Silicon in Photonics

Made by : Sheeba khanam

M.Tech-3rd sem.

(VLSI design & Embedded systems)

Contents

- Introduction
- Features of photonics
- Silicon material
- Silicon light source
- Filtering light
- Silicon modulator
- Silicon based photo detector
- Latest research
- Disadvantages
- conclusion

Introduction

- Silicon photonics is an evolving technology in which data is transferred among computer chips by optical rays.
- Optical rays can carry far more data in less time than electrical conductors..
- It's performance results the greater available bandwidth and higher propagation speed of infrared (IR) beams compared with electric current.
- It increase the processing speed and power of computers.

Features of photonics

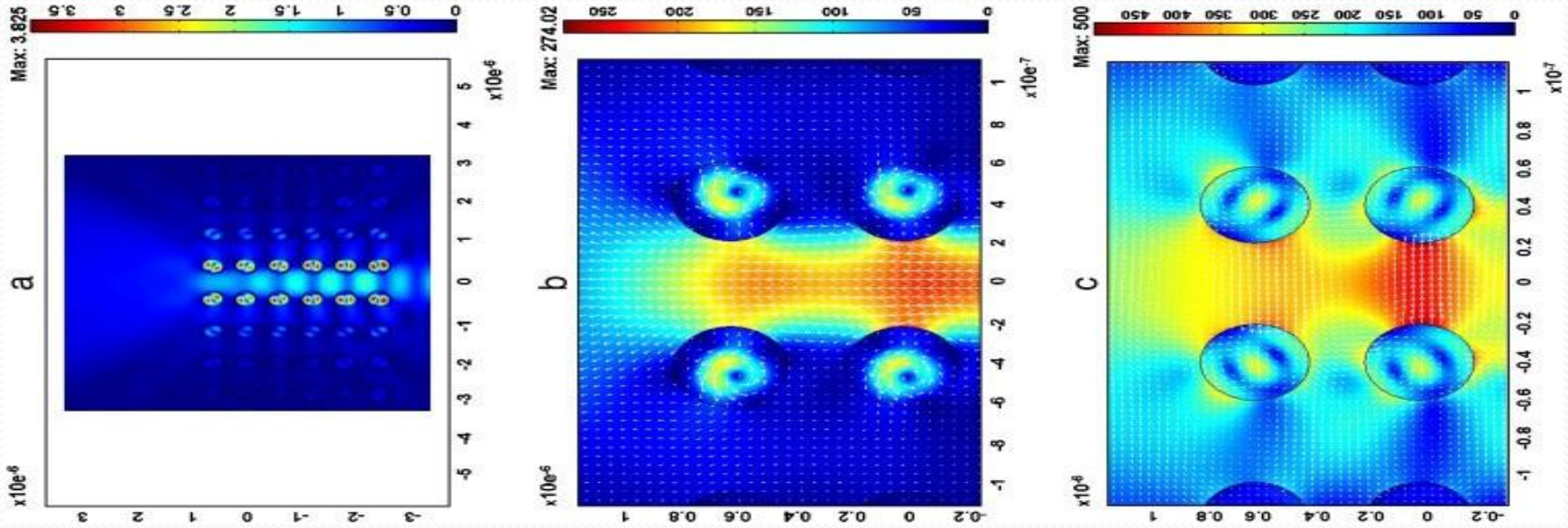
- phase insensitive.
- frequency conversion
- processing and regeneration.
- alternative to semiconductor-based photonics.

Silicon Materials

- Amorphous silicon
- Porous silicon
- Black silicon

Light propagation through silicon crystal

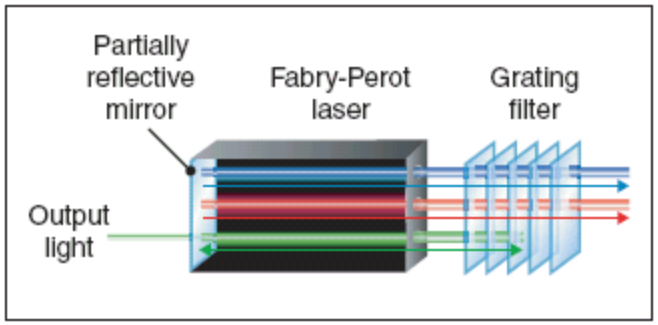
silicon is opaque in the visible spectrum, it is transparent at the infrared wavelengths used in optical transmission, hence it can guide light



Silicon light source

- A hybrid silicon laser is an optical source.
- It comprises a silicon waveguide fused to an active, light-emitting, III-V epitaxial semiconductor wafer.
- The emitted light from the active layer couples into the silicon waveguide due to their close proximity where it can be guided to reflect off mirrors at the end of the silicon waveguide to form the laser cavity.
- The work towards a silicon-based emitter is ongoing but still far from nature.

