Low-power Integrated Acousto-Optics for Atomic Quantum Sensors

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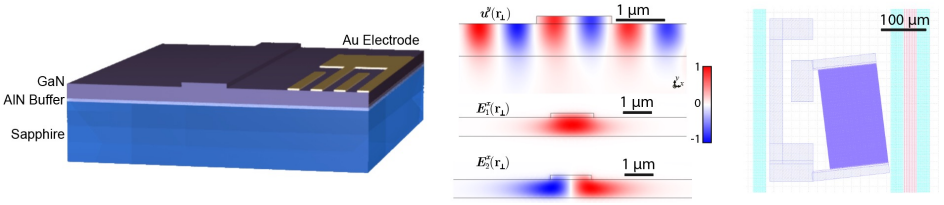
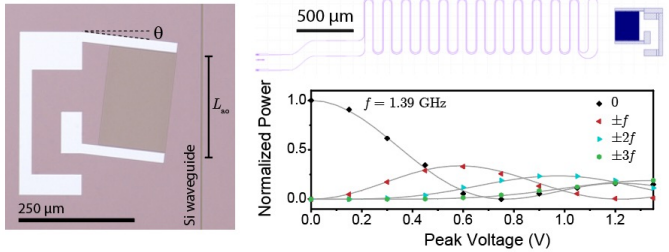
Objective

- Develop integrated photonic acousto-optic modulators (AOMs)based on a GaN-on-Sapphire waveguide platform.
  - AOMs are a key component technology for spaceborne cold-atom quantum sensors, such as atom interferometer gravity gradiometers or Rydberg-atom radars.
- Demonstrate operation at RF drive powers < 10 mW (and $V_\pi < 1$ V), 100× lower than conventional AOMs
  - The impact of successful AOM development is to lower power requirements from ~300 W to < 50 W for satellite-based deployment of quantum sensors.



Top: Diagrams and simulations of proposed device concept.



Left: Previously developed integrated photonic AOMs fabricated in integrated silicon photonics

Approach

- Design and optimize integrated photonic waveguides and electromechanical surface wave transducers using a multi-physics simulation package.
- Develop fabrication process. Fabricate test structures in advance of the full device to confirm and characterize the fabrication steps
- Fabricate devices on the surface of a GaN-on-Sapphire microchip leveraging the developed process.
- Perform laboratory-based experiments to confirm performance.
- Test devices in an existing cold atom experiment testbed.

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Key Milestones

• Design device based on multi-physics simulations	07/23
• Develop process flow and fabricate test structure	09/23
• Fabricate and test low-loss waveguides	03/24
• Demonstrate operation of modulator	06/24
• Demonstrate acousto-optic phase and single-sideband modulators at <10 mW power	09/25
• Test fiber-coupled devices in cold atom experiment	03/26

TRL_{in} = 2 **$TRL_{current}$ = 2**

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