Semiconductors: Nanowire Lasers on Silicon

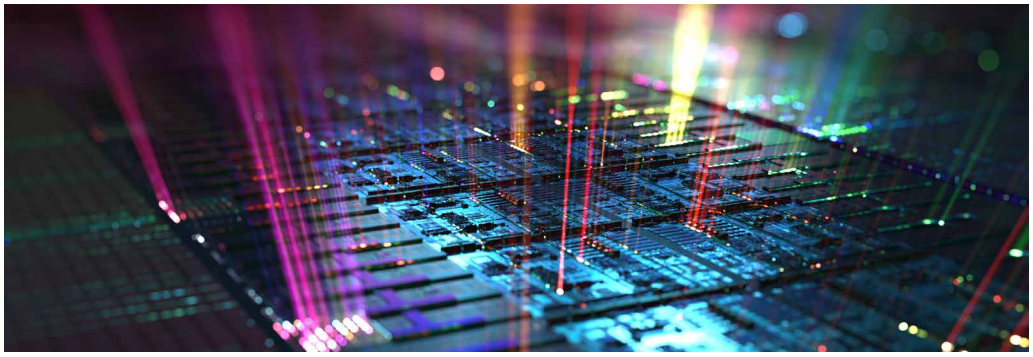
Reference No: B75073

CHALLENGE

Silicon constitutes the fundamental resource of semiconductor industry and microelectronics but is hardly compatible with the ongoing trend towards optical communication. The indirect nature of the silicon bandgap prohibits the generation of light on microchips and low-cost silicon wafers. Therefore, the monolithic integration of optically active III-V semiconductors on silicon is considered the “holy grail” of silicon photonics and could enable a new generation of light-enabled microchips and low-price laser diodes.

INNOVATION

Planar growth of III-V materials on silicon causes threading dislocations and defects that have a deleterious impact on the optical properties of the otherwise optically active materials. In contrast, nanowires can be grown on silicon on predefined positions whilst maintaining their excellent optical properties. However, the refractive index of III-V materials is typically very similar to the refractive index of the silicon substrates which prevents light reflection and optical feedback from the nanowire-silicon interface that is required for the lasing operation of the devices. The presented patent describes the combination of a reflection layer and a nanowire structure that efficiently enables optical feedback for the lasing operation of the device on silicon. The fabrication of the structure is highly scalable and can be performed with both common semiconductor growth methods: Molecular Beam Epitaxy (MBE) and Metal Organic Chemical Vapor Epitaxy (MOVPE). In a single growth process on a 300mm silicon wafer, billions of nanowire laser can be fabricated and positioned with nanoscale precision. The patent further describes in detail how light of the nanowires can be efficiently coupled to proximal silicon waveguides to allow optical communication and logic operations. Other implementations described in the patent enable the vertical emission of coherent light from nanowires on silicon to replace existing laser diodes in commercially available applications with a new generation of ultra low-cost devices. The fabrication on silicon could reduce the fabrication costs of many types of laserdiodes by several multiples as wafer costs are reduced and, most importantly, larger wafers with much higher scaling can be used.



COMMERCIAL OPPORTUNITIES

- Disruptive approach for optical data processing
- Communication at lighspeed
- Low energy consumption
- Lasers and LIDAR for mobile Applications
- Low-cost laserdiodes fabricated on silicon substrates

DEVELOPMENT STATUS

Successful nanowire-laser operation on silicon and on silicon waveguides by optical pumping, electrical pumping is under investigation.

REFERENCES:

1. Paper: https://pubs.acs.org/doi/10.1021/acs.nanolett.5b03404
2. Paper: https://aip.scitation.org/doi/full/10.1063/1.4939549
3. Paper: https://pubs.acs.org/doi/10.1021/acsphotonics.7b00805
4. Published Patents: WO2017046138A1 and WO2017046151A1

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