Methane Sensing Immersion Grating Spectrometer (MSIGS)

Completed Technology Project (2016 - 2018)

Project Introduction

Develop long-wave infrared (LWIR) immersion grating fabrication techniques and mature high resolution LWIR spectrometer technology to demonstrate an imaging spectrometer testbed for remote sensing of methane.

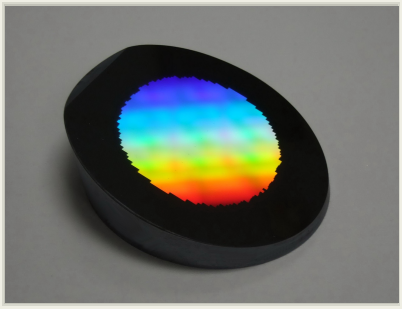
Our objective is to develop an imaging spectrometer testbed for remote sensing of the trace gas methane. The testbed will demonstrate compact spectrometer optical designs that will be enabled by using immersion gratings fabricated from silicon or germanium. Such designs are significantly more compact than non-immersion designs because the grating refractive index reduces the wavelength inside the material, leading to reduced grating groove spacing and thus reduced grating area to achieve a desired spectral resolution. The gratings will be fabricated by several techniques and evaluated to determine which material and fabrication technique yields the best system performance for this application. The testbed will capture methane emission spectra in the long-wave infrared (7.65 μm wavelength region) and will allow JPL to build on its existing techniques and algorithms for analyzing methane emission spectra in the long-wave infrared.

Anticipated Benefits

The NASA Hyperspectral Thermal Emission Spectrometer (HyTES) currently images methane plumes in the 7.65 μm wavelength region remotely, but it is challenging for HyTES to determine the absolute uncertainly of the methane retrieval to better than 20% primarily due to its low spectral resolution. We will develop the thermal infrared Methane Sensing Immersion Grating Spectrometer (MSIGS) testbed with an immersion grating tuned to the 7.65 μm methane feature. Simulations predict that this will allow methane retrievals of with nearly 10X improvement on the current uncertainty, with effectively zero interference error and substantial sensitivity right at Earth's surface. MSIGS will also be imaging like HyTES allowing mapping of any methane plumes at lower concentrations.

Remote detection of methane from space could provide revenue for commercial satellite providers.

Methane sensing is of interest to a variety of agencies involved with energy production, gas monitoring, and intelligence.

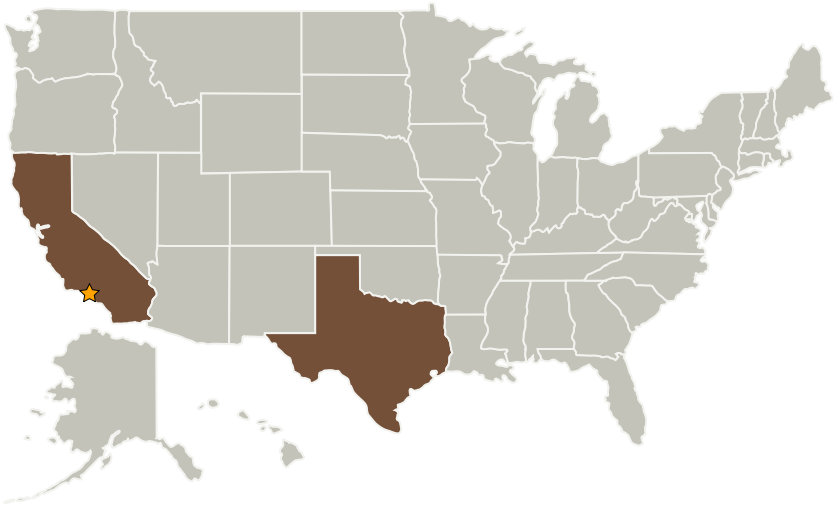


Photograph of a silicon immersion grating with blazed grooves etched into a silicon prism.

Table of Contents

Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Organizational Responsibility	2
Project Management	2
Images	3
Technology Maturity (TRL)	3
Technology Areas	3
Target Destinations	3
Supported Mission Type	3

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Jet Propulsion Laboratory(JPL)	Lead Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Texas

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Jet Propulsion Laboratory (JPL)

Responsible Program:

Center Independent Research & Development: JPL IRAD

Project Management

Program Manager:

Fred Y Hadaegh

Project Manager:

Fred Y Hadaegh

Principal Investigator:

Daniel W Wilson

Co-Investigators:

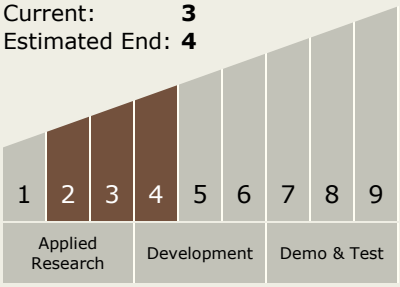
Cynthia Brooks
Simon J Hook
Daniel Jaffe
William R Johnson

Images

JPL_IRAD_Activities Project Image
Photograph of a silicon immersion grating with blazed grooves etched into a silicon prism.
(https://techport.nasa.gov/image/27905)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.3 Optical Components

Target Destinations

Foundational Knowledge, Earth

Supported Mission Type

Push