Tailoring the diamond - solid immersion lens coupled to colour centres in diamond

Luca Marseglia[1,2], L. Rogers[1], K. Jahnke[1], C. Müller[1], B. Naydenov[1], H. Schauffert[1], C. Kranz[1], T. Teraji[1], J. Isoya[1], L. McGuinness[1], F.Jelezko[1] and P. Cappellaro[2]

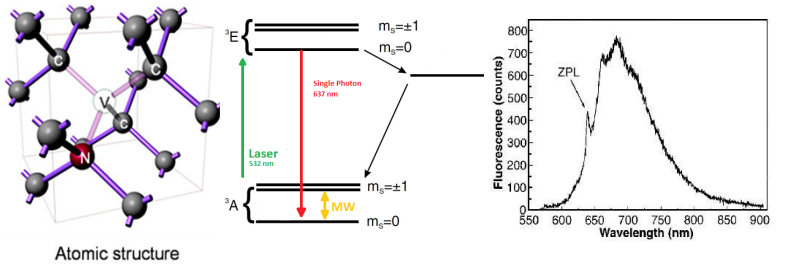
[1] *Department of Nuclear Science and Engineering, Massachusetts Institute of Technolgy, U.S.A.*

[2] *Institut für Quantenoptik Universität Ulm, Germany*

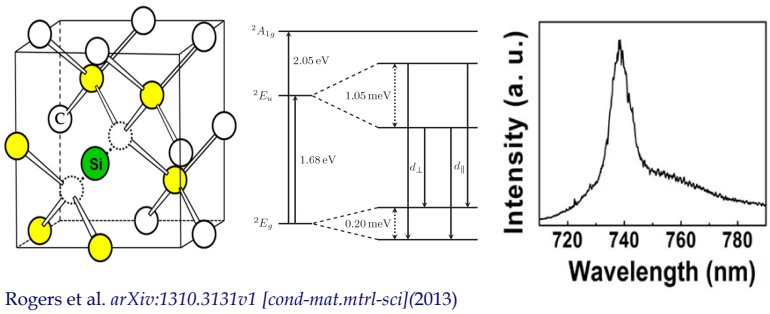
1. Colour Centres in Diamond

The nitrogen vacancy colour centre (**NV**$^-$) is a three level who emits photon at a wavelength of **637 nm** at room temperature . The defect has a ground state spin that can be addressed optically.
The silicon vacancy colour centre (**SiV**) defect is understood to be comprised of a silicon atom located between adjacent vacancies in the diamond lattice. It is associated with strong optical transition with a prominent zero-phonon line (ZPL) at **738.4 nm** and only a weak phonon sideband.

NV$^-$ Centres



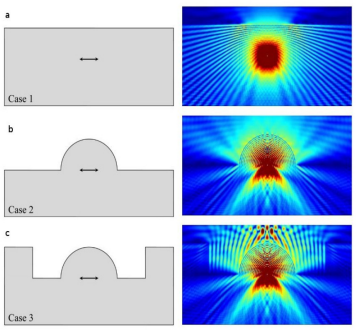
SiV Centres

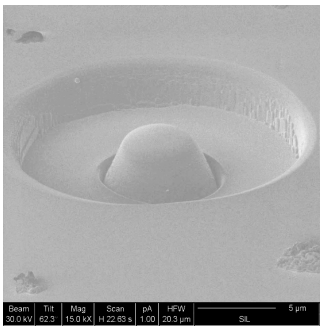


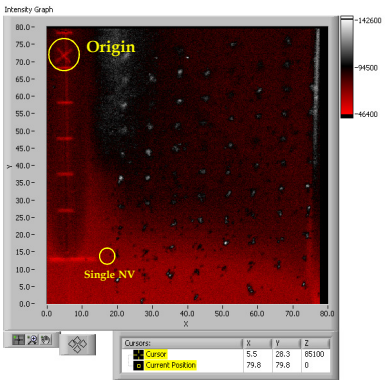
Rogers et al. *arXiv:1310.3131v1 [cond-mat.mtrl-sci]*(2013)

