UC San Diego
JACOBS SCHOOL OF ENGINEERING
NanoEngineering

UCSD NANO & CHEMICAL ENGINEERING

# SPECIAL SEMINAR

**March 15th 2023**

**Seminar Presentation: 9:30 AM – 10:30 AM**

**SME Room 248**

## *"Engineering Defects in Diamond to Enable Future Quantum Technologies"*


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**Abstract:** The ability to control and manipulate defects in semiconductors has revolutionized the electronic and optoelectronic industries that make up modern society. In the case of silicon semiconductors, p– and n-type doping has enabled the creation of the transistor and the proliferation of solar photovoltaics – a critical technology to combatting climate change. For quantum technologies, spin-active defects in diamond can be coherently controlled and used as quantum sensors to detect weak magnetic fields, such as those emanating from single protons. Although there has been great success in controlling defects in classic semiconductors, such as silicon, future disruptive technologies will require the ability to isolate and utilize defects in more complex material systems and in ways that have never been achieved. The goals of my research have been to develop new techniques to synthesize, characterize, and control defects in advanced materials. In this seminar, I will discuss leading the construction and optimization of a specialized plasma-enhanced chemical vapor deposition reactor to grow ultra-low strain diamond with dense layers of nitrogen-vacancy centers for quantum microscopy. Next, I will demonstrate the use of supervised machine learning and Bayesian optimization to identify new growth parameters to fabricate some of the highest quality quantum diamonds for magnetic field sensing ever created. These studies form the basis of several new and exciting directions in the engineering of defects in quantum materials poised to disrupt the fields of quantum sensing, communication, and computing.


**Educational Development and Training:** In this presentation I will also share my personal journey in navigating through academia as a first-generation college student and pairing my research interests with supportive mentors along the way. I will share my first-hand experience seeing the value in switching research fields and identifying new synergies across separate fields. For those interested in federally funded research and development centers (FFRDC), I will share my experience at MIT Lincoln Lab and compare it to my experiences as a post-doctoral scholar at MIT's main campus. Finally, I will highlight the cross-disciplinary nature of quantum information science and technology and how students and researchers can gain new knowledge in physics, chemistry, materials science, nanotechnology, and chemical engineering.

**Biosketch:** Dr. Dane W. deQuilettes is a member of the Technical Staff at MIT Lincoln Laboratory working in the Quantum Information and Integrated Nanosystems Group, and a Principal Investigator in the Center for Quantum Engineering at MIT. Prior to Lincoln Lab, he held a postdoctoral position at MIT in the group of Vladimir Bulovic, where he led a team in achieving the longest charge carrier lifetime ever measured in a direct bandgap semiconductor through the chemical design of surface fields. In 2017, he received his Ph.D in Chemistry and Nanotechnology from the University of Washington working in David Ginger's group as a NSF Graduate Research and Clean Energy Institute Fellow. During his graduate studies, he was the first to discover the location of defects in polycrystalline metal halide perovskite semiconductors and he subsequently developed some of the first passivation strategies that have since been used to set world records in perovskite LED efficiency as well as photovoltaic power conversion efficiency. He has been named 1 of the 11 "Rising Stars" in the Natural Sciences by Nature Index, awarded the IUPAC-Solvay International Award for Young Chemists, and was listed to Forbes 30 under 30 in Energy for his work in developing new materials for solar energy conversion.