

On-chip Photonic Devices for Coupling to Color Centers in Silicon Carbide

Thesis by
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In Partial Fulfillment of the Requirements for the
Degree of
Doctor of Philosophy

CALIFORNIA INSTITUTE OF TECHNOLOGY
Pasadena, California

2020
Defended December 16, 2019

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ACKNOWLEDGEMENTS

Andrei, thank you so much for the opportunity of joining your lab and working on this research project. I learned a lot that I could not learn in my undergraduate studies. This project effectively pushed my limit to become more independent researcher. I deeply appreciate your patient attitude regarding my research and coursework, allowing myself to have enough time for reflection and planning.

I thank my thesis committee members professor Painter, professor Vahala and professor Minnich for reading my thesis and providing insightful feedback during my defense.

I am very grateful to KNI staff members for maintaining tools to make cutting edge science happen. Many thanks to Guy, Matt, Nathan, Alex, Bert and Melissa for training me to operate various tools safely and efficiently.

Thank you to Faraon group members for inspiring talks and discussions in group meetings. Thank you Ioana for a lot of discussions not only related to work but also to general interests. Thank you for putting up with me when I talked too much. Thank you Evan for your help to catch up with the lab and KNI work in the beginning. Thank you Yu for your help with simulations on servers and fabrication. Thank you Tian Z. and John for asking good questions and help in the lab. Thank you Mahsa and Ehsan for many observations and operational runs in KNI. Thank you Jon for your help with the laser and the single photon detector setup. Thank you Jake for your help with fabrication and communicating with people at Montana Instruments. Thank you Mi for your strong curiosity and for convincing me to go to the gym again. Thanks again to Ioana, Mahsa, Ehsan and Jon for help with coursework.

I am thankful to my previous advisors during my undergraduate studies, professor Kai-Mei Fu and professor Kohei Itoh for introducing me into the world of quantum applications.

I am thankful to my parents for exposing me to different environments when I was kid, and for allowing me to have a good education. Thank you for the support through the years. I am thankful to my grandparents for teaching me the importance of education and how a person should live.

ABSTRACT

Optical quantum networks are important for global use of quantum computers, and secure quantum communication. Those networks require storage devices for synchronizing or making queues of processing transferred quantum information. Practical quantum information networks should minimize loss of transmitted data (photons) and have high efficiency mapping when writing data on memories (solid state qubits). This requires strong light-matter interaction that is enabled by coupling qubits to optical cavities.

The first half of the thesis focuses on emerging candidates for promising qubits in silicon carbide (SiC). The optical and quantum properties of these color centers are discussed with focus on divacancies in 4H-SiC due to their long spin coherence time. Optically detected magnetic resonance of divacancies is shown, an essential technique for reading out the qubit state using the intensity of optical emission.

The second half of the thesis focuses on hybrid photonic devices for coupling to silicon carbide qubits. Hybrid devices are made of another layer of high refractive index material other than the qubit hosting material. Evanescent coupling to qubits close to the surface can be achieved without damaging the host material. Mainly the silicon (Si) on 4H-SiC hybrid ring resonator architecture is discussed starting from design, simulation to fabrication. The fabrication includes Si membrane transfer that is an important step to create a light confining layer on 4H-SiC. The final ring resonator device shows quality factors as high as 23000.

PUBLISHED CONTENT AND CONTRIBUTIONS

- [1] Chuting Wang et al. “Hybrid silicon on silicon carbide integrated photonics platform”. In: *Applied Physics Letters* 115.14 (2019), p. 141105.
DOI:10.1063/1.5116201
W.C participated in the conception of the project, fabricated and characterized the device, gathered and analyzed the data, and wrote the manuscript with F.A.
- [2] Chuting Wang et al. “Silicon on Silicon Carbide Ring Resonators for Coupling to Color Centers”. In: *2018 Conference on Lasers and Electro-Optics (CLEO)*. IEEE. 2018, pp. 1–2.
W.C participated in the conception of the project, fabricated and characterized the device, gathered and analyzed the data, and wrote the manuscript with F.A.

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