Project Title: Synthesis and Optoelectronic Characterization of Nitrogen-Vacancy Centers in Diamond for Quantum Sensing

Project Reference Code: Baker-UAB

Name of Project Leader: Paul A. Baker

Host Facility: University of Alabama at Birmingham

Internship Location: Science and Engineering Complex

Host Facility Location: 902 14th St. S, Birmingham, AL 35205

Project Description (roughly 300 words):
This 9-week undergraduate research project at the University of Alabama at Birmingham (UAB) focuses on the intersection of materials physics, quantum mechanics, and advanced sensing technologies. The selected student will actively participate in the laboratory-controlled growth and analysis of synthetic diamond to engineer Nitrogen-Vacancy (N-V) centers—atomic-scale defects that act as highly sensitive, isolated quantum systems.
They will utilize a Microwave Plasma Chemical Vapor Deposition (MPCVD) reactor to synthesize nitrogen-doped diamond thin films. By varying critical growth parameters—such as microwave power, methane-to-hydrogen gas ratios, and nitrogen doping concentrations—they will optimize the formation density and optical quality of the N-V centers.
Following synthesis, the student will evaluate these quantum defects using Optically Detected Magnetic Resonance (ODMR) spectroscopy. This technique uses green laser excitation and microwave manipulation to read out the spin state of the N-V centers, allowing the diamond to function as a nanoscale magnetometer and thermometer.
This project bridges hands-on materials manufacturing with fundamental quantum optics, preparing students for future pathways in quantum computing, solid-state physics, and advanced hardware engineering.

Disciplines: Materials Science, plasma physics

Importance:
Diamond N-V centers are an important topic of research due to their extreme sensitivity to local environmental changes. They can be used as quantum sensors to detect weak magnetic fields or to sense temperature changes in cells. N-V centers are being used in biomedical imaging and diagnostics to perform structural biology and chemical analysis on proteins or DNA strands in living cells.

Requirements:

- Preferred Major
  - Physics
- Class work
  - Physics, math, or other background (list if specific level of classes are necessary)
- Programming knowledge
  - Labview, python

- Software knowledge
    - Data analysis
- Other

Biography (roughly 100-150 words):
I am the Core Director of the Advanced Materials Characterization Core Facility. My work involves the fabrication of advanced sensors for high pressure diamond anvil cell research. I am also setting up the first metal 3D printing facility at UAB which will be used to create new high entropy alloys. I have been involved in a number of previous projects involving the development of implantable devices that were made or modified using plasma processes.

Is U.S. citizenship required to participate in this project? No

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