Nitrogen-Vacancy Photoionization from the Singlet State: Micro-diamond electrodes

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Why Nitrogen-Vacancy Diamond Electrodes?

Nitrogen-Vacancy as a Solid-State Electron Spin

The NV^- has the potential to be a solid-state realization of quantum system at room temperature. This has applications in

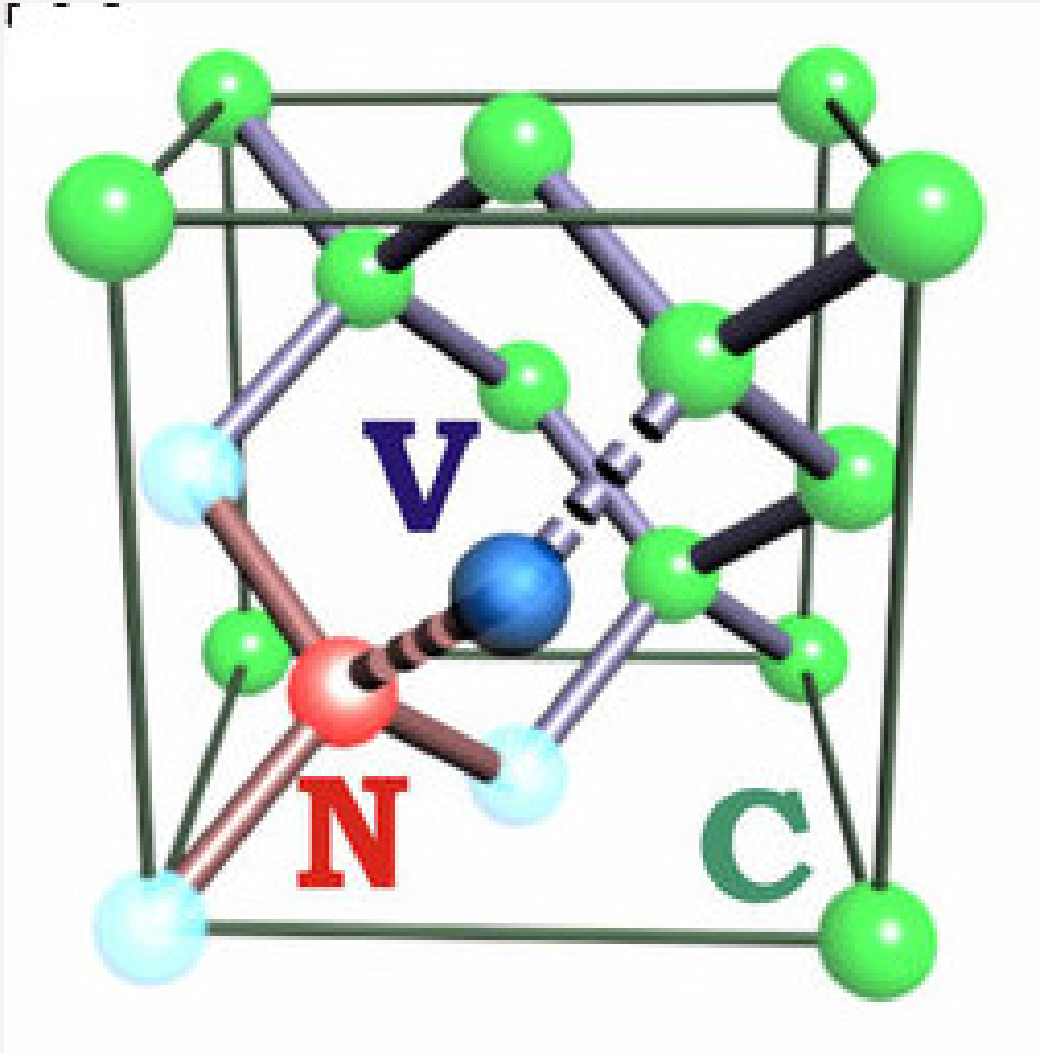
- Quantum Information and Metrology
- Nanoscale Magnetometry and Thermometry

