NASA SBIR/STTR Technologies

Self-calibrating High-resolution Tunable Filter for Remote Gas Sensing Applications

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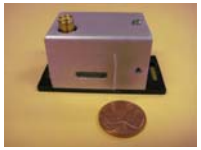
Identification and Significance of Innovation

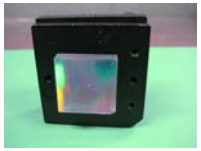
The objective of Phase-I work has been to design and develop a compact, robust, optically based sensor for local and remote sensing of oxygen (O2) at 1.26 µm, carbon dioxide (CO2) at 1.56 µm and other species in spectral region of up to 2µm. We employed acousto-optic technology for accomplishing this objective, and in that we designed and fabricated two acousto-optic devices, one an Acousto-Optic Tunable Filter (AOTF) and the other an Acousto-Optic Deflector (AOD). Using these Acousto-Optic devices in conjunction with diffraction grating (DG) and employing deconvolution techniques we demonstrated that signal filtering with sub-100pm resolution is achievable. Passive filters employing Fabry-Perot etalons and fiber Bragg gratings have also been studied and devised schemes for more demanding NASA lidar applications..

TRL: Range at the end of Contract –Phase I – 4; Phase 2 – 6.

(a)



(b)



(c)

(d)

(a) An Acousto-Optic Tunable Filter fabricated at Brimrose.
(b) An Acousto-Optic Deflector fabricated at Brimrose
(c) A commercially available diffraction grating used in the setup
(d) A dual-channel RF driver assembled at Brimrose for operating the Filter system.

Technical Objectives

- Design and develop widely tunable narrowband optics filter
-Study self calibration and resolution enhancement by deconvolution data processing
-Test and characterize high resolution Acousto-Optic based filter system
-Study other passive filters involving Fabry-Perot etalons and fiber Bragg gratings

Work Plan

- Design and develop filters based on Acousto-Optic based technology
- Establish self-calibration and deconvolution procedures for achieving higher measurement resolution
- Demonstrate enhanced spectral resolution using AOTF
- Evaluate applicability of passive filter techniques based on Fabry-Perot etalons and Fiber Bragg gratings.
- Develop prototype so that a full scope instrument in Phase-II can be built for practical applications.

NASA Applications

Useful in suppressing background noise in lidar gas sensing applications of O_2 and CO_2 and many other atmospheric species. Other applications include gas sensing in propulsion systems, concentration mapping both for local and remote sensing, including on mobile platforms.

Non-NASA Applications

Fuel tank oxygen concentration sensing and monitoring the combustion efficiency in terrestrial gas turbine and high-pressure combustion systems. The instrument can also be used as a sensor for real-time biological measurements and in detection of complex molecules that have extremely broad absorption signatures could be fully resolved with this sensor, with application to national security sensing of weapons and explosives.

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