

Quantum Spin Defects for Sensing: Magnetic Imaging and Ion-Processed Nanoscale Platforms

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Solid-state defects in wide band gap semiconductors, specifically those with addressable spin states, stand as a premier platform for quantum technologies, with applications in all branches of quantum information sciences. Of particular interest is the Nitrogen-Vacancy (NV) center in diamond: due to its room temperature operation, long coherence time, and optically detected spin, the NV center has emerged as a powerful quantum sensor.

In this talk, I will present our work on leveraging NV centers in diamond for high-resolution, wide-field magnetic imaging. I will detail the development of quantum sensing protocols designed to image magnetic fields across a broad spectral range, from DC to the GHz regime. These results establish NV quantum sensing as a robust tool for diverse applications, ranging from microelectronic failure analysis to the characterization of emerging quantum information science platforms. Additionally, I will highlight our recent progress in using ion implantation to engineer nanoscale-thick diamond membranes, a novel diamond-based platform designed to overcome current challenges in sensor-to-device integration and to enable new architectures in photonic integrated circuits. Finally, I will present our recent progress in developing quantum sensing protocols based on 2D materials, specifically hexagonal Boron Nitride (hBN). I will also discuss the use of targeted ion implantation to selectively generate boron vacancy VB centers.