Photoionization as a New Approach to NV^- Spin Control

- Ionization experiments can provide a new measurement of the singlet state
- Ionization can enhance current contrast of magnetic resonances
- Photocurrent can open an new avenue for spin-state measurements

Nitrogen-Vacancy Diamonds

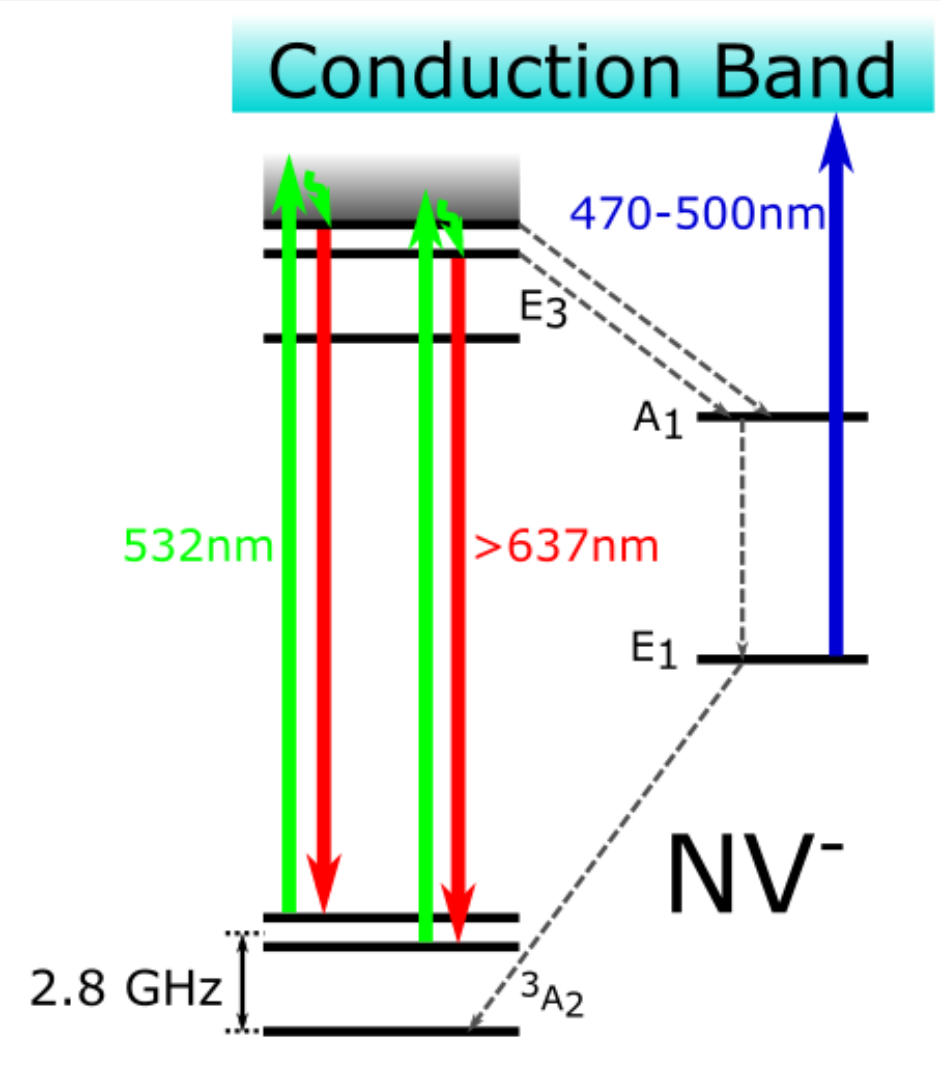
NV Defect



I. V. Fedotov, et al. Sci. Rep. 4, 5362 (2014).

