Sonderforschungsbereich 631
Festkörperbasierte Quanteninformationsverarbeitung

TECHNISCHE UNIVERSITÄT MÜNCHEN

Seminarvortrag

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Top-down pathways to devices with few and single atoms placed to sub-20 nm precision for quantum information technologies

Solid state devices based on diamond or silicon that exploit the quantum attributes of single atoms to store and process information present special fabrication challenges. This is because of the very demanding requirements for the perfection of the materials and the required fabrication precision. Devices based on spin, charge location, excitation of colour centres or other phenomena typically require the positioning of single atoms with a sub-20 nm precision. In the case of nitrogen-vacancy colour centres in diamond, we have developed a novel ion beam lithography method employing MeV and keV focused ion beams for the machining of micro and nanostructures in diamond substrates. We have used this technique to fabricate diamond devices containing NV– colour centres that display optical antibunching combined with nanostructures that, with further development, could have useful optical properties. In the case of donors in silicon, we have developed a deterministic doping method in which we count single ion implants through precision surface masks by detection of the electron-hole pairs created in the substrate as the ion dissipates its kinetic energy. We have coupled and engineered donor atom to a nano-scale double-gated field effect transistor device that demonstrates control and read out of transitions corresponding to two charge states on the single donor successively occupied by a spin-down and spin-up electron. This presentation is a review of recent progress in these areas.

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