2. Solid Immersion Lens (SIL)

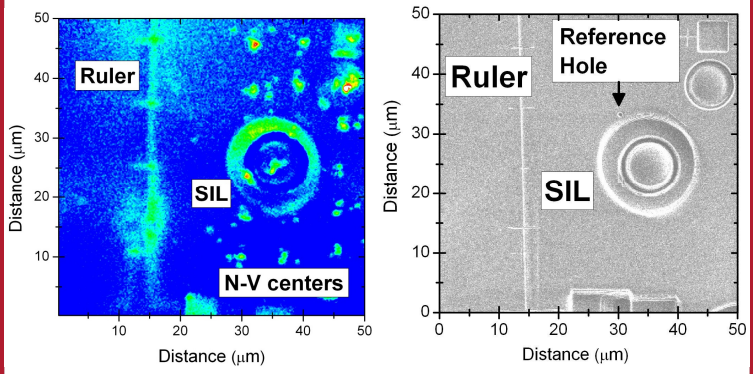
The efficient photon collection from color centers in bulk diamond is frustrated by the relatively high refractive index (2.42) of the material. At the diamond–air interface the angle for total internal reflection (TIR) is ~25°.
A conceptually simple solution to the problem of TIR is to have the emitter at the focal point of a hemispherical lens .This type of optic is called a solid immersion lens (SIL).







Using confocal fluorescence microscopy and focused ion beam etching, we initially locate a suitable defect with respect to registration marks on the diamond surface then etch a structure using these coordinates.
Then we etched an 8µm diameter hemisphere positioned with single negatively charged nitrogen-vacancy defect lies at its origin.



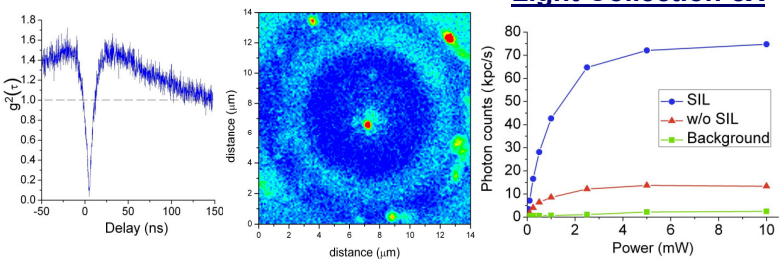
Castelletto et al. *New Journal of Physics 13 025020 (2011).*

3. Solid Immersion Lenses Fabrication & Measurement

NV$^-$ Centres

Direct comparison of the fluorescence photon count rate before and after fabrication shows an increase in ligth collection efficiency due to the presence of the SIL by **8X**

Light Collection 8X

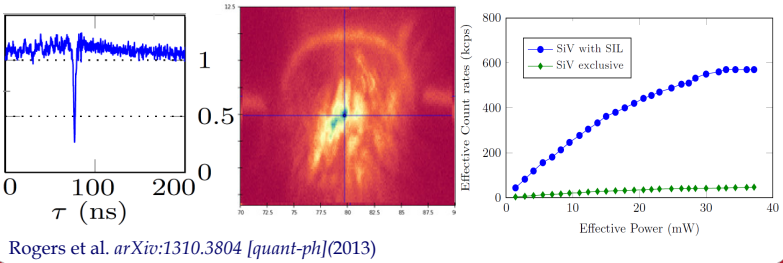


Marseglia et al. *Applied Physics Letters 98, 133107 (2011).*

SiV Centres

Direct comparison of the fluorescence photon count rate before and after fabrication shows an increase in ligth collection efficiency due to the presence of the SIL by **10X**

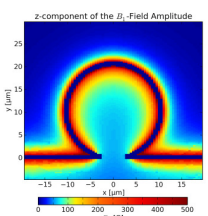
Light Collection 10X



Rogers et al. *arXiv:1310.3804 [quant-ph]*(2013)

4. Future Work

The further steps would consist of creating microwave structures directly around the SIL coupled to NV centres in order to drive its spin ground state



5. Acknowledgements

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