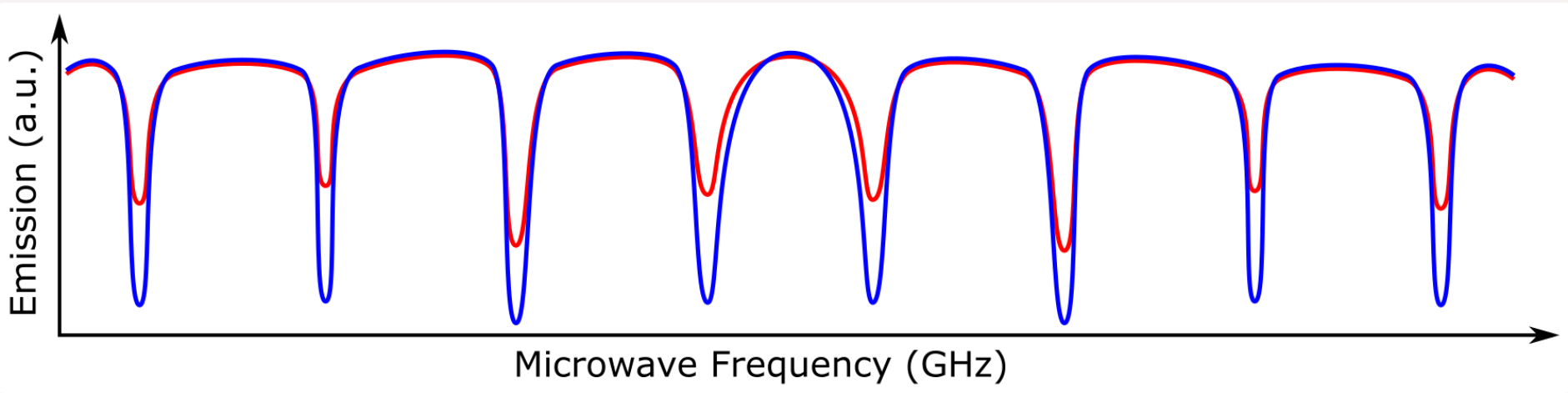
Nitrogen-Vacancy Photoionization

NV Energy and Fluorescence



Enhanced Contrast ODMR Spectrum

Optically Detected Magnetic Resonance

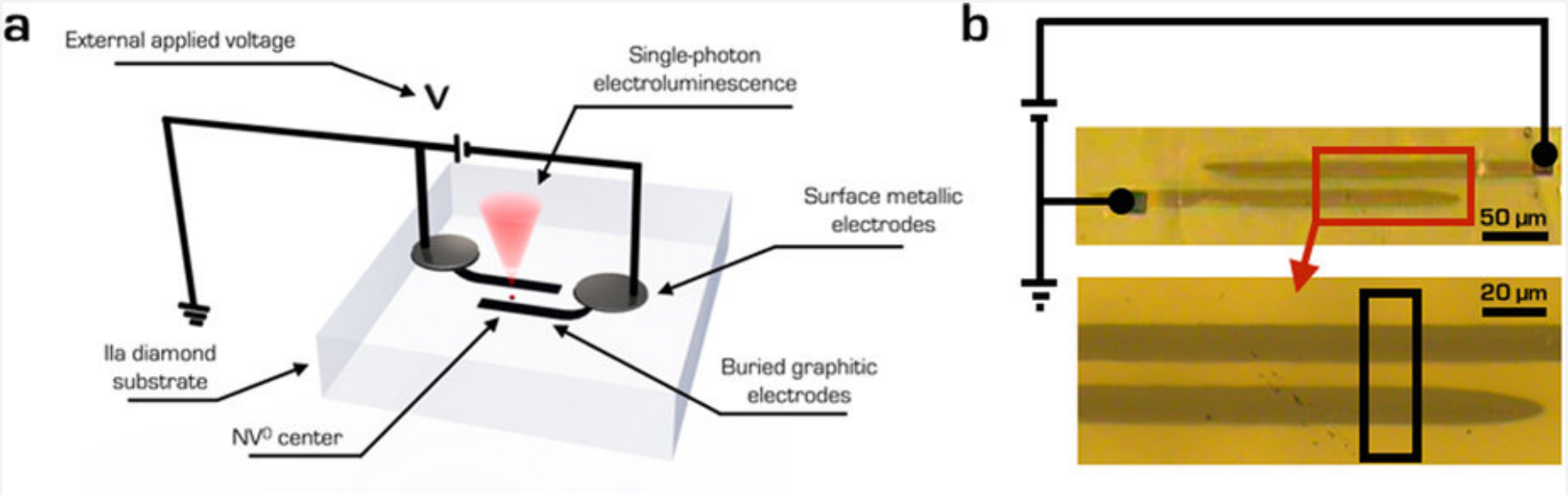


By increasing resonant peak contrast we:

- Improve signal to noise
- Increase sensitivity of magnetic field or temperature measurements

