RX21-8

DAGSI Research Topic

1. **Research Title:** Engineering Qubit-Phonon Interactions in Ultra-wide Bandgap Semiconductors for Room Temperature Quantum Technologies
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:**

   Physics, Quantum Optics, Solid State Physics, Electrical Engineering, Computer Science (MS or PhD level)

4. **Objectives:** The objectives of the proposal would be two-fold: 1) Develop modeling and simulation techniques to inform fabrication of phononic metamaterials and 2) Fabricate and test phononic metamaterials in order to demonstrate decoupling of qubits in ultra-wide bandgap 3D and 2D materials (diamond, silicon carbide, hexagonal boron nitride, etc...) from the detrimental effects of the phonon bath at room temperature.
5. **Description:** The control, generation, and manipulation of light within solid-state materials has been an active area of research for many decades, leading to a plethora of photonics-based technologies over wide frequency bands of the electromagnetic spectrum. This same level of control does not exist for phonons, however, which play a dominant role in the optical and thermal properties of many materials. The focus of this topic will be on ultra-wide bandgap semiconductors which have the advantage of hosting qubit states that can persist to room temperature, but still suffer from uncontrolled phonon interactions thus reducing their coherence lifetimes, and mitigating their usability in real-world quantum technologies. The topic calls for proposals aimed at developing computational tools to explore phononic metamaterials designs to mitigate qubit-phonon interactions, as well fabrication and testing of designs. In order to efficiently explore the large parameter space of potential phononic metamaterial designs we require the development of computational tools such as (but not limited to) COMSOL and machine learning, as well as atomistic modeling in order to capture the physics of optical and acoustic phonons. In order to demonstrate decoupling of qubits from the detrimental effects of phonon interactions, a combination of techniques can be used including (but not limited to): photoluminescence, time-resolved photoluminescence, resonance Raman spectroscopy, CW ODMR, and pulsed ODMR.
6. **Research Classification/Restrictions:** Unclassified and unrestricted. Eligible for public release.
7. **Eligible Research Institutions:** All DAGSI institutions.

NOTE: Topics submitted to DAGSI must be approved for public release. Need PA Approval #