]; a stable roughness factor between cleanings shows that the film is not being eroded.
- **Frequency.** On a clean, stable surface the frequency returns to the same value at the end of each cycle; a steady drift means dissolution [7] or adsorbate build up. In air, 1 nm of platinum corresponds to about 485 Hz [24].
- Users without a potentiostat (gas phase, catalysis) can follow the water contact angle: clean platinum is fully wetted by water and the angle increases with organic contamination.

STORAGE AFTER USE

Finish the last voltammogram on the cathodic sweep in the double layer region, so that the surface is stored reduced. Store dry in clean glass, polypropylene or PTFE containers, away from silicone, rubber and sulfur sources; never in chloride containing buffers. Carbon contamination keeps growing on platinum in air [12]: repeat Level 1 or 2 shortly 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, 25]. 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 [26]. In water near 25 °C the shift is about +23 Hz/°C at 10 MHz (calculated from the Kanazawa-Gordon equation with the viscosity of water [27]). 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 [28, 29]; chromium does the same and oxidizes at the surface at about 300 °C [30, 31]. 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 [32], cooling stresses between 200 and 550 °C create Dauphiné twins that ruin the resonator [18], and at 573 °C quartz goes through the alpha to beta transition with a sharp change of thermal expansion [33].

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 [34]. 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.

REFERENCES

[1] K. R. Williams, K. Gupta, and M. Wasilik. "Etch rates for micromachining processing. Part II". In: *Journal of Microelectromechanical Systems* 12.6 (2003), pp. 761–778. DOI: 10.1109/JMEMS.2003.820936.

[2] J. C. Hoogvliet and W. P. van Bennekom. "Gold thin-film electrodes: an EQCM study of the influence of chromium and titanium adhesion layers on the response". In: *Electrochimica Acta* 47 (2001), pp. 599–611. DOI: 10.1016/S0013-4686(01)00793-9.

[3] *QCM200 Quartz Crystal Microbalance Digital Controller: Operation and Service Manual, Revision 2.5*. Stanford Research Systems. 2018. URL: https://www.thinksrs.com/downloads/pdfs/manuals/QCM200m.pdf.

[4] D. Scaccabarozzi et al. "Measurement of the Instrumental Effect Caused by Flexure Clamping on Quartz Crystal Microbalances". In: *Applied Sciences* 15 (2025), p. 9261. DOI: 10.3390/app15179261.

[5] J. R. Vig. *Quartz Crystal Resonators and Oscillators for Frequency Control and Timing Applications: A Tutorial*. Tech. rep. SLCET-TR-88-1 (Rev. 8.4.2), AD-A328861. US Army Communications-Electronics Command, 2000.

[6] L. S. J. Ho, J. L. Limson, and R. Fogel. "Certain Methods of Electrode Pretreatment Create Misleading Responses in Impedimetric Aptamer Biosensors". In: *ACS Omega* 4 (2019), pp. 5839–5847. DOI: 10.1021/acsomega.9b00075.

[7] A. A. Topalov, I. Katsounaros, M. Auinger, et al. "Dissolution of Platinum: Limits for the Deployment of Electrochemical Energy Conversion?" In: *Angewandte Chemie International Edition* 51 (2012), pp. 12613–12615. DOI: 10.1002/anie.201207256.

[8] S. Geiger, S. Cherevko, and K. J. J. Mayrhofer. "Dissolution of Platinum in Presence of Chloride Traces". In: *Electrochimica Acta* 179 (2015), pp. 24–31. DOI: 10.1016/j.electacta.2015.03.059.

[9] A. N. Ivanovskaya, A. M. Belle, A. M. Yorita, et al. "Electrochemical Roughening of Thin-Film Platinum for Neural Probe Arrays and Biosensing Applications". In: *Journal of The Electrochemical Society* 165 (2018), G3125–G3132. DOI: 10.1149/2.0171812jes.

[10] M. Łukaszewski, M. Soszko, and A. Czerwiński. "Electrochemical Methods of Real Surface Area Determination of Noble Metal Electrodes: an Overview". In: *International Journal of Electrochemical Science* 11 (2016), pp. 4442–4469. DOI: 10.20964/2016.06.71.

[11] J. R. Vig. "UV/ozone cleaning of surfaces". In: *Journal of Vacuum Science & Technology A* 3 (1985), pp. 1027–1034. DOI: 10.1116/1.573115.

[12] P. J. Cumpson and M. P. Seah. "Stability of reference masses IV: Growth of carbonaceous contamination on platinum-iridium alloy surfaces, and cleaning by UV/ozone treatment". In: *Metrologia* 33 (1996), pp. 507–532. DOI: 10.1088/0026-1394/33/6/1.

[13] P. J. Cumpson and N. Sano. "Stability of reference masses V: UV/ozone treatment of gold and platinum surfaces". In: *Metrologia* 50 (2013), pp. 27–36. DOI: 10.1088/0026-1394/50/1/27.

[14] M. Bojinov, G. Fabricius, T. Laitinen, and T. Saario. "The Mechanism of the Transpassive Dissolution of Chromium in Acidic Sulfate Solutions". In: *Journal of The Electrochemical Society* 145 (1998), pp. 2043–2050. DOI: 10.1149/1.1838595.

[15] Y. Garsany, O. A. Baturina, and K. E. Swider-Lyons. "Impact of Sulfur Dioxide on the Oxygen Reduction Reaction at Pt/Vulcan Carbon Electrocatalysts". In: *Journal of The Electrochemical Society* 154 (2007), B670. DOI: 10.1149/1.2736648.

