

Uniform Mass Sensitivity Thickness Shear Mode Quartz Resonator

Researchers at the University of South Florida have developed a Thickness Shear Mode (TSM) Quartz resonator to produce radial uniformity of mass sensitivity for absolute mass measurement at the Nano-gram level.

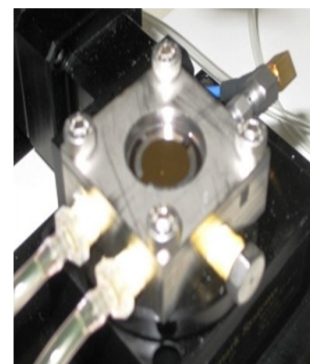
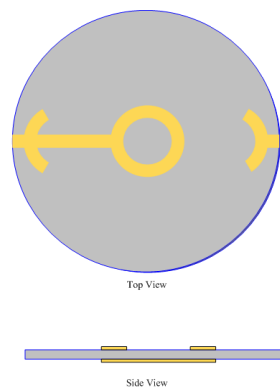
TSM quartz resonator, typically referred to as a Quartz Crystal Microbalance (QCM), is utilized as a mass characterization device for minute mass loadings, at the Nano-gram level. Deposition of mass, either in the form of a thin mass layer or point mass, on the device surface causes a reduction in the resonance frequency which is directly proportional to the minute mass deposited or loaded. However, there is a critical limitation on the mass sensitivity of current TSM devices. The non-uniformity of mass sensitivity in TSM devices is well documented in literature and it could be attributed to the reduction in quartz particle displacement amplitude away from the center and, consequently, reducing mass sensitivity. On the other hand, commercially available analytical and mechanical mass balances are limited to microgram measurement based on their low mass sensitivity.

To overcome this limitation, our inventors have developed a tangible TSM device exhibiting constant mass sensitivity across the active sensing area and high frequency stability, yielding a robust Nano-balance. It involves modification of the electrode configuration, based on model predictions, resulting in a mass sensitivity profile that is independent of material placement on the sensor platform. The Nano-balance would find applications in mass measurement, specifically in Droplet Gravimetry, the study of Non-Volatile Residue (NVR) contamination in solvents. Using a microvalve capable of depositing Nano-gram droplets and a linear stepping stage for radial positioning across the sensor platform, measurements of mass sensitivity distributions are conducted.

ADVANTAGES:

- **Robust Nano-balance responsive to Nano-gram mass loadings**
- **Uniform mass sensitivity across the sensing area**
- **Improved device resonance frequency stability**
- **Could be adapted for use with liquids and biological molecules that bind to the substrate**

Uniform Mass Sensitive Quartz Nano-Balance



Left: QCM Electrode in Ring Electrode Configuration

Right: Test Fixture

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