Virtually Levitated Hybrid Shell Resonator Gyroscope (#6855, 6581)

A micro-hemispherical resonating gyroscope that can operate in whole angle mode.

Georgia Tech inventors have developed a micro-hemispherical resonating gyroscope that can operate in whole angle mode. The resonating assembly is comprised of a hemispherical resonating body virtually levitated over the substrate by a support stem. The resonating body may also incorporate a mass-loading ring. A ring of capacitive electrodes surrounds the resonating body. The three-dimensional resonator structure can obtain a lower resonant frequency than other MEMS structures, and the design can potentially achieve an ultra-high quality factor, leading to long ring-down times. The axisymmetry also provides for a consistent resonant frequency as the vibration precesses. This results in a high-performance, small-sized resonator suitable for both whole angle mode and rate mode operation that can be fabricated using standard semiconductor fabrication techniques.

Benefits/Advantages

- **Low Cost** – Successful fabrication and operation of micro-hemispherical shell resonators (mHSR) have provided great potential for low-cost fabrication of integrated micro-hemispherical resonating gyroscopes (mHRG).
- ?**Simplified Process** – Self-aligned drive, sense and tuning electrodes, all fabricated using a single wafer process
- **Increased Sensitivity** – Strong rotation rate sensitivity

Potential Commercial Applications

- Consumer electronics
- Gaming consoles
- Platform stabilizers
- Personal navigation systems
- Satellites and spacecraft

Background/Context for This Invention

The use of MEMS gyroscopes for inertial navigation systems is generally limited by the accumulation of errors over time due to the integration of angular velocity when calculating the angle of rotation, which requires periodic recalibration. Whole angle gyroscopes (rate-integrating or RIGs) directly measure the angle of rotation and eliminate integration errors but require resonators with a long ring-down time to allow the vibration pattern to precess freely around the resonator as the device rotates, which is difficult to achieve in micro-fabricated sensors.

Dr. Farrokh Ayazi
Professor and Director of Integrated MEMS (IMEMS) Laboratory – Georgia Tech School of Electrical and Computer Engineering

Vahid Tavassoli
Postdoc - Georgia Tech department of Electrical and Computer Engineering

Peng Shao
Graduate Research Assistant – Georgia Tech School of Electrical and Computer Engineering

Xin Gao
Graduate Research Assistant – Georgia Tech School of Electrical and Computer Engineering

Patent/IP Information

U.S. Patent Issued

Publications

Integrated MEMS Laboratory

A Polysilicon Microhemispherical Resonating Gyroscope, Journal of Microelectromechanical Systems, August 2014

A 3D-HARPSS Polysilicon Microhemispherical Shell Resonating Gyroscope: Design, Fabrication, and Characterization

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/virtually-levitated-hybrid-shell-resonator-gyroscope