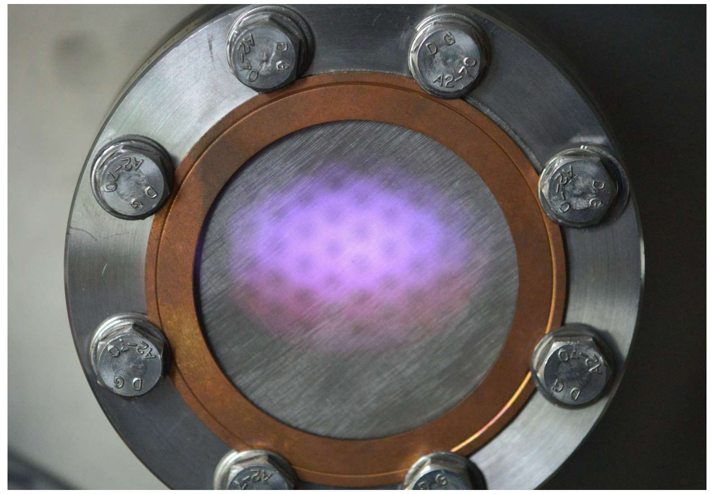
DIAQ
Diamond material for room temperature quantum computer

We are developing diamond qubit systems for quantum computers that can operate at room temperature. Adjusting the diamond composition regarding spin concentration with reliable coupling probabilities is key to realize such a quantum computing device.

Applications:
- Diamond-based quantum-computing
- Room-temperature operation
- Mobile quantum-computing

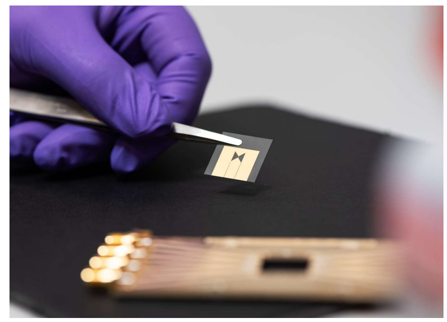


Motivation

Quantum computers based on NV centers in artificial diamonds are a promising approach for quantum computing. However, controlled fabrication of high-quality NV centers is still a challenge. We overcome them by exploiting synergy effects in diamond production using chemical vapor deposition (CVD) processes and the ion implantation method. This allows us to place individual atoms (and thus NV centers) with nanometer precision. For the development and fabrication of the artificial diamond layers, we combine three core elements at a common production site: the production of the dedicated diamond layers, the targeted generation of the NV and ^{13}C nuclear spin qubits and finally the characterization using the latest confocal microscopes for spin qubit analysis

Challenge

There are two major hurdles in the production of diamond quantum hardware: on the one hand, the production of artificial diamond layers, which must meet special requirements in terms of purity and isotopic composition to even be considered as a base material for the targeted generation of qubits. On the other hand, the reproducible production of NV centers and distance-optimized ^{13}C nuclear spins. With our holistic manufacturing and characterization process, we enable both and can thus reliably provide diamond hardware with NV centers for use in room temperature quantum computers.

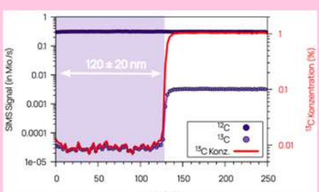


„Development of subsystems and auxiliary technologies for spin-based quantum computing "

Quantum grade diamond

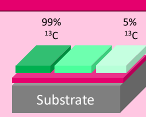
- ^{12}C enriched diamond
- Purity w.r.t. native NV
- Isolated NV with high T_2

Secondary Ion Mass Spectrometry (SIMS)



Qubit diamond

- ^{13}C qubit enrichment
- Layer thickness
- ^{13}C concentration



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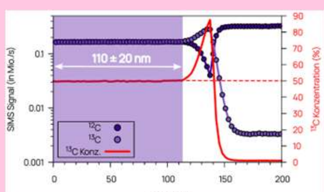
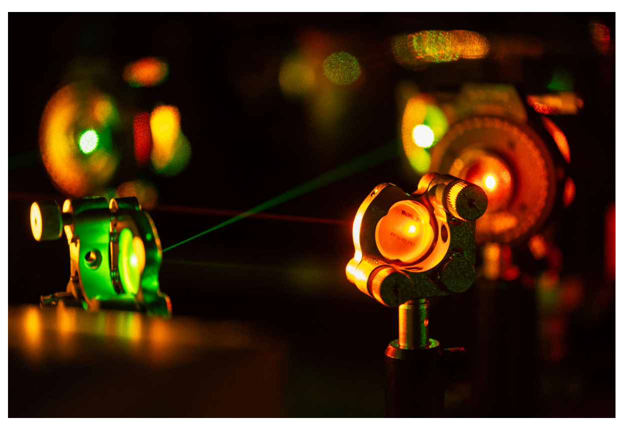


Kick-off	Q2/2023
M1 Fabrication Line & Growth Process	End 2023
M2 Control on Diamond Growth Best NV Performance	End 2024
M3 Qubit Creation ^{13}C-NV Coupling	End 2025
M4 Reproducibility & Reliability	Mid 2026

Achievements

Quantum-grade diamond is available with a high enrichment of ^{12}C and NV coherence times of up to 500 µs. Qubit diamond plates can be manufactured with varying concentrations of ^{13}C, ranging from 5% to 99%. The next steps involve combining these two materials to create a quantum computing diamond that incorporates both a recent concentration of ^{13}C qubit spins and the NV center, which can exchange information through dipolar coupling and built the basis for diamond-based quantum computing at room-temperature.



Technology

The core technology used to produce on-demand synthetic diamond material with potential use in quantum technology are based on the following procedures:

- CVD Diamond Growth
- Ion Implantation
- High-Temperature Annealing
- Quantum Characterization and Testing

A rapid feedback loop connecting the generation of diamonds and color centers to their potential applications is a key aspect of Diatope. All essential technological processes are conducted in-house, ensuring a reliable and reproducible supply of engineered diamond materials. The project's primary technological advantages lie in the precise nanometer-scale deposition of diamond layers, coupled with the accurate placement of foreign atoms at the angstrom level. Comprehensive spin characterization rounds out the portfolio of high-tech measurement equipment required to analyze single qubit clusters at the atomic level. Our specially designed, custom-built laser confocal microscopes can detect magnetic signatures on the nanoscale. These systems have established the initial prototypes for diamond-based quantum computers, though they remain in the developmental stage and are not yet suitable for real-world applications or mobile solutions

Mehr Infos zu dem Projekt finden Sie auf unserer Website.

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Get in touch.
We enable quantum!

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