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JOHANNES GUTENBERG UNIVERSITÄT MAINZ

Seminar über Quanten-, Atom- und Neutronenphysik (QUANTUM)

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Lorentz-Raum (05-127), Staudingerweg 7

Dr. Elke Neu-Ruffing
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Optimal nanoscale quantum sensor-devices based on individual color centers in diamond

Nitrogen vacancy (NV) color centers in diamond are versatile sensors due to their stable photoluminescence (PL), optically readable spin and high coherence time even at room temperature. NV centers form multifunctional sensors that simultaneously detect magnetic fields and optical near fields, the latter via energy transfer processes [1].
To reach high spatial resolution down to the nanoscale and to investigate samples with non-flat geometry, we incorporate NV centers into tip-like, single-crystal diamond nanostructures: Our diamond scanning probes consist of diamond nanopillars on thin (< 1 µm) Simultaneously, our optimized diamond nanopillars, in the shape of truncated cones, serve as waveguides efficiently channeling the NV center's PL [2]. We summarize our latest results on fabricating diamond scanning probes as well as roads towards up-scaling of the fabrication via using novel, large-scale, single-crystal diamond material [3].
To obtain nanoscale resolution, NV centers must be created shallowly (< 10 nm) below the diamond's surface. This might lead to charge state instabilities and lowers the spin coherence of shallow NV centers. We investigate wet chemical fluorine treatments of the diamond surface as well as approaches towards low damage etching of diamond. To demonstrate the potential of color centers as multifunctional sensors, we demonstrate quenching of NV PL via depositing graphene onto the diamond surface and transferring luminescent WSe2 flakes onto diamond nanopillars. We discuss potential

applications of our sensor devices especially for applications connected to the life sciences e.g. for investigating magnetic composite particles.

References

[1] E. Bernardi et al., Crystals., 7, 124 (2017)
[2] P. Fuchs et al., New J Phys 20, 125001 (2018)
[3] R. Nelz et al., https://arxiv.org/abs/1810.09350 (2018)

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