Optical Gyroscope based on Disc resonators: fabrication and packaging

Eyal Yacoby[1], Yosef London[1], Itzik Engel[2], Harel Sharabi[2], and Shaul Pearl[1]

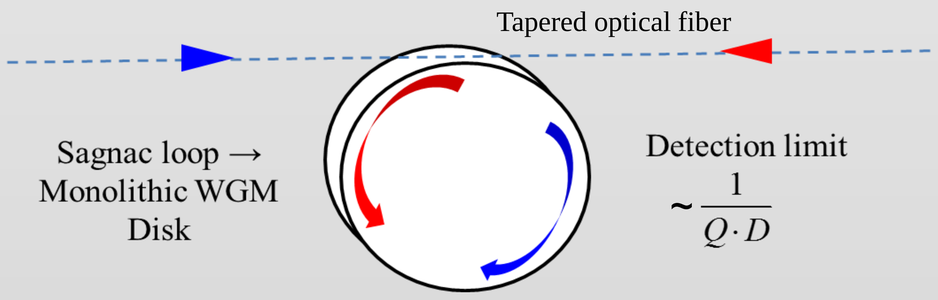
[1]Applied Physics Division, Soreq NRC, Rd 4111, Yavne, Israel
[2]CIELO Inertial Solutions LTD

A monolithic photonic gyroscope is demonstrated based on Sagnac effect in ultra-high Q (~10^9) Optical Whispering Gallery Modes (WGMs) resonator. The suggested gyroscope is considerably cheaper, smaller, and should provide better thermal stability than commercial Fiber Optics Gyroscopes (FOGs). Here we present the fabrication and packaging of silica disk WGM resonator, and demonstrate preliminary measurements of rotation.

1

Concept

Frequency shift between counter propagating WGMS indicates on angular velocity

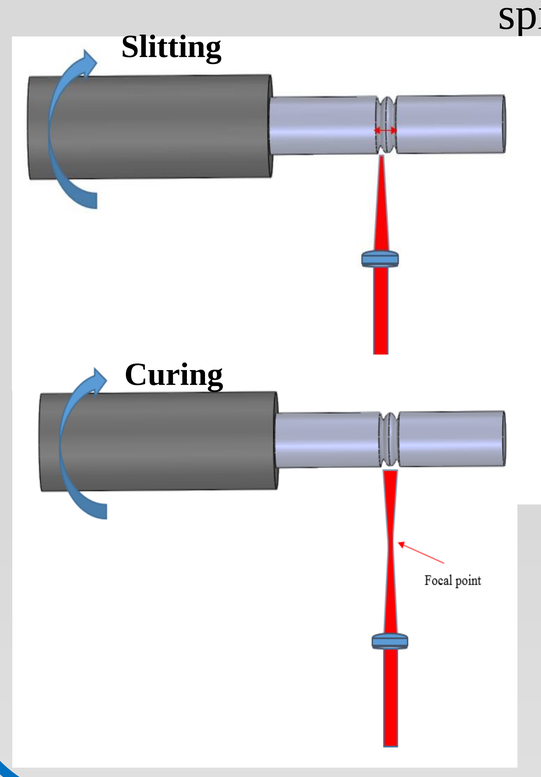


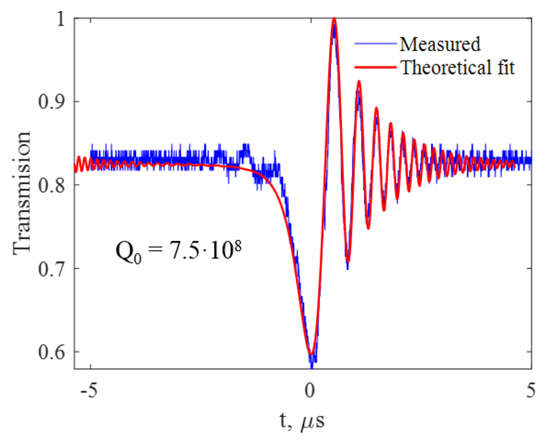
In FOGs – length serves for high angular velocity sensitivity. Here, the effective **long lifetime** of the optical mode inside the resonator alleviates the need for long distance phase accumulation.

2

Fabrication

The disc resonators are imprinted on thick silica rod (14 mm – 25 mm) using a CO_2 laser while spinning in a motorized spindle.



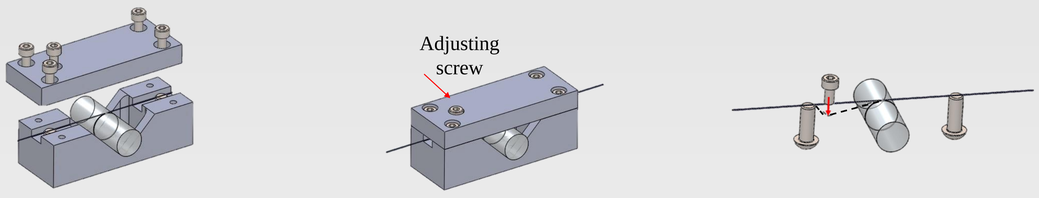


Ultra high Q is evaluated from the ringing pattern in the transmission of the tapered fiber.[1]

3

Packaging

A unique packaging method provides the ability to tune and adjust the coupling efficiency.

