

MSc Thesis Project

Characterization of single-photon avalanche diodes and integration with diamond for quantum biosensing

Nitrogen-vacancy (NV) centers in diamond are very promising biosensors. Our goal is to bring the sensing component of such setups down to chip level and realize an on-chip, portable system to perform high-sensitivity and high-accuracy sensing of bio-samples, such as detection of magnetic footprint of cancerous cells.

Project Goals:

To achieve this, we will fabricate a diamond substrate with an array of single NV centers and integrate it with a CMOS chip featuring an array of Single-Photon Avalanche Diodes (**SPADs**). These photodetectors will enhance detection sensitivity, speed, and signal-to-noise ratio by efficiently capturing light emitted by individual NV centers in the diamond.

This chip has been fabricated using **40 nm CMOS technology** (TSMC) and includes on-chip quenching circuits.

- In this work, you will characterize the fabricated SPADs, implement readout schemes and finally integrate the chip with the diamond, into the desired compact quantum biosensor.

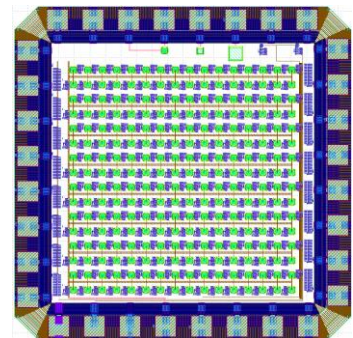


Fig.1 CAD image of the chip containing a 16x16 SPAD array.

Outcome:

By the end of this MSc thesis project, we anticipate achieving the following outcomes:

- **Characterization** of the fabricated SPADs. This includes both electrical and optical **measurements**, carried out in the EKL lab and our own optical lab.
- **Implementation** of a readout scheme, using FPGA and other tools, which will enable efficient data collection, from the SPADs to the PC.
- **Integration** of the chip containing SPADs with a diamond substrate. In doing so, you will foster scientific advancement and gain valuable **experience** working in an optical lab whose research focuses on quantum sensing and quantum computing applications.

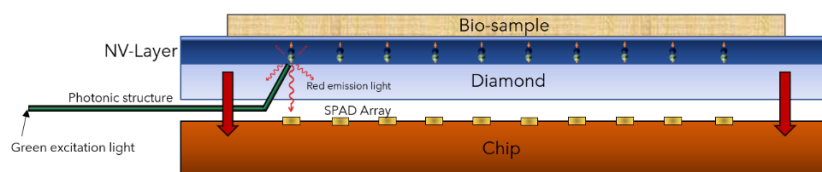


Fig.2 Concept of photonic structure driving the excitation light towards the NV-centers of a diamond integrated in a SPAD array chip.

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