1. **Research Title:** Quantum Photonics Hybrid Integration

2. **Individual Sponsor:**

Dr. Yunjo Kim,
AFRL/RXEEG
2179 12th St., B653/R134
WPAFB, OH 45433
yunjo.kim.1@us.af.mil

3. **Academic Area/Field and Education Level**
Materials Science Engineering, Electrical Engineering, Mechanical Engineering, or equivalent (MS or PhD level)

4. **Objectives:** Leverage fabrication capabilities at AFRL to design scalable process for deterministic placement of semiconductor thin films onto a Si-based photonic integrated circuit (PIC). Investigate approaches for Van der Waals bonding of relevant photonic and quantum materials, with particular focus on III-V thin films, on to a material platform that is relevant to Si photonics (i.e. SiO2 and SiN). Characterize and optimize coupling efficiency of monolithically integrated photonic elements to set foundation for hybridized solid-state quantum devices.

5. **Description:** There exists a wide range of material systems that are relevant to photonic and quantum research, such as quantum dots for single photon sources in GaAs, InP and GaSb material platform. However, scalable integration of these photonic elements necessitates integration onto a PIC with low loss waveguides and high coupling efficiency. Recent developments in micro-transfer printing have enabled monolithic integration of wide variety of material systems onto a SiN/SiO_2 platform which include thin film lithium niobate, GaN membranes, diamond membranes, etc… In this topic, we investigate and develop processes for transfer printing of chiplet-scale membranes and characterize its optical performance on PICs to realize low loss coupling of photonic devices. Methods developed for integration of quantum emitters and quantum grade thin film materials into PICs will enable opportunities for application of quantum sensors on AF platforms.

6. **Research Classification/Restrictions:** Unclassified and unrestricted. Eligible for public release.

7. **Eligible Research Institutions:** All DAGSI Institutions.

8. **PA Approval #:** Distribution A. Approved for public release: distribution unlimited. AFRL-2024-4565