Silica sphere optical resonators are used to provide surface-enhanced spectroscopic signal.

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The motivation of this work was to have robust spectroscopic sensors for sensitive detection and chemical analysis of organic and molecular compounds. The solution is to use silica sphere optical resonators to provide surface-enhanced spectroscopic signal.

Whispering-gallery mode (WGM) resonators made from silica microspheres were used for surface-enhanced Raman scattering (SERS) without coupling to a plasmonic mechanism. Large Raman signal enhancement is observed by exclusively using 5.08-micron silica spheres with 785-nm laser excitation. The advantage of this non-plasmonic approach is that the active substrate is chemically inert silica, thermally stable, and relatively simple to fabricate. The Raman signal enhancement is broadly applicable to a wide range of molecular functional groups including aliphatic hydrocarbons, siloxanes, and esters. Applications include trace organic analysis, particularly for in situ planetary instruments that require robust sensors with consistent response.

WGM SERS using microspheres or quartz surface structures provide a chemically robust surface for sensor applications that could be cleaned by resistively heating the sensor element. This is particularly useful for spacecraft instruments used for the detection of organics in planetary soils. The conventional silver-based SERS substrates are limited by reactivity of silver. In the case of gold SERS substrates, high temperatures (<200 °C) will cause diffusion in the gold that degrades the nanostructure. The use of WGM SERS may also be used for surface analysis in a manner similar to attenuated total reflectance used in infrared spec-