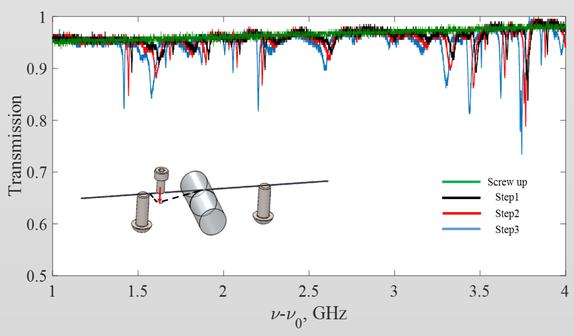


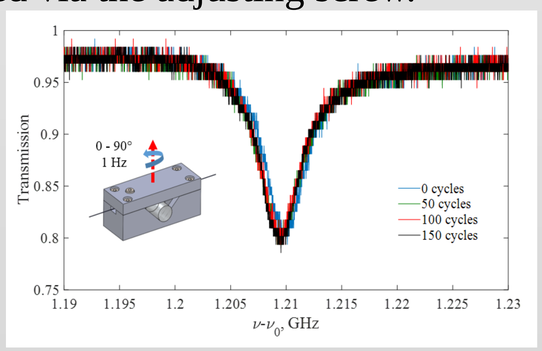
An adjusting screw, when fastened, "pushes" the tapered fiber toward the disc resonator, changing the effective coupling length.

4

Tunability and stability

An initial air gap between the tapered fiber and the resonator is closed during the first rotation step of the adjustment screw, and as a consequence multiple dips appear in the transmission spectrum. Coupling can be further altered via the adjusting screw.

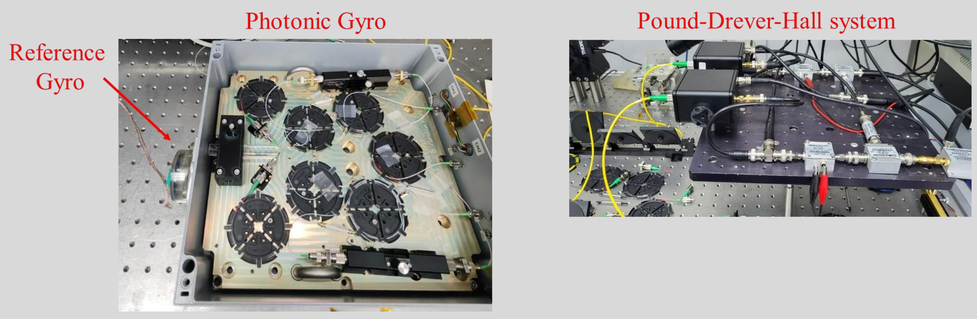


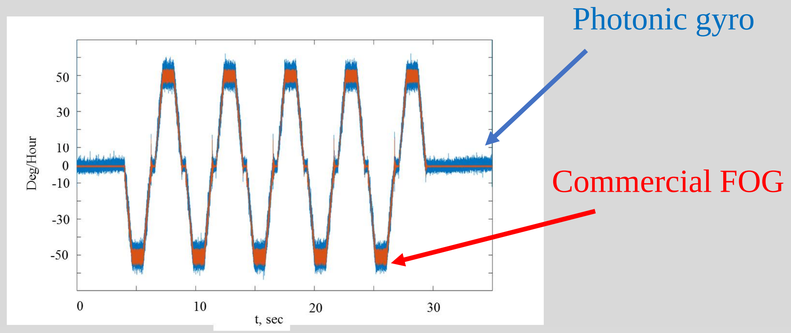


The robustness of the device was examined by rotating the entire construction back and forth ± 45 degrees at a frequency of 1 Hz.

5

Photonic Gyro - Demonstration





ARW – 1.4 deg√hr

Bias instability$_{@T300}$ = 4.9 deg/hr

6

Summary

- Fabrication and packaging of a cm-scale silica disc resonator with a Q factor as high as $7.5 \cdot 10^8$.
- We describe a unique packaging scheme which offers the ability to tune and adjust the coupling efficiency of light into the WGMs.
- Preliminary measurements of rotation (performed at CIELO LTD).

[1] Dong, C., Zou, C., Cui, J., Yang, Y., Han, Z. and Guo, G., "Ringing phenomenon in silica microspheres," Chin, Opt. Lett. 7(4), 299-301(2009).