SAND2022-3696C

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As quantum systems become more complex factors such as device footprint, mechanical/thermal stability, and power consumption become increasingly important, and can even be driving determiners of system performance. I'll give an overview of some of our work on integrated photonics for neutral atom and trapped ion systems at Sandia National Laboratories. Key elements of these systems include integrated waveguides for light delivery, single-photon detectors for fluorescent detection, and microfabricated piezo-optomechanical modulators for fast and high extinction switching of delivered light.

*** Abstract text for technical review purposes**

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As quantum systems become more complex factors such as device footprint, mechanical/thermal stability, and power consumption become increasingly important, and can even be driving determiners of system performance. I'll give an overview of some of our work on integrated photonics for neutral atom and trapped ion systems at Sandia National Laboratories. Key elements of these systems include integrated waveguides, input/output coupler gratings, single-photon avalanche detectors (SPADs), and microfabricated piezo-optomechanical Mach-Zehnder modulators. Concerning waveguides, we've shown record low absorption in the UV, going down to 320 nm, allowing coverage for most ion and atom wavelengths. Output gratings, the final component for light delivery from the waveguide to the ion/atom, consistently show angle accuracy to within 0.5 degrees of target with 0.1 degree uniformity. Our integrated SPADs, which were the first published ion trap integrated SPADs, currently have detection quantum efficiencies ~ 24 % at 369 nm, and new designs promise lower dark count rates and higher efficiencies. Finally, our integrated Mach-Zehnder absorption switches allow for high fidelity quantum operations as demonstrated by gate set tomography.

BIO

Hayden started his research in quantum system with his graduate work in quantum optics at the University of Oregon, studying single photon generation and frequency translation of single photon states via four-wave mixing in photonic crystal fibers. Moving on to Sandia National Laboratories, he began work on neutral atom-based inertial guidance technology, helping to develop the first high-data rate atom interferometer (AI) accelerometer, as well as a compact combination AI gyroscope/accelerometer system. He then went onto work on a variety of quantum information projects involving neutral and ionized atoms, as well as integrated photonics. He is currently the PI of the DARPA funded Trapped Ion Clock with photonic Technologies On Chip (TICTOC), which aims to develop a highly miniaturized optical atomic clock using trapped ions and enabled by integrated waveguides and single photon detectors.