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Non-Confidential Description - PSU No. 4198
"Thermal Stabilized Silicon Circuits"

Keywords:
silicon photonics, optical devices, semiconductor fabrication, liquid crystals

Background

Silicon photonics, with its ability to manifest CMOS-compatible photonic devices, is a promising technology for next-generation optical links. Eventually, silicon photonics may replace a computer chip's semiconductor transistors with optical equivalents for greater computing performance. As optics penetrate deeper into the chip, temperature stability becomes more important. Silicon's high thermo-optic coefficient, accompanied by its modified refractive index in the presence of rising temperatures, results in performance degradation of photonic devices. Heat dissipation is a major challenge in modern microelectronic very large scale integration chips, even with advanced packaging technologies. Temperature stabilization becomes a challenge with thousands of devices of varying temperature profiles across a single chip.

Invention Description

This invention allows for passive and active temperature stabilization of silicon photonic devices and circuits by using a liquid crystal (LC) layer as the cladding. The invention consists of a material platform (e.g., silicon), a CMOS-compatible photonic device (e.g., waveguide, filter, modulating structure, coupler), and a LC layer clad over the photonic device. LC has many benefits as a cladding, including compatibility with back-end CMOS processes, active tuning capabilities, and negative thermo-optic coefficients which aid in temperature stabilization. By using a LC layer with a negative thermo-optic coefficient, the temperature of the photonic device can be passively stabilized. The temperature can also be actively stabilized by tuning the refractive index of the LC cladding layer. The invention may be adapted to alleviate temperature variations of a multitude of photonic devices on a chip, each with its own temperature profile. Anticipated Applications include telecommunications, high-speed signal transmission systems, integrated optical networks, high performance computing, and consumer connection devices. A US utility patent application has been filed.

Advantages/Applications

- Eliminates the need for existing power hungry, large-footprint temperature stabilization techniques based on Joule heating
- Avoids use of polymer cladding, external heaters, or thermo-electric coolers, resulting in a smaller size, power, and cost footprint

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