RX18-11

1. **Research Title:** In-situ incorporation of NV center defects during single crystal diamond growth

2. **Individual Sponsor:**

Dr. Michael Page, AFRL/RXAN
Bldg 654, Room 0114
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 synthesis of single crystal diamond by microwave plasma assisted chemical vapor deposition. Incorporate nitrogen vacancy (NV) center defects in-situ with long spin lifetime and controllable density. Explore NV center orientation dependence on diamond substrate plane.

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 defect centers, such as the nitrogen vacancy color center in diamond. The nitrogen vacancy color center is a substitutional nitrogen and adjacent lattice vacancy hosted in a diamond crystal. NV centers provide an optical readout of their spin state, which when manipulated with radio frequency magnetic fields allows sensitive optical detection of magnetic fields, and encoding of information as a qubit state. While a variety of diamond structures can incorporate NV centers, single crystal diamond is promising due to the deterministic and regular arrangement of the NV centers, in contrast to polycrystalline or nanodiamond based NV centers with random defect orientation. Typically, NV centers are created in single crystal diamond by ion irradiation and subsequent annealing. This leads to lattice damage and can be difficult to control the density, location, and orientation of the defects. An alternative approach to creating NV centers is to incorporate them in-situ during diamond growth. This project seeks to develop diamond synthesis using microwave plasma assisted chemical vapor deposition to create long spin coherence time NV centers directly in single crystal diamond. In addition, by first creating an oriented diamond face as the growth plane, NV centers can be grown with controllable defect orientation as opposed to all possible lattice growth directions as in typical growth protocols. The NV center properties will be evaluated using scanned confocal microscopy, and optically detected magnetic resonance. When successful, the NV centers in single crystal diamond will serve as a suitable platform for quantum information and magnetic sensing.

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