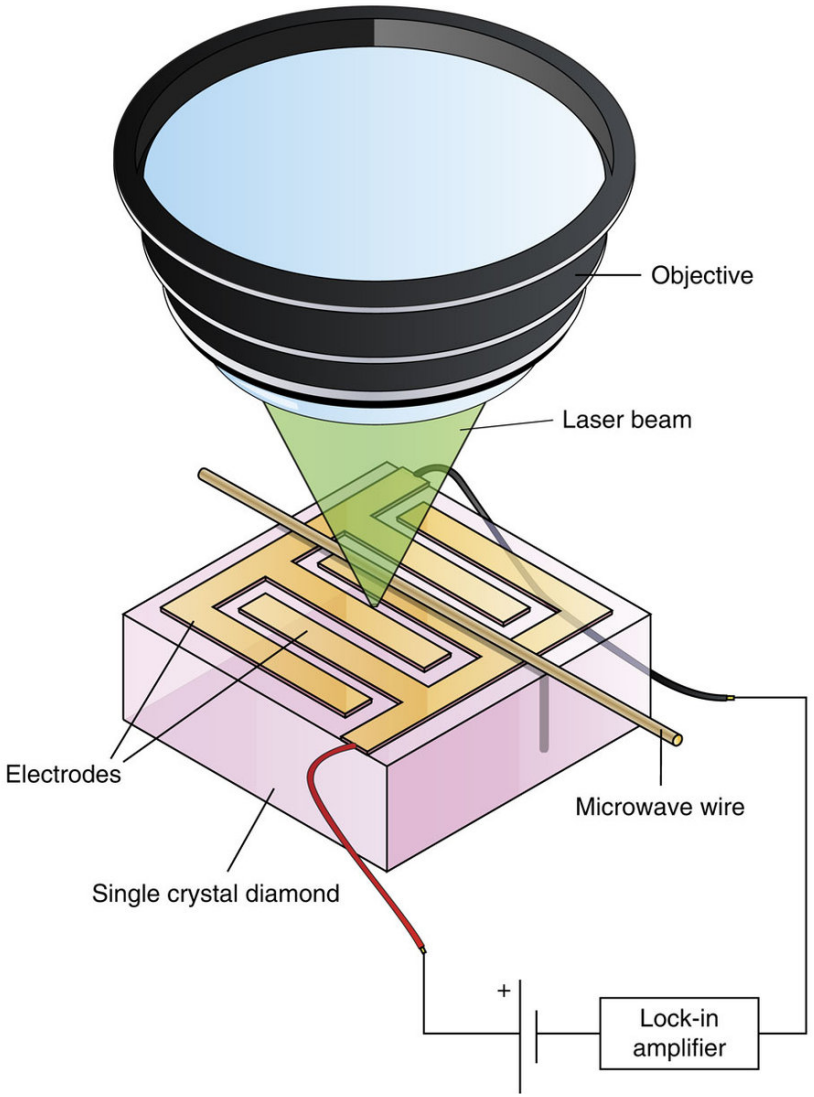
Single-Photon Electroluminescence

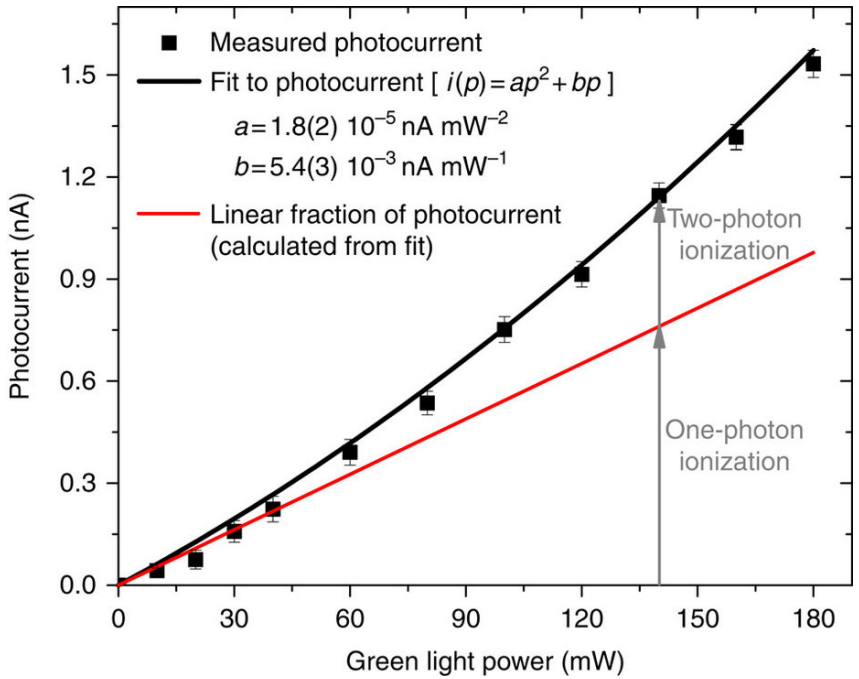
