4th URSI AT-RASC, Gran Canaria, 19 – 24 May 2024

X-Band Overmoded Sapphire Bragg Resonator

Craig W. Nelson*(1), and Archita Hati(1)
(1) National Institute of Standards and Technology, Boulder, CO, 80305, http://tf.nist.gov

Low phase noise microwave sources are a pivotal area of research for applications such as radar, imaging, time and frequency metrology, and quantum processing. Low-loss resonators utilizing sapphire dielectric to shield cavity modes from the lossy metal walls have produced many outstanding low-noise oscillators in various configurations such as whispering gallery mode, interferometric [1], cryogenic and distributed Bragg reflectors (DBR) [2–4].

We extend the work of [2, 4] by exploring the higher order modes of a cylindrical metal cavity with distributed sapphire Bragg reflectors on the z-axis. Utilizing a sandwich design, we can stack various layers together, and create different configurations with the same base components. With our design, we have created TE011, TE013, and TE015 center mode sections, which we can pair with single or multiple reflectors in both 1/4 wavelength and 3/4 wavelength thickness. We will present simulated results with cavity modes exhibiting unloaded quality factor $(Q_U) > 10^6$ and experimental results of a 10 GHz oscillator with single sideband phase noise of $\mathscr{L}(1\text{kHz}) = -155$ dBc/Hz.

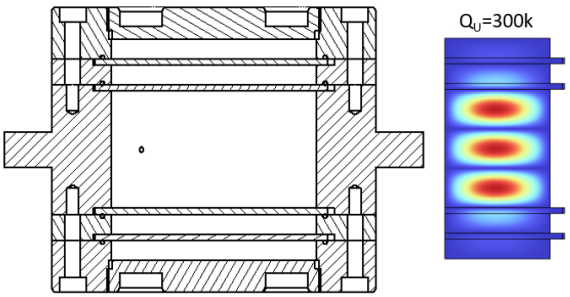

Figure 1. Distributed Bragg Resonator with a TE013 center section, two 1/4λ sapphire wafer reflectors on each end, and threaded end caps for fine tuning. A simulated 2D-Axisymetric mode shape is shown on the left.

References

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