Selection Guide for Low-Loss Silicon Photonics Technology in Smart Buildings



Overview

Roadmapping the next generation of silicon photonics We chart the generational trends in silicon photonics technology, drawing parallels from the generatio.

Key Takeaways

For smart building applications, ultra-low-loss silicon and silicon nitride photonic platforms offer the best combination of low propagation loss, high integration density, and compatibility with CMOS fabrication. Key Material Platforms1.

Silicon-on-

Insulator (SOI)Advantages: High refractive index contrast allows compact waveguides and tight bends, enabling dense integration for optical interconnects and sensors. Compatible with heterogeneous integration of III-V materials for lasers and modulators. Loss Characteristics: Typical single-mode propagation loss ranges from 0.

5 dB/cm to 2 dB/cm, with lower losses requiring advanced lithography and careful waveguide design. Applications: Optical gyroscopes, ultra-low-noise lasers, and on-chip communication networks. 2.

Silicon Nitride (Si_3N_4)Advantages: Ultra-low propagation loss (as low as 1. 4 dB/m), wide transparency window from visible to mid-IR, high power handling, and low nonlinearities. CMOS-compatible and suitable for large-scale PICs.

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Loss Characteristics: Significantly lower than silicon, making it ideal for long delay lines, high-Q resonators, and frequency combs. Applications: LiDAR, RF-optical links, neuromorphic computing, and microcomb-based sensors. 3.

Hybrid Platforms (Si/SiN or Si/III-V)Advantages: Combines the high integration density of silicon with the ultra-low-loss and nonlinear properties of SiN or active III-V devices. Enables heterogeneous integration of lasers, modulators, and detectors on a single chip. Applications: Smart building optical networks requiring both active and passive components with minimal loss.

Design Considerations

Waveguide Geometry: Sub-micron silicon thickness (400–500 nm) balances low scattering loss and tight confinement.

Si

N waveguides benefit from the photonic damascene process for ultra-low-loss fabrication. Bend Radius: Larger bend radii reduce scattering loss but increase footprint; SiN allows tighter bends with minimal loss. Coupling Efficiency: Low-reflection tapers and optimized interfaces are critical for integrating heterogeneous components without introducing excess loss.

Fabrication Quality: High-resolution lithography, low-defect deposition, and stress management in SiN films are essential to achieve ultra-low-loss performance.

Performance Metrics

Propagation Loss: Target

Article Content

Roadmapping the next generation of silicon photonics

We chart the generational trends in silicon photonics technology, drawing parallels from the generational definitions of CMOS technology. We identify the crucial challenges that must be...

Low-loss High-uniformity Silicon Nitride Optical Building Blocks ...

We introduce low optical loss and highly uniform passive silicon nitride optical building blocks including straight waveguides, bends, tapers, 1-by-2 MMI, silicon nitride-tosilicon transitions

New-generation ultra-low loss silicon photonic waveguide and devices

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The state-of-art micro-racetrack resonator, high-resolution microwave filter and 100-cm-long delayline are demonstrated with standard 220-nm-SOI (silicon-on-insulator) MPW-foundry processes.

Leti (english)

Pioneering silicon photonics for more than 20 years, CEA-Leti has designed a technology toolbox featuring state-of-the-art performance for communication, computing and optical sensors.

Progress in Passive Silicon Photonic Devices: A Review

We survey the state of the art in fundamental building blocks, including strip, rib, and silicon nitride waveguides, with a focus on achieving ultra-low propagation loss.

OFC2025|Integration of TSMC''s Low-Loss and High-Uniformity Silicon ...

Cross-sectional schematic of photonic integrated chip platforms showing silicon-and SiN-based photonic devices, including two types of optical I/Os: silicon grating couplers and SiN edge couplers.

Supporting quantum technologies with an ultralow-loss silicon

His research focuses on the micron-scale silicon waveguides that are used to make ultracompact and low-loss photonic integrated circuits for communication, imaging, and sensing applications at infrared

Silicon Photonic Filters: A Pathway from Basics to Applications

Among various silicon photonic elements, one of the most important components is the silicon photonic filter which selectively passes or blocks wavelengths, and is suitable for spectral

Towards low-loss monolithic silicon and nitride photonic building ...

We review recent progress in loss reduction of Si and SiN waveguides in GLOBALFOUNDRIES 300mm monolithic Si photonics platform. Primary challenges to creating low-loss CMOS integrated photonic

Low-loss optical waveguides made with a high-loss material

Guiding of light is fundamental to optical communication and integrated photonic circuits. To confine the propagating electromagnetic waves and guide them with low loss, the use of select ...

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