Ion-Microbeam Buried Electrodes



J. Forneris, et al. Nat. Publ. Gr. 1 (2015).

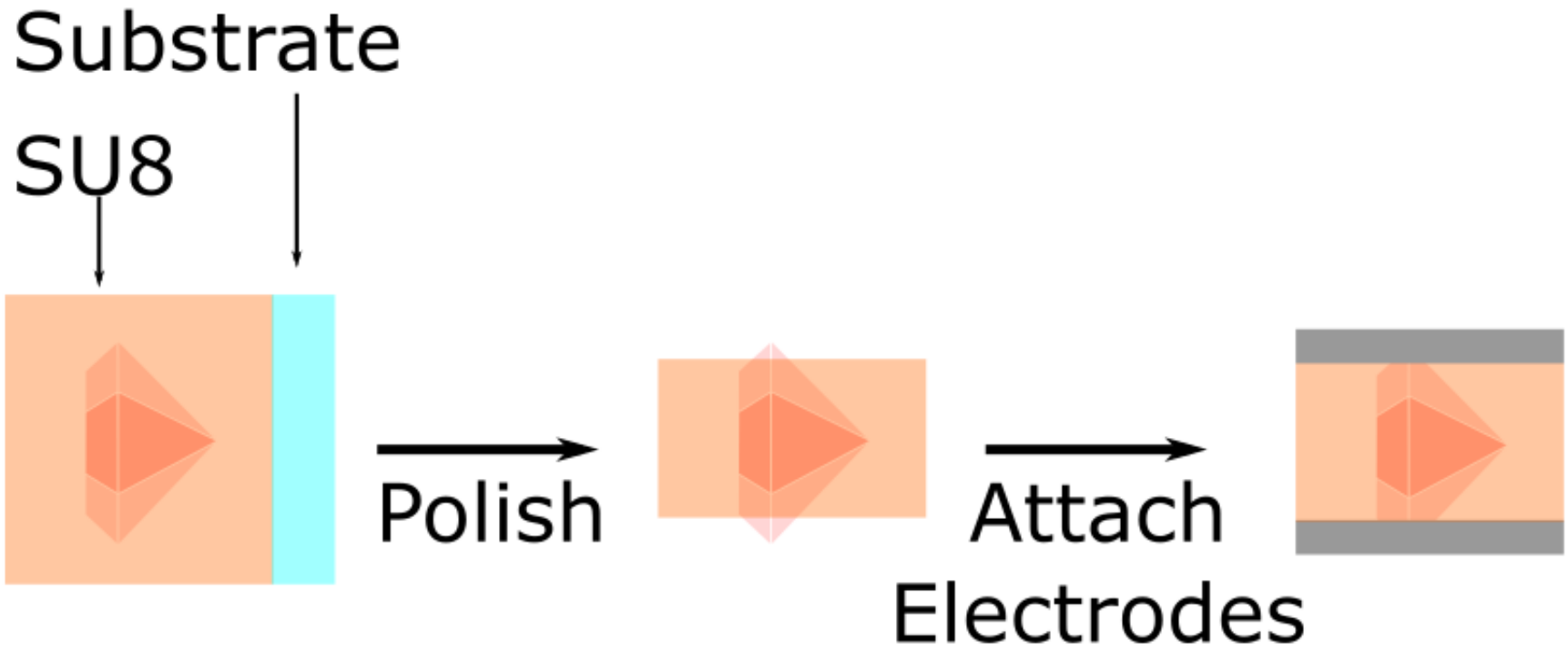