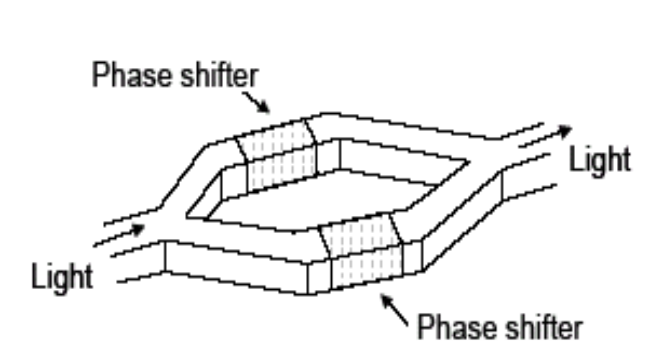
Filtering light

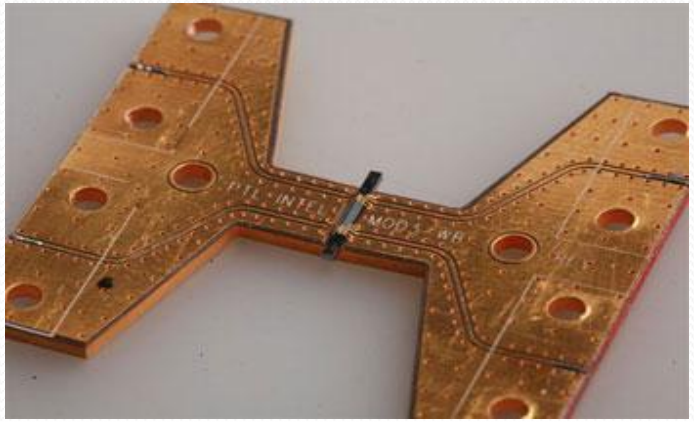


To cause the laser to generate only one specific wavelength, the light can be filtered by a grating, which reflects a specific set of wavelengths in a different direction. The specific wavelengths needed for communication can be individually selected and directed toward other photonic components.

Silicon modulator

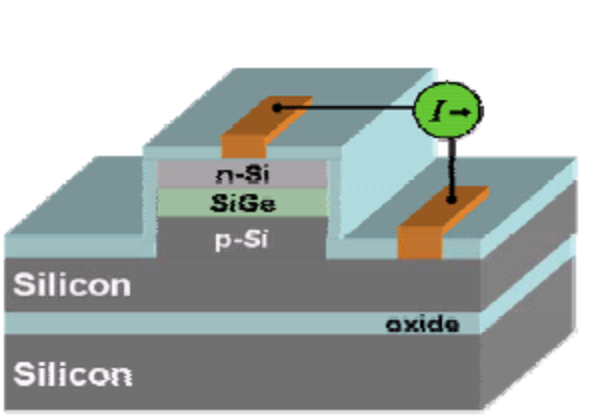
To modulate the light, thus causing it to carry data in the form of optical pulses. One such technique is to control the density of free charge carriers, which alter the optical properties of the waveguide.





Schematic of a Mach-Zehnder interferometer modulator with two phase shifter sections

Silicon based photo detector



Si_{1-x} Ge_x waveguide-based photodetector on a SOI wafer. The waveguide is formed by the ridge of p-Si material and is running perpendicular to the cross-section. The SiGe MQW are inside the region labeled SiGe.

Disadvantages

- Laser devices, which generate the IR beams that carry the data, are power-hungry.
- Production is not efficient but cost is efficient.
- Wave guides and fibers are harder to use than wire.
- The components are more expansive.

Latest researches

- Researchers are developing methods of overcoming problems that prevent the use of silicon.
- The research of the Electronics Laboratory is focused on advanced CMOS compatible silicon photonics, for on-chip optical signaling.
- Using silicon nanophotonics to integrate optical functionality into processors on the nanometer scale.

Conclusion

From the above report it can be concern that Silicon modulators operating at 2.5 GHz have demonstrated two orders of magnitude improvement over other known Si-based modulators, with theoretical modeling indicating performance capacities beyond 10 GHz.


Thank
You