Whispering gallery mode microresonators for trace gas sensing

Infrared absorption spectroscopy is a powerful technique for identifying and characterizing molecules of interest in a gas sample. However, its sensitivity is limited by the effective path length over which infrared radiation can interact with the gas. Consequently, analysis of trace gases requires cavity-enhanced spectroscopy methods. One type of resonant cavity, the dielectric microsphere, has been comprehensively studied for visible light in silica glass. These resonators sustain whispering gallery modes, where radiation is confined to the microsphere equator region by repeated total internal reflection at a glancing angle. Recently, optical fiber materials with a high transmission and index of refraction in the near/mid-infrared have become available. We propose adapting microsphere resonators to these wavelengths, where molecules have strong absorption bands. These compact optical cavities offer great potential for use in practical trace gas sensing devices. In this talk, I will present the preliminary results of this endeavour. Using a CO_2 laser reflow process, microspheres have been fabricated from ZrF_4, As_2S_3, and As_2Se_3 optical fiber. The efficacy of this technique as applied to these fluoride and chalcogenide glasses has been demonstrated, and the results also suggest some possible improvements. To couple radiation from an infrared diode laser (at ~2.65 μm) into the microspheres, frustrated total internal reflection at a rutile TiO_2 prism surface has been selected for investigation. The experimental implementation of this coupling method will be discussed in detail, along with some of the challenges that have emerged.