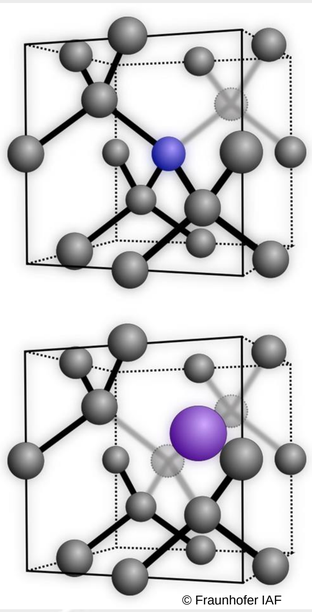
moduleqnc
quantum & neuromorphic computing

Color Centers: Materials, Production & Integration

1 Color centers for qunatum technologies

Color centers in solids are atomically small defects that can be optically excited and read out.
Materials with color centers are:
- Diamond
- Silicon carbide
- Novel 2D materials e.g. hexagonal boron nitride (h-BN)

Special color centers:
- NV Center in the Diamant (usable at room temperature as a qubit)
- Inversion centers (SiV, GeV, SnV) (Photonic applications and qubits)



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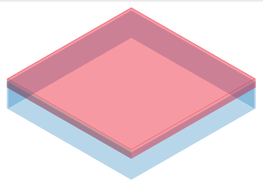
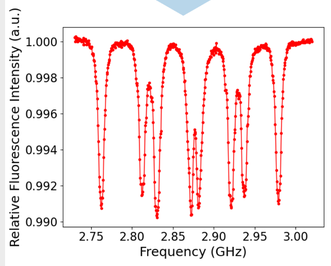
2 Color centers through diamond growth

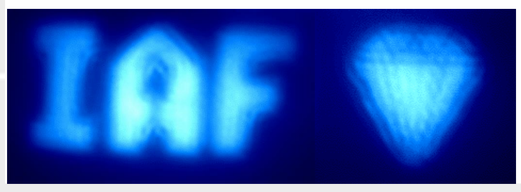


NV centers as well as SiV centers can be introduced into layer structures in defined concentrations by diamond synthesis.



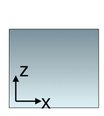
Properties:
- High coherence times
- Control of ambient spins, e.g. through isotopically pure depositions

Positioning:
- Delta doping
- Local growth in structures

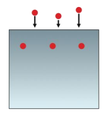


3 Integration in Nanostructures

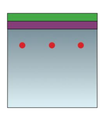
Integration into **nanostructures** improves the efficiency of the **spin-photon interface**, a cornerstone for the development of **photonic quantum networks**



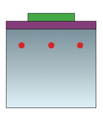
1. cleaning and polishing the surface



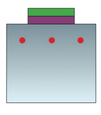
2. ion implantation and annealing



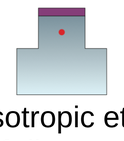
3. deposition of mask layers



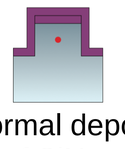
4. electron beam lithography



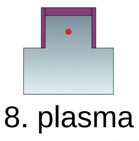
5. transfer pattern to SiNx layer



6. anisotropic etching of diamond

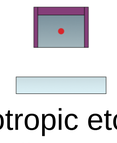


7. conformal deposition of SiNx

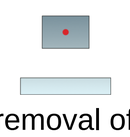


8. plasma etching of SiNx

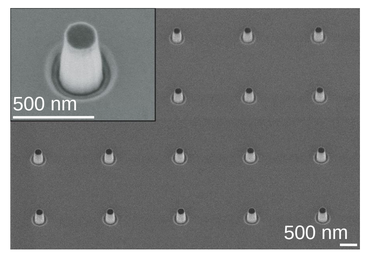
9. anisotropic etching of diamond



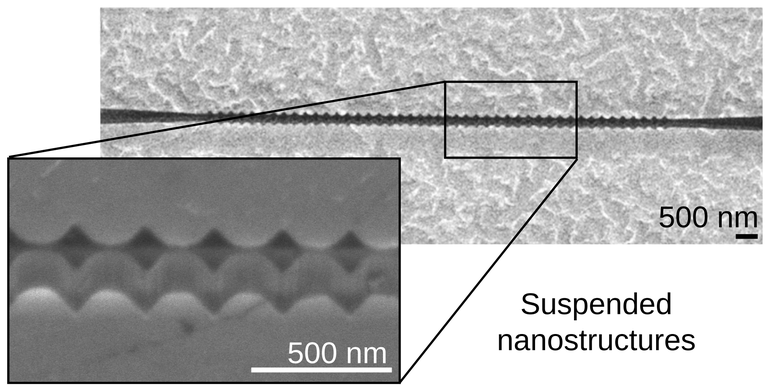
10. isotropic etching of diamond



11. removal of the SiNx mask



Vertical nanostructures



Suspended nanostructures

4 Color centers for quantum computing - outlook and challenges

Color centers in solids are promising candidates as qubits for quantum computing. Their high coherence times and simple addressing and readout options make them an ideal basis. The NV center in diamond could play a particularly important role here, as quantum computing can be realized at room temperature. Currently, ^{13}C spins around the NV center are used for this purpose.

Current Status: Quantum computing at room temperature with up to 4 qubits possible at IAF.

Challenges: exact positioning, charge stability of the color centers, scaling of the qubits or quantum registers (^{13} C + color center), research into new color centers (e.g. SnV).

For inquiries, email us at experts@module-qnc.de

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