[16] K. G. Knauss and T. J. Wolery. "The dissolution kinetics of quartz as a function of pH and time at 70 °C". In: *Geochimica et Cosmochimica Acta* 52 (1988), pp. 43–53. DOI: 10.1016/0016-7037(88)90055-5.

[17] M.-S. Kim, J.-C. Lee, S.-W. Park, J. Jeong, and V. Kumar. "Dissolution behaviour of platinum by electro-generated chlorine in hydrochloric acid solution". In: *Journal of Chemical Technology & Biotechnology* 88 (2013), pp. 1212–1219. DOI: 10.1002/jctb.3957.

[18] C. Frondel. "Secondary Dauphiné twinning in quartz". In: *American Mineralogist* 30 (1945), pp. 447–460.

[19] P. D. Hren, H. Al-Shareef, S. H. Rou, A. I. Kingon, P. Buaud, and E. A. Irene. "Hillock Formation in Platinum Films". In: *MRS Proceedings* 260 (1992), p. 575. DOI: 10.1557/PROC-260-575.

[20] S. L. Firebaugh, K. F. Jensen, and M. A. Schmidt. "Investigation of high-temperature degradation of platinum thin films with an in situ resistance measurement apparatus". In: *Journal of Microelectromechanical Systems* 7 (1998), pp. 128–135. DOI: 10.1109/84.661395.

[21] G. Jerkiewicz, G. Vatankhah, J. Lessard, M. P. Soriaga, and Y.-S. Park. "Surface-oxide growth at platinum electrodes in aqueous H2SO4: Reexamination of its mechanism through combined cyclic-voltammetry, electrochemical quartz-crystal nanobalance, and Auger electron spectroscopy measurements". In: *Electrochimica Acta* 49 (2004), pp. 1451–1459. DOI: 10.1016/j.electacta.2003.11.008.

[22] P. Daubinger, J. Kieninger, T. Unmüssig, and G. A. Urban. "Electrochemical characteristics of nanostructured platinum electrodes: a cyclic voltammetry study". In: *Physical Chemistry Chemical Physics* 16 (2014), pp. 8392–8399. DOI: 10.1039/C4CP00342J.

[23] S. Trasatti and O. A. Petrii. "Real surface area measurements in electrochemistry". In: *Pure and Applied Chemistry* 63 (1991), pp. 711–734. DOI: 10.1351/pac199163050711.

[24] G. Sauerbrey. "Verwendung von Schwingquarzen zur Wägung dünner Schichten und zur Mikrowägung". In: *Zeitschrift für Physik* 155 (1959), pp. 206–222. DOI: 10.1007/BF01337937.

[25] R. Bechmann. "Frequency-temperature-angle characteristics of AT-type resonators made of natural and synthetic quartz". In: *Proceedings of the IRE* 44.11 (1956), pp. 1600–1607. DOI: 10.1109/JRPROC.1956.274879.

[26] K. K. Kanazawa and J. G. Gordon. "The oscillation frequency of a quartz resonator in contact with liquid". In: *Analytica Chimica Acta* 175 (1985), pp. 99–105. DOI: 10.1016/S0003-2670(00)82721-X.

[27] M. L. Huber, R. A. Perkins, A. Laesecke, et al. "New International Formulation for the Viscosity of H2O". In: *Journal of Physical and Chemical Reference Data* 38 (2009), pp. 101–125. DOI: 10.1063/1.3088050.

[28] W. E. Martinez, G. Gregori, and T. Mates. "Titanium diffusion in gold thin films". In: *Thin Solid Films* 518 (2010), pp. 2585–2591. DOI: 10.1016/j.tsf.2009.07.187.

[29] T. C. Tisone and J. Drobek. "Diffusion in thin film Ti-Au, Ti-Pd, and Ti-Pt couples". In: *Journal of Vacuum Science and Technology* 9 (1972), pp. 271–275. DOI: 10.1116/1.1316577.

[30] P. H. Holloway, D. E. Amos, and G. C. Nelson. "Analysis of grain-boundary diffusion in thin films: Chromium in gold". In: *Journal of Applied Physics* 47 (1976), pp. 3769–3775. DOI: 10.1063/1.323259.

[31] M. A. George, W. S. Glaunsinger, T. Thundat, and S. M. Lindsay. "Electrical, spectroscopic, and morphological investigation of chromium diffusion through gold films". In: *Thin Solid Films* 189 (1990), pp. 59–72. DOI: 10.1016/0040-6090(90)90027-B.

[32] J. Haines, O. Cambon, D. A. Keen, M. G. Tucker, and M. T. Dove. "Structural disorder and loss of piezoelectric properties in alpha-quartz at high temperature". In: *Applied Physics Letters* 81 (2002), pp. 2968–2970. DOI: 10.1063/1.1515363.

[33] R. J. Ackermann and C. A. Sorrell. "Thermal expansion and the high-low transformation in quartz. I. High-temperature X-ray studies". In: *Journal of Applied Crystallography* 7 (1974), pp. 461–467. DOI: 10.1107/S0021889874010211.

[34] T. Wasilewski et al. "Development and Assessment of Regeneration Methods for Peptide-Based QCM Biosensors in VOCs Analysis Applications". In: *Biosensors* 12 (2022), p. 309. DOI: 10.3390/bios12050309.