PROJECT SUMMARY

Firm: **MetroLaser, Inc.**
Contract Number: **NNL07AA07C**
Project Title: **One-Dimensional Tunable Photonic-Crystal IR Filter**

Identification and Significance of Innovation:

MetroLaser, Inc. has designed and developed an innovative narrowband tunable IR filter based on the properties of a one-dimensional photonic crystal structure with a resonant cavity. Such a structure exhibits an ultra-narrow, high-throughput band in the middle of a wide low-transmission stop-band. During this Phase II project, we demonstrated experimentally the proof-of-concept for the filter with 0.1 cm^{-1} bandpass and a tuning range of at least 10 cm^{-1} with out-of-band rejection level ~ 30 dB in the spectral region around 10.6 µm. We completed modeling of the functional characteristics, based on the specific features of photonic crystal structures with a resonant cavity, and developed a strategy for building a prototype of the instrument. Fine-tuning of the filter will be accomplished by varying the optical cavity length. The filter has an acceptance angle of at least 1° and an aperture of about 1 inch.

Technical Objectives and Work Plan:

The overall objective of the Phase II effort was to develop, design, build and field-test a photonic crystal based filter with the following performance characteristics in a specified LWIR spectral region with the following performance characteristics in the long-wave infra-red (LWIR) spectral region (around 10µm):

- a bandpass width ~ 0.1 cm^{-1},
- a bandpass transmission > 50% (at the specified spectral range of operation),
- a tuning range ~ 10 cm^{-1},
- background rejection > 30 dB,
- acceptance angle up to 1°, and
- working aperture diameter ~1 inch

Technical Accomplishments:

MetroLaser designed and developed an innovative narrowband tunable IR filter with its features based on the properties of a one-dimensional photonic crystal structure with a resonant cavity. Such structure exhibits an ultra-narrow, high-throughput band in the middle of a wide, low-transmission stop-band. During Phase II, we will design, build, and perform field testing of a compact and robust prototype module of a 2” diameter narrowband filter with a tunability range of 10 cm^{-1}, a bandpass range of 0.1 cm^{-1}, background rejection of 30 dB, and transmittance better than 50%.

NASA Application(s):

The proposed narrowband tunable IR bandpass filter will expand the capabilities of NASA’s Earth-Sun System Division for high spectral resolution and high accuracy measurements of tropospheric, atmospheric, and surface parameters from space and airborne platforms. These include remote sensing capabilities, measurements of climate and meteorological parameters, and terrain mapping.

Non-NASA Commercial Application(s):

The narrowband tunable bandpass filter can find commercial applications in space-based and airborne multi-spectral imaging and remote sensing systems, including tropospheric chemistry studies and atmospheric science. It will expand capabilities for high accuracy spectral measurements within the tunable narrow spectral regions necessary for resolving individual spectral features. Due to its high

spectral resolution, wide tunability range, compactness, ruggedness and stability, the proposed filter will allow for innovative solutions in high-resolution spectroscopic instrumentation, especially when portable devices are of interest. The performed experiments have shown that such filter can be applicable for detection, identification and characterization of the remote objects.

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