LONG-TERM FREQUENCY STABILITY OF HFF CRYSTALS SEALED WITH HIGH VACUUM TECHNOLOGY

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This work describes results of long-term stability (aging) study for 155.52 MHz fundamental mode quartz crystal resonators. The resonator contains an "inverted mesa" AT-cut crystal wafer fabricated using wet chemical etching process and base-plated with Cr-Ag or Cr-Au electrodes. The structure is packaged in HC-45 holder and sealed in high vacuum using cold-welding method. In the sealing chamber devices were vacuum baked at about 200°C prior to welding.

Test of about 100 crystals fabricated with above process was conducted at 85°C with daily frequency reading. As a result of the test, most of the units showed frequency changes less than 1 ppm for the first 3 months while some crystals showed no noticeable changes in frequency. Obtained results on aging essentially surpass those of the back-filled (usually dry nitrogen or nitrogen/helium mixture) HFF resonators packaged using conventional resistance-welding process.

Due to quite different content of residual gases inside the vacuum-sealed crystals as compared to conventional ones, essentially different aging mechanisms take place. The paper analyzes influence on the aging of various factors such as the electrodes material, baking process parameters, and others.

Since prolonged pre-aging tests are difficult to realize in large-scale production, the accelerated method has been developed to predict and improve long-term stability of the vacuum-sealed resonators.