RX20-20

1. **Research Title:** Investigation and optimization of hexagonal boron nitride (h-BN) as a telecom single quantum emitter

2. **Individual Sponsor:**

Dr. Michael Page, AFRL/RXAN
Bldg 651, Room 233
2941 Hobson Way
WPAFB, OH, 45433
Michael.page.16@us.af.mil

3. **Academic Area/Field and Education Level**
Physics, Chemistry, Materials Science Engineering, Electrical Engineering, Mechanical Engineering, Chemical Engineering (Ph.D. level)

4. **Objectives:** Develop measurement tools for the investigation of h-BN as a potential telecom single quantum emitter. Carry out measurements on both in house and externally grown h-BN to determine the emission spectrum, quantum efficiency, and identify mechanism of emission. Enhance h-BN quantum emission properties with selective laser annealing and alternative growth methods.

5. **Description:** Platforms for solid state quantum information, computing, and sensing will be highly desirable in future air force applications. Current state of the art quantum systems require bulky packaging and often cryogenic temperatures for operation. A suitable solid state alternative focuses on room temperature emitters, such as the recently discovered emission from point defects in atomically thin, two-dimensional (2D) hexagonal boron nitride (h-BN). This emission source is a bright, photostable, room-temperature and solid state source of single photons with emission ranging from visible to NIR. It possesses desirable properties such as narrow emission, excitation via non-linear driving, and capability of integration into photonic circuits. As a 2D van der Waals material, its properties can be manipulated through proximity effects by embedding within stacked heterostructures, leading to designer quantum point defects that are tunable by electric fields, magnetic fields, strain, and atomic-scale modification. While the emission in h-BN appears to be promising, the details of the emission spectra and source of emission have yet to be definitively identified.

   This project seeks to develop the characterization tools and heterostructures necessary for the investigation of the point defect emission sources in h-BN. The emission in the short wave infrared (SWIR) region will be of particular interest, and the required methods for excitation and detection will need to be implemented for this purpose. The spectrum of emission should be investigated to determine the location, and quantum efficiency of available emitters for telecom quantum communications applications. In addition, refinement of the emitter host material, h-BN, will be investigated by means of selective laser annealing.

6. **Research Classification/Restrictions:** Unrestricted