IMEC's CMORE platform

Silicon photonics

Technology

IMEC has developed submicron SOI optical waveguides, wavelength filters and fiber interfaces which can be used to realize advanced photonic integrated circuits. Nanometer-scale accuracy is required for a sufficient performance. Using CMOS processing tools and methods, such accuracy is reached over a large writing field, enabling true large-scale photonic integrated circuits with a large functionality. The fabrication processes were developed within IMEC's 200mm CMOS pilot line and tailored for very diverse nanophotonic structures.

Applications

Silicon photonics enables much more compact photonic integrated devices compared to current commercially existing solutions by integrating much larger functionality on a single photonic chip. Through heterogeneous integration on the same photonic IC of III-V components, such as high-performance light sources and detectors, and the integration with other materials, silicon photonics is regarded by many as an upcoming disruptive technology.

One of the main applications of silicon photonics is optical telecommunication. For fiber-to-the-home, optical access networks and wide area networks, silicon photonics can deliver compact, low-cost components with a high functionality. Wavelength division multiplexing concepts can be introduced closer to the end-user and allow for much more reconfigurable, flexible and intelligent access networks.

The same technology can be used for optical interconnects, all the way from system-to-system, over board-to-board and chip-to-chip to intra-chip communication. Silicon photonics may solve bandwidth, space and power problems in high-performance computing (HPC) centers, in future ASICs and in general-purpose ICs through truly new approaches.

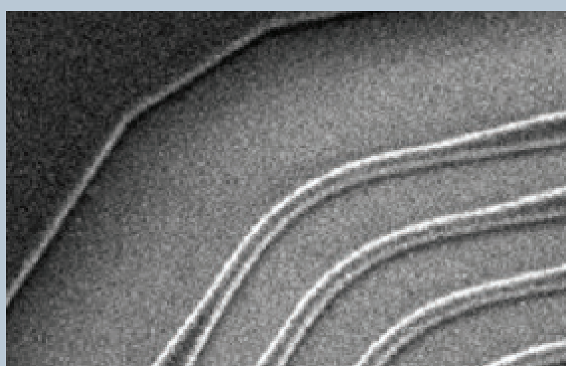
Silicon photonics can also be used for compact, cheap and highly functional sensors and innovative sensor read-out systems. Silicon photonics based sensors and electronic sensors are complementary and therefore allow for a pervasive, ubiquitous use of sensors systems. Sensors for temperature and pressure and chemicals can be exploited for early problem detection and safety in plants and tools, and for monitoring and fine-grained usage-tracking. Label-free biomolecule sensors can be integrated with hundreds to thousands on a chip. Applications include drastically cheaper bio-analysis devices for early detection, faster drug development and fine-grained environmental monitoring.

Technology advantages

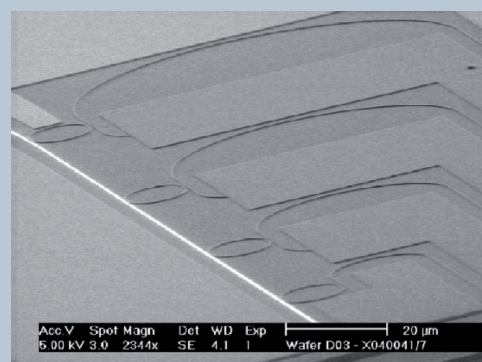
The fabrication processes are run in IMEC's CMOS pilot line and are transferable to industrial CMOS processing lines. By building research and development of SOI photonic integrated circuits on IMEC's nanophotonic waveguides, the user gets the advantage of real large-scale photonic integration processes with a path towards high volume fabrication and high yield.

Large-scale integration limits the number of chips and components in a package. As the cost of today's optical components is mainly determined by packaging and testing, fabrication costs and end user prices can be greatly reduced. Solving many of the alignment problems in smaller-scale integration, results in robust components with improved yields. Furthermore, silicon-on-insulator is a robust and relatively cheap substrate, available in high volume.

Silicon photonics not only offers a cost advantage, but can deliver solutions that were simply impossible before. In the high-performance market, optical interconnects based on SOI can deliver a truly high bandwidth density and remove much of the thermal and space problems. On-chip optical interconnects are on the ITRS roadmap and are part of the solution for the tremendously increasing intra-chip bandwidth need. In the sensor markets, up to thousands of sensors can be integrated on a single chip, as opposed to the single-device-single-sensor approach offered by other technologies.



On-chip optical interconnect networks based on SOI waveguides can have a pitch smaller than 2μm. The accessible bandwidth per path is in the Tbit/s range.



A WDM demultiplexer in SOI based on ring resonators allows to exploit the large waveguide bandwidth.

Benchmarking

The IMEC CMOS research environment has proven to be well-suited for fabrication of nanophotonic integrated circuits in SOI. IMEC's processes deliver world-leading performance of optical waveguides and wavelength filtering structures, and are being further improved for better accuracy. Fiber coupler interfaces with large alignment tolerances are available. A large writing field and high-throughput enable fabricating a much larger number of structures, compatible with industrial use of silicon photonic circuits.

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