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Realization of Hadamard, Pauli-X and rotation gate for polarization-encoded qubits on chip RENE HEILMANN, MARKUS GRAEFE, STEFAN NOLTE, ALEXANDER SZAMEIT, Institute of Applied Physics, Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany, DIAMOND-/ CARBON-BASED OPTICAL SYSTEMS TEAM — The implementation of quantum operations in photonic devices plays a central role towards quantum computing, as light is a logical choice when low decoherence and stability is of interest. Particular interest is thereby given to polarization-encoded photonic qubits on chip that are superior in terms of stability and size. However, to date waveguide-based modulating polarization states was beyond technological capabilities, preventing from the implementation of universal quantum computing algorithms on chip. In our work we close this gap and present integrated Hadamard, Pauli-X and rotation gates of high fidelity for photonic polarization qubits by employing a reorientation of the birefringent waveguide's optical axis. To this end, we employ laser-written waveguides and use several of their unique features. Due to the impact of an artificial stress field created by an additional defect close to the waveguide, its optical axis is rotated. Further on, by adjusting the length of the defect, the retardation between ordinary and extraordinary field components is precisely tunable including half-wave plate and quarter-wave plate operations. A theoretical treatment as well as characterization of the implemented gates by classical and quantum light are presented.

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