Fabrication and Characterization of Micrometer-thin Diamond Platelets for Open Microcavities

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Diamond-based open microcavities are a promising next-generation node platform for quantum networks[1]. Utilizing color centers in diamond, such as nitrogen-vacancy (NV), silicon-vacancy (SiV), and tin-vacancy (SnV) centers, these systems enable robust, on-demand single-photon sources, entanglement distribution, and quantum memory operations. Ongoing research focuses on improving coherence, scalability, and hybrid integration with photonic and superconducting platforms to realize a global quantum internet. The exceptional optical and spin properties of diamond emitters, combined with the high-quality factors and small mode volumes of open microcavities, facilitate an efficient spin-photon interface. These features are critical for scalable quantum repeater nodes, enabling long-distance quantum communication by mitigating photon loss and decoherence. Recent advances in fabrication, alignment, and integration techniques have enabled efficient coupling of diamond emitters to microcavities, achieving significant reductions in lifetime and linewidth broadening[2].

In this work, we demonstrate the fabrication process of micrometer-thin, diamond platelets with an edge length between 50 to 90 µm. The platelets contain NV centers created by electron irradiation and subsequent annealing[3]. We show how the thinned down platelets, using a micromanipulator, are bonded to microscopic flat Bragg mirrors via Van der Waals forces. After successful bonding and pre-characterization of the NV center density, gold strip lines are fabricated onto the mirror, which can be utilized for microwave control of the NV centers electron spin. In addition, the platelets are incorporated into a fiber-based, open microcavity. The influence of the platelet on the cavity finesse is characterized at room temperature by scanning cavity microscopy[4].

Figures

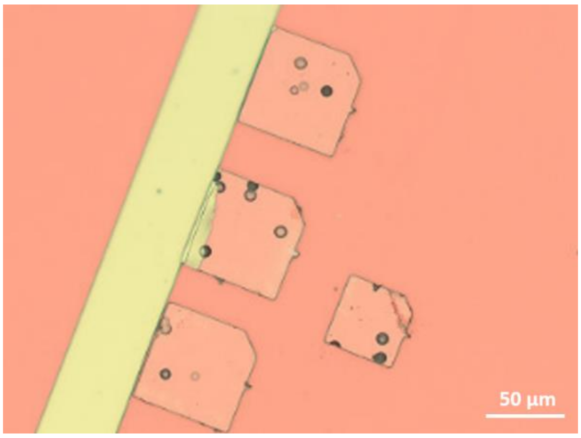

Figure 1: *Example of diamond platelets bonded to a Bragg mirror next to a gold strip line for microwave delivery.*

References

[1] E. Janitz, M. K. Bhaskar, and L. Childress, Optica 7 (2020), 1232.
[2] Y. Herrmann, J. Fischer, J. M. Brevoord,C. Sauerzapf, L.G. Wienhoven,L.J. Feije, M. Pasini, M. Eschen, M. Ruf, M.J. Weaver, and R. Hanson, Phys. Rev. X 14 (2024), 041013.
[3] M. Ruf, M. IJspeert, S. van Dam, N. de Jong, H. van den Berg, G. Evers, and R. Hanson, Nano Letters 19(6) (2019), 3987.
[4] J. Körber, M. Pallmann, J. Heupel, R. Stöhr, E. Vasilenko, T. Hümmer, L. Kohler, C. Popov, D. Hunger, Phys. Rev. Applied 19 (2023), 064057.