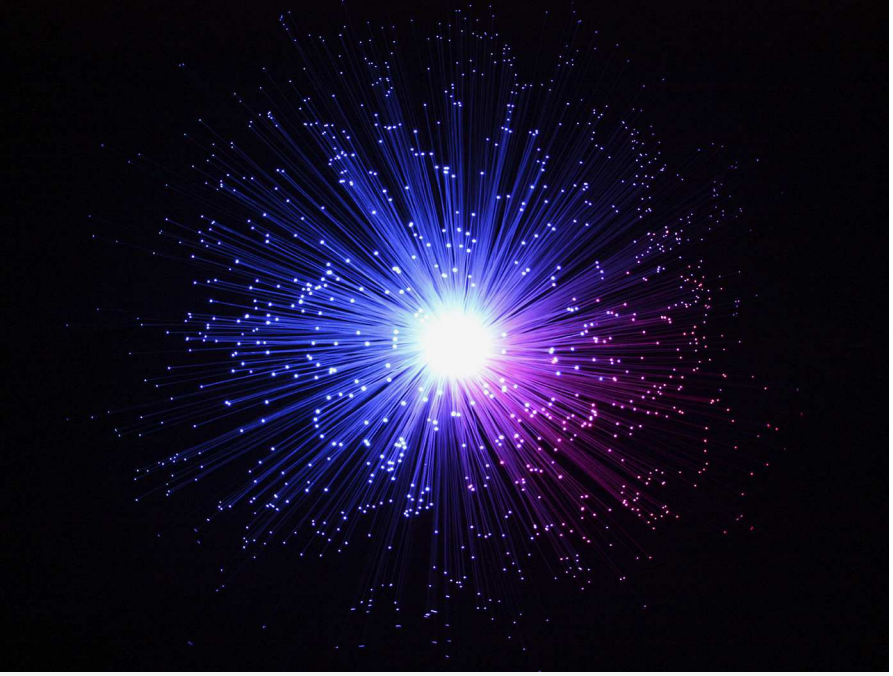


National Aeronautics and
Space Administration

technology solution

Communications

# Polarization Dependent Whispering Gallery Modes in Microspheres

## Have sensitivities that exceed conventional sensors

Dielectric microspheres are optical structures that exhibit resonant properties, meaning they can be used to select very narrow wavelengths of an incoming light beam's spectrum for further manipulation and processing. The optical resonances of a microsphere are frequently called morphology dependent resonances (MDRs) or whispering gallery modes (WGMs). Innovators at NASA's Glenn Research Center have developed a method of separating low-level modes propagating in an optical fiber through the use of WGMs in spherical resonators. The unusually high quality factors (Q-factors) that can be achieved by side coupling of light into the dielectric spheres allows for measurement sensitivities that may far exceed those of more conventional sensors. Whispering gallery modes' high sensitivity to environmental conditions and their small size make them good candidates for a wide range of sensors.

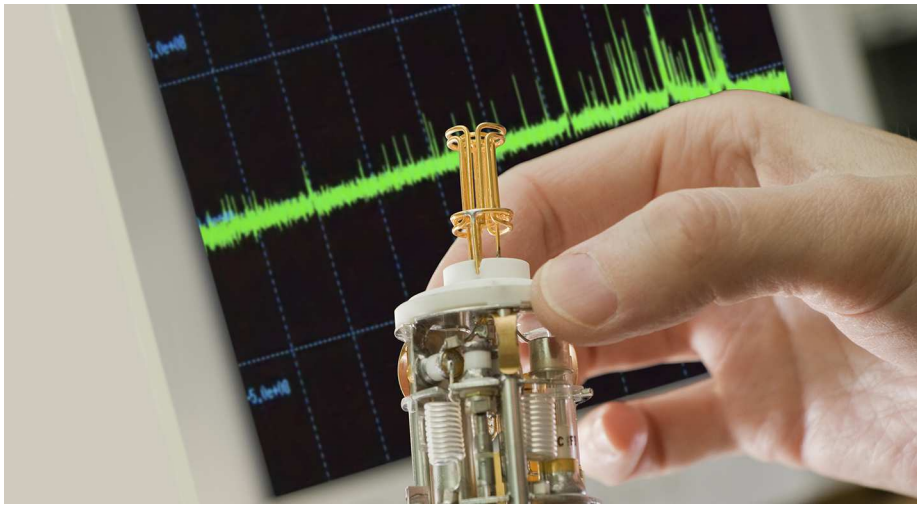
## BENEFITS

- Small size: With typical sphere sizes in the range from 100 to 1000 micrometers (m), a large number of different types of sensors can be packed inside a small volume
- Unique fiber coupling approach: Allows for the development of distributed sensors with multiple spheres on a single optical fiber
- Unusually high Q-factors: Offers very high sensitivity; Q-values as high as 109 can be achieved

## THE TECHNOLOGY

NASA Glenn's whispering gallery modes enable new ways to utilize the morphology-dependent resonances in a sphere or other body of revolution. In this innovation, the incident light delivered to the microsphere is manipulated before it reaches the destination. That manipulation could be achieved by either changing the geometry or physical properties of the waveguide or changing the parameters of the light itself. Different propagation modes may be selected for coupling into the optical resonant cavity by changing the polarization of light introduced to the system that contains the optical fiber and the body of revolution that functions as the optical resonator. Selection of the parameters of light introduced to the optical fiber (which is adjacent to the optical resonant cavity) produce changes in the mode of propagation that is allowed to couple to the sphere as a morphology-dependent resonance.

This is an early stage-technology requiring additional development. Glenn welcomes co-development opportunities.



The high sensitivity of NASA Glenn's whispering gallery modes makes them good candidates for a wide range of sensors

## APPLICATIONS

The technology has several potential applications:

- Aerospace vehicle control sensors
- Health and performance monitoring sensors
- Optical communication sensors
- Biological sensors

## PUBLICATIONS

Patent No: 9,291,774

More Information

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