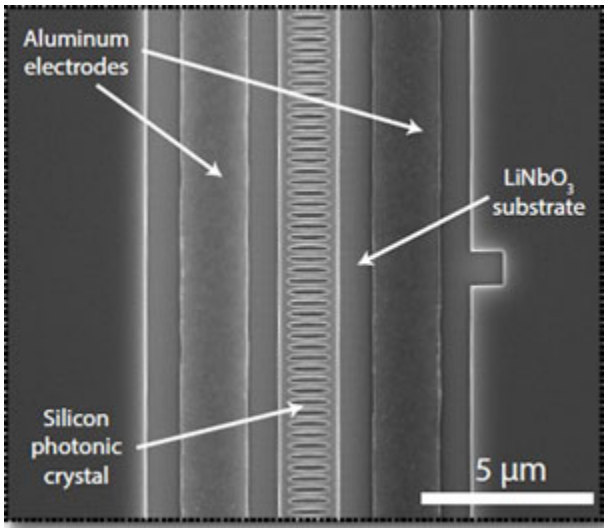
Docket #: S16-292

Quantum electro-optic converter

Stanford researchers developed a device that converts microwave signals (quantum logic) to optical signals using a silicon-on-lithium-niobate photonic crystal cavity. They integrated nonlinear materials with silicon photonic circuits and superconducting quantum electronics using nanophontonic fabrication techniques. Their quantum electro-optic modulator bridges superconducting microwave and optical domains, a key to quantum computing and communications.



SEM image of silicon-on-lithium-niobate photonic crystal with electrodes

Stage of research
Researchers have demonstrated high-Q electro-optically tunable photonic resonators on a chip with loss rates smaller than previously reported in lithium niobate microresonators. They will combine these signal converters with superconducting quantum circuits to enable high bit-rate connectivity between nodes in quantum communication networks.

Applications

- Quantum computing

- Quantum communication networks
- High-sensitivity acousto-optic and electro-optic devices

Advantages

- **Easier fabricaton** - Lithium niobate is combined with widely available thin film silicon, using a direct wafer bonding process rather than patterning the lithium niobate directly.
- **Smaller mode volumes** (tighter confinement of the light) and **avoids phase-mismatch issues** present in ring and disk structures.
- **Increased strength of the electro-optic interactio**n by the quality factor of the microwave cavity (typically about 100) by using a superconducting microwave resonator instead of using a non-resonant structure.
- Optical and microwave resonators are **co-integrated on a single chip**.
- **Compact and scalable** - Current systems use dozens of microwave coaxial cables to transfer signals in and out of the quantum hardware, a system that cannot be scaled for useful quantum computers.

Publications

- Witmer, Jeremy D., Joseph A. Valery, Patricio Arrangoiz-Arriola, Christopher J. Sarabalis, Jeff T. Hill, and Amir H. Safavi-Naeini. "High-Q photonic resonators and electro-optic coupling using silicon-on-lithium-niobate." arXiv preprint arXiv:1612.02421 (2016).

Patents

- Published Application: 20180113373
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