NASA STTR 2019 Phase I Solicitation

T8.04 Metamaterials and Metasurfaces Technology for Remote Sensing Applications

Lead Center: GSFC

Participating Center(s): GSFC

Technology Area: TA8 Science Instruments, Observatories & Sensor Systems

Metamaterials are manmade (synthesized) composite materials whose electromagnetic, acoustic, optical, etc. properties are determined by their constitutive structural materials and their configurations. Metamaterials can be precisely tailored to manipulate electromagnetic waves, including visible light, microwaves, and other parts of the spectrum, in ways that no natural materials can (Kock 1946, 1948; Cotton 2003; Alici et al. 2007). The development of metamaterials continues to redefine the boundaries of materials science. In the field of electromagnetic research and beyond, these materials offer excellent design flexibility with their customized properties and their tunability under external stimuli. The vast possibilities for metamaterial technology to apply to remote sensing applications could apply to various areas across SMD, including Earth, lunar, and planetary science.

Topics of potential interest to explore for NASA's applications are listed below:

- Antenna beam shaping with metamaterials (at optical as well as microwave wavelengths).
- Reconfigurable metamaterial filters covering microwave to optical frequency bands
- Development of microwave and millimeter-wave metamaterials: radar scanning systems, flat panel antennas, novel magnetic materials and high-performance absorbing and shielding materials for electromagnetic compatibility or interference (EMC/EMI). Single feed horn antennas to cover multiple frequencies, including 10, 18, 36, and 89 GHz (Caloz et al. 2001; Caloz and Itoh 2002).
- Development of fabrication processes for metamaterials with nanoparticles
- Tunable, reconfigurable metamaterials using liquid crystal medium (Applications: IR and Optical spectrometers).
- Development of artificial ferrites and artificial dielectrics using metamaterial concepts to design electrically small, lightweight, and efficient RF components.
- Use of Gradient Indexed Metamaterial (GIM) for on-chip routing of light and THz frequency signals. Design and prototype development of broadband (covering 10 GHz) THz components such as transmission line bends, power splitters, filters, and photonics.

Phase I should provide a comprehensive feasibility study to address an applicable area of interest within the field of metamaterial technology. Phase II Deliverables may include prototypes and demonstration of performance. Expected TRL is from 1 to 3.

Relevance to NASA

Metamaterial technology has the biggest potential to impact the future of spaceborne instrumentation by reducing size, weight, and power (SWaP) as well as the overall cost of future space missions. Due to the nature of metamaterials, there are a multitude of possible applications for this technology. For example, applications of metamaterials for remote sensing include tunability, complex filtering, light channeling/trapping, superbeaming, and determination of optical angular momentum modes via metamaterials. For additional information regarding SMD technology needs, please review https://science.nasa.gov/about-us/science-strategy/decadal-surveys.

References:

- www.centerformetamaterials.org
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