Photoelectric Quantum Chips for Sensing and Quantum Registers

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The physics of NV diamond spin qubits has advanced significantly over the last decade. However, for practical applications, integrating NV diamond systems into quantum chips and readout electronics remains a major challenge. Here, we present an integrated diamond quantum chip based on photoelectric readout and discuss its key characteristics. The diamond chip, combined with a tailor-made current amplifier, enables the detection of ultra-low currents at the level of single-NV photocurrents with high bandwidth, compatible with Rabi oscillation.

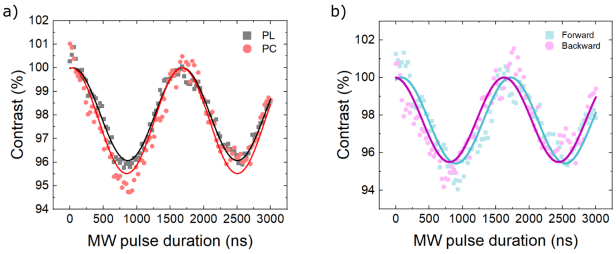

Figure 1: (a) PC – (red) and PL-RPQST (black) Rabi trace. The experimental data is fitted and phase angles of y-Rabi sinusiod are extracted. From these parameters the electron spin state was reconstructed with a fidelity of 0.99991 (PL-RPQST) and 0.9998 (PC-RPQST). b) – forwad and reverse Rabi scan with phase shift induced by measurement delays

Additionally, we demonstrate quantum state tomography of single NV electron and nuclear spins, performed on an optical table, achieving fidelities of up to 0.9999 at room temperature for optical readout and approximately 0.999 for electrical readout. We discuss the fabrication of NV–NV pairs and driving electrodes, and demonstrate high-frequency dipole–dipole coupling. Chips containing NV ensembles can serve as magnetometers, with an electronic-noise-limited sensitivity floor of 100 pT per sqrt (Hz).

References

[1] A Shukla, B Carmans, M Petrov, D Vrancken and M Nesladek, Phys. Rev. Res. **8**, 023151 (2026); DOI: 10.1103/j1s1-w37c