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

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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.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

LIST OF TABLES