

## DAGSI Research Topic Proposal

1. **Research Title:** *High-Throughput CVD Synthesis of Diamond Nanoparticles as Single Photon Sources for Quantum Encryption*
2. **Individual Sponsor:**

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3. **Academic Area/Field and Education Level:** Materials Science and Engineering/  
Nanomaterials/ Quantum Optics; Ph.D. level
4. **Objectives:** Develop scalable synthesis of diamond nanoparticles based on seed induced nucleation of nanoparticles in a microwave chemical vapor deposition (MCVD) reactor. Characterize the incorporation and optical properties of engineered color centers in diamond nanoparticles using chemically functionalized seed molecules.
5. **Description:** Diamond color centers, which are defects substituted in the diamond lattice, have tremendous potential in advanced applications of importance to the Air Force, including secure communication, quantum information processing, and sensing. However, in order for this potential to be realized, synthesis methods allowing for highly efficient incorporation of color centers while also providing precise stoichiometric and spatial control are essential. The nitrogen vacancy (NV) center has been intensely studied due to its favorable properties for quantum information applications. So far, top-down approaches to fabricate NV centers have yielded systems with excellent properties for proof-of-concept demonstrations, yet device level scalability remains elusive. A bottom-up approach to precisely and efficiently incorporate color centers in MCVD grown diamond films and nanocrystals by using molecular seed clusters to controllably induce nucleation. Taking advantage of the broad range of chemistries available to functionalize potential seed clusters would allow us to very precisely incorporate color centers in the resulting lattice. If successful, this approach would help provide a deeper understanding of the fundamental molecular species involved in diamond nucleation and how functionalization of such species can be leveraged to deterministically engineer defects. Ultimately, this could be a major step towards device level scalable synthesis of diamond color centers.
6. **Research Classification/Restrictions:** Not classified. Not restricted.
7. **Eligible Research Institutions:** Indicate to what organizations this topic should be provided.
  - DAGSI (Wright State University, AFIT, Ohio State University, University of Dayton, Miami University, Ohio University, University of Cincinnati)  
PA Approval #: 88ABW-2015-3569
  - AFIT (only)
  - USAFA (only)

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If you are submitting a topic for the USAFA, please indicate if you are also interested in sponsoring a USAF Cadet in summer of 2015 (Avg Cost for USAF Cadet for 33 days was \$5000)

Yes    No