Implanted Er^{3+}-ions targeting integrated quantum photonics hosted in 4H Silicon-carbide on Insulator

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Optically addressable single photon emitting color center's hosted in 4H-Silicon carbide on Insulator (4H-SiCOI) are emerging contenders to be utilized as qubits in defect-based integrated quantum photonics, enabling a scalable approach to real-world application of quantum technologies. Erbium-dopants (Er^{3+}) have been demonstrated in other platforms previously, like Silicon (Si) [1], titanium oxide (TiO_2) [2], lithium niobate on Insulator (LNOI) [3] as well as bulk SiC [4]. However, a demonstration in thin film 4H-SiCOI is lacking. The applications of Er^{3+}-defects for quantum technologies are stringent, requiring low spin bath noise of the host material as well as narrow spectral emission and seamless integration into photonic circuits. While oxide-materials have a low nuclear-spin bath noise, their photonics integration relies on hybrid platforms, e.g. Si or LNOI. 4H-SiCOI, compared to Si, could offer a reduced Er^{3+}-emission quenching at higher temperature. Furthermore, compared to LNOI, 4H-SiCOI could offer an integrated quantum photonics platform with lower nuclear-spin noise and enhanced spectral Er^{3+} -emission caused by higher material purity and increased nuclear-spin bath control, matching or surpassing Si capabilities.

Here, we present the successful demonstration of ensemble Er^{3+}-defects embedded in thin-film 4H-SiCOI utilizing ion implantation. Ideal implantation conditions to link the generated defects to an optical mode as well as thermal annealing procedures will be reported. Furthermore, we present deep insights into the characterized defect by presenting previously unknown optical and polarization properties. With the zero-phonon line (ZPL) determined near 1540nm, this defect has ideal prerequisites to be utilized in a spin-photon interface (SPI) operating at telecommunication wavelength which could enable long distance transmission of quantum information embedded in a CMOS-compatible material.
Er^{3+}-emitters in 4H-SiCOI photonic integrated circuits could be utilized as quantum memory combined with other nonlinear heralded single photon emission in ring resonators [5] or even provide directly a single photon source [6].

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