SAGNAC OPTOMECHANICAL GYROSCOPE

Sandia National Laboratories

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SD# 14018
Technology Readiness Level: 3
Concept Demonstrated Analytically

A miniaturized gyroscope with improved sensitivity and performance for navigation applications requiring low-cost and reduced power devices

Gyroscopes are important for applications in navigation, guidance, and control. Ideally, gyroscopes are accurate, stable, low cost, low power, and small weight and size, in some cases with high dynamic range. Many of these applications could benefit from miniaturization; however, the possibilities are limited because designs for conventional gyroscopes tend to exhibit better sensitivity and resolution at larger scales.

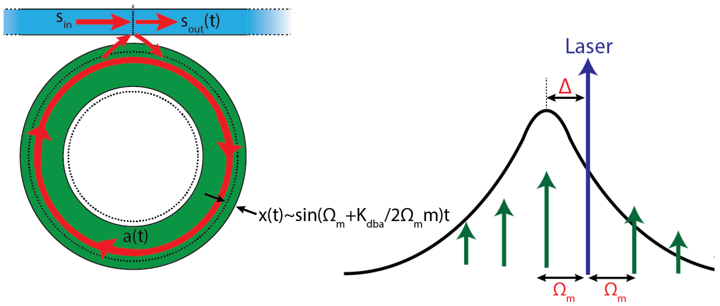

Figure 1 (left): Top view of gyroscope. S_{out} is output laser field amplitude. S_{in} is input laser field amplitude is output laser field amplitude. a(t) is circulating field amplitude. x(t) is displacement. Ω_m is mechanical frequency (rad/sec). k_{dba} is optomechanical spring value. m is effective mass. Figure 2 (right): Frequency domain representation. Δ is detuning (rad/s).

Sandia researchers have developed an **Optomechanical Gyroscope** to sense rotation in applications that require high-performing, small form-factor devices for navigation, guidance, and control applications requiring low-cost and reduced power requirement devices. This gyroscope design solves a longstanding trade-off between size and performance by leveraging the scaling properties of the optomechanical spring effect, which improves scale factor sensitivity as device dimensions shrink. Upon rotation, the laser frequency detuning changes due to the Sagnac effect. The change in detuning induces a change in the mechanical resonant frequency due to the well-known optical spring effect. This gyroscope design may achieve sensitivity that competes with fiber-optic gyroscopes at an order of magnitude lower cost and size.

TECHNICAL BENEFITS

- Scale factor sensitivity improves as the device dimensions shrink
- Miniaturization (15 microns) leads to lower cost per unit and reduced power requirements
- No laser modulation required
- Supports co-located and coupled optical and high Q mechanical modes
- Manufacturable in semiconductor microfabrication facilities
- Reduces reliance on GPS

INDUSTRIES & APPLICATIONS

- Military / defense
- GPS-denied navigation and guidance
- Navigation alternative to GPS in high-end consumer products such as cell phones and vehicles

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U.S. Department of Energy NNSA National Nuclear Security Administration

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