Two Photon Photoionization





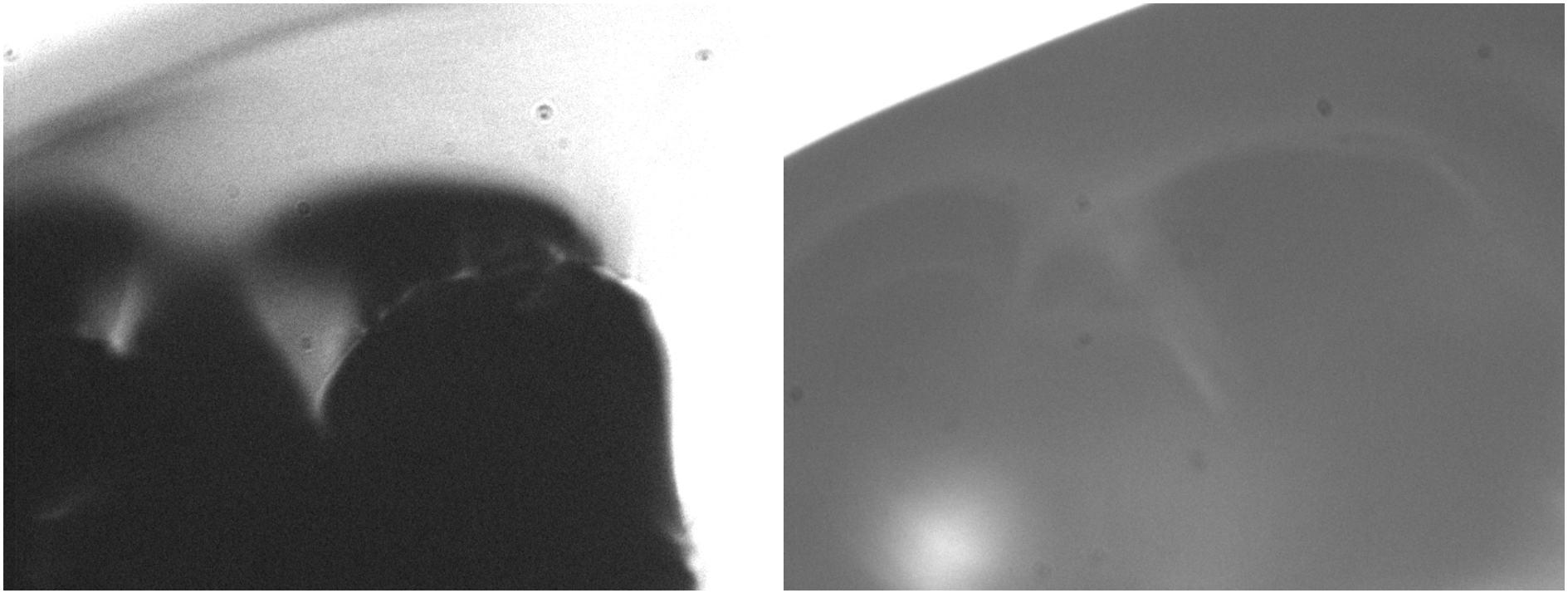
E. Bourgeois, et al. Nat. Commun. 6, 8577 (2015).

