NASA STTR 2021 Phase I Solicitation

T8.07 Photonic Integrated Circuits

Lead Center: GSFC

Participating Center(s): GRC, LaRC

Scope Title:

Photonic Integrated Circuits

Scope Description:

Photonic integrated circuits (PICs) generally integrate multiple lithographically defined photonic and electronic components and devices (e.g., lasers, detectors, waveguides/passive structures, modulators, electronic control, and optical interconnects) on a single platform with nanometer-scale feature sizes. PICs can enable size, weight, power, and cost reductions and improve the performance of science instruments, subsystems, and components. PIC technologies are particularly critical for enabling small spacecraft platforms. Proposals are sought to develop PIC technologies including the design and fabrication of PICs that use nanometer-scale structures and optical metamaterials. On-chip generation, manipulation, and detection of light in a single-material system may not be practical or offer the best performance, so hybrid packaging of different material systems are also of interest. This subtopic solicits methods, technology, and systems for development and incorporation of active and passive circuit elements for PICs for:

- PICs for in situ and remote sensors—NASA application examples include but are not limited to lab-on-a-chip systems for landers, 3D mapping lidar, front end and back end for remote-sensing instruments including trace gas lidars, optical spectrometers, gyroscopes, and magnetometers.
- PICs for analog radiofrequency (RF) applications—NASA applications require new methods to reduce the size, weight, and power of passive and active microwave signal processing. As an example, PICs having very low insertion loss (e.g., ~1 dB) and high spurious-free dynamic range for analog and RF signal processing and transmission that use monolithic high-Q waveguide micro-resonators or other filters with a few GHz RF passbands. These components should be suitable for designing chip-scale tunable optoelectronic RF oscillator and high-precision optical clock modules. Example applications include terahertz spectroscopy, microwave radiometry, and hyperspectral microwave sounding.

Expected TRL or TRL Range at completion of the Project: 2 to 4
Primary Technology Taxonomy:
Level 1: TX 08 Sensors and Instruments
Level 2: TX 08.1 Remote Sensing Instruments/Sensors
Desired Deliverables of Phase I and Phase II:

- Research

- Analysis
- Prototype
- Hardware

Desired Deliverables Description:

Phase I does not need to include a physical deliverable to the government but it is best if it includes a demonstration of feasibility through measurements. This can include extensive modeling but a stronger proposal will have measured validation of models or designs.

Phase II should include prototype delivery to the government. (It is understood that this is a research effort and the prototype is a best effort delivery where there is no penalty for missing performance goals.) The phase II effort should be targeting a commercial product that could be sold to the government and/or industry.

State of the Art and Critical Gaps:

There is a critical gap between discrete and bulk photonic components and waveguide multifunction PICs. The development of PICs permits size, weight, power, and cost reductions for spacecraft microprocessors, communication buses, processor buses, advanced data processing, and integrated optic science instrument optical systems, subsystems, and components. This is particularly critical for small spacecraft platforms.

Relevance / Science Traceability:

HEOMD—Astronaut health monitoring.

SMD—Earth, planetary, and astrophysics compact science instrument (e.g., optical and terahertz spectrometers and magnetometers on a chip).

STMD—Game-changing technology for small spacecraft communication and navigation (optical communication, laser ranging, and gyroscopes).

STTR—Exponentially increasing interest and programs at universities and startups in integrated photonics.

Space Technology Roadmap 6.2.2, 13.1.3, 13.3.7, all sensors, 6.4.1, 7.1.3, 10.4.1, 13.1.3, 13.4.3, 14.3.3

References:

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3. Integrated Photonics in the 21st Century. By: Thylen, Lars; Wosinski, Lech: Photonics Research, vol. 2, issue 2, pp. 75-81, Published April 2014.
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