Development of a new CQCM/TQCM sensor to achieve good usability and temperature measurement

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Background – QCM: Contamination Sensor

Requirements for space use
- Wide temperature range: -190°C to +125°C
- Temperature measurement
- Frequency drift compensation

Our proposal for improving the QCM
- Sensor crystal replaceability for refreshment
- Temperature measurement with high accuracy
- Frequency drift compensation
- Usability

Advantages

Conventional structure

- Simple structure.
- Frequency drift compensation, without crystal matching.
- Direct temperature measurement using free area on the crystal disk.
- Sensor replaceable by using small clips.
- Equivalence of each electrode’s temperature condition.

Twin-QCM

- Easy sensor replacement
- Crystal matching.
- Long distance connection between the sensor unit and the controller.

Test Results

Fig. 5. Allan deviation of Twin-CQCM at room temp. and +125°C

When the averaging time is 10 seconds, the frequency deviation values were 0.011 Hz and 0.099 Hz at room temperature and +125°C.

Fig. 6. Twin-CQCM frequency drift in fundamental mode

When looking at the QTGA spectrum in Fig. 7, the temperature and rate of the desorption peaks are almost the same. From these results, compatibility with another QCM sensor was confirmed.

New application – Atomic Oxygen measurement

- Easy sensor replacement
  1. Open the sensor cover.
  2. Remove the clips and the sensor crystal disk.
  3. Put a new sensor on the LTCC holder.
  4. Close the cover.

Fig. 9. The sensor crystal with a polyimide film coated using a spin coater on the sensor electrode

Fig. 10. AO flux measurement by the Twin-CQCM sensor with a polyimide thin film

Other advantages – Unique technical points

- Long distance connection between the sensor unit and the controller
  The Twin-CQCM sensor guarantees a communication distance of at least 20 m using LVDS signals.
  Twin-TQCM development
  The simplified structure is applicable to Twin-Thermoelectric QCM (TQCM) in terms of tolerance against shock and vibration environment because the weight of the LTCC holder is light. The consumer model (Twin-TQCM) has passed shock testing with a peak level of 1000 G.

Conclusion

- NDK and JAXA has developed the new QCM sensor.
- Twin-CQCM has sufficient performance to measure contamination deposition and TGA.
- Temperature measurement seems to be very reliable.
- This good usability enables not only simplified sensor replacement but also new applications, such as atomic oxygen (AO) measurement and the fixation of contaminants by ultraviolet (UV) irradiation.