Temperature-Compensated CMOS-MEMS Oxide Resonators

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Abstract— Integrated CMOS-MEMS clamped-clamped beam resonators using metal wet etching technique are demonstrated with passive temperature compensation through the use of SiO2 and large stopband rejection via circuit integration. Such performance is enabled by the high- Q structural material (i.e., SiO2) and embedded electrodes (i.e., metal) for capacitive transduction without the need of complex post-CMOS processes. In virtue of exceptional selectivity of metal wet etchant to SiO2 among CMOS layers, the use of release holes needed for most of isotropic etching processes could be eliminated, hence substantially preserving the integrity of resonator structures. In this paper, CMOS-MEMS clamped-clamped beams with SiO2-rich structural design are fabricated and tested in vacuum under a two-port measurement configuration, exhibiting the lowest temperature coefficient of frequency (TCf) in CMOS-MEMS-based resonators with a turnover point at room temperature. Such a resonator monolithically integrated with readout circuitry using a standard CMOS 0.35 m 2P4M process is tested with significantly enhanced performance, showing resonator Q's up to 6100, stopband rejection ~60 dB, and low noise floor at center frequency ~8 MHz, therefore benefiting future timing references and RF-MEMS building blocks for next-generation wireless communication applications.

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