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Microfabricated quantum processor unit with integrated optics

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Trapped ions have shown great promise as a platform for quantum computing, with long coherence time, high fidelity quantum logic gates, and the successful implementation of quantum algorithms. However, to develop trapped-ion based quantum computers from laboratory setups to practical devices for solving real-world problems, the number of controllable qubits must be increased while improving error rates. One of the major challenges for scaling trapped-ion quantum computers is the need to switch from free space to integrated optics, to achieve lower drift and vibrations of light relative to the ion, and therefore more stable and scalable ion-addressing.

At Infineon and the University of Innsbruck, we are working on the integration of optical elements in surface ion traps, which are fabricated in industrial semiconductor facilities at Infineon. We use femtosecond-laser written waveguides to guide light in a glass-block that is manufactured on the chip's surface in wafer-level processes. The integrated waveguides eliminate vibrations between optics and the ion, and therefore reduce intensity fluctuations of the laser light at the position of the ion. Moreover, integrated waveguides can enable complex light routing to multiple trapping sites and make quantum information processors more robust and more scalable.

In this contribution, we present recent progress on fabrication of our iontrap.

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