Proposed Micro-diamond Electrode Process



Current Progress

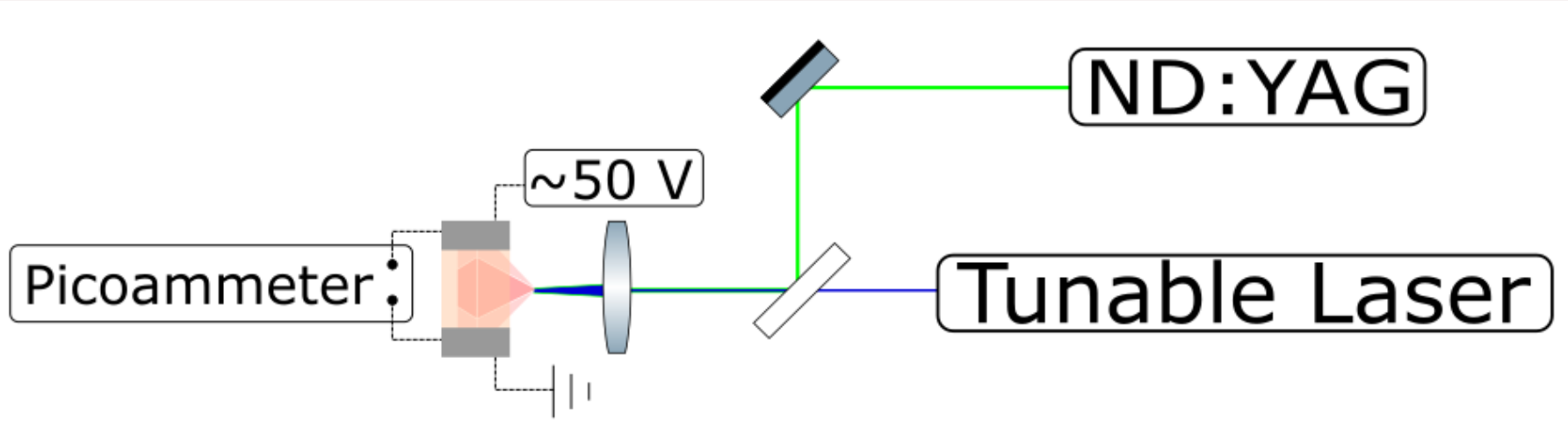
Currently we have successfully suspended a 100 μm diamond within freely suspended SU8



We still need to find a polishing process that allows for a clean binding surface for silver coating.

Photoionization Current Measurement

Experimental Schematic



We intend to measure the photocurrent caused by photoionization in three wavelength regimes.

1. At 532 nm to verify a measured photocurrent (two-photon)
2. In the range of 470 to 500 nm (single-photon)
3. Then in the enhanced contrast ODMR regime with both green and blue light

Conclusions

- Singlet state ionization is a single photon process.
- If we can ionize from the singlet state we should be able to measure a photocurrent with a linear dependence on pump power.
- Ionization from the singlet state will open the possibility of enhanced contrast ODMR. Increasing the sensitivity of NV^- based magnetometers and thermometers.