Docket #: S22-318

Integrated Laser Stabilization with Built-In Isolation

Stanford Nanoscale and Quantum Photonics Lab researchers developed a passive, magnet free, integrated on-chip laser stabilization and isolation device. Lasers need a way to prevent the light they emit from reflecting into the laser and destabilizing it. Bulky magnetic devices are typically used to block the reflections, which is unfeasible for chip-scale lasers. Jelena Vuckovic's group solves this problem by combining the laser feedback stabilization and isolator into a single integrated device (see figure 1). This device uses a high quality factor ring or disk resonator that acts as a circulator under high optical power. The ring coupled to a laser or optical gain media and combined with a feedback path stabilizes the lasing mode, reducing laser linewidth by several orders of magnitude. These devices need no external drives and operate without generating electromagnetic or magnetic field background interference. Simplifying and integrating the stabilization and isolation, reduces data communication systems costs and enhances performance, which opens new commercial opportunities in LiDAR, spectroscopy, and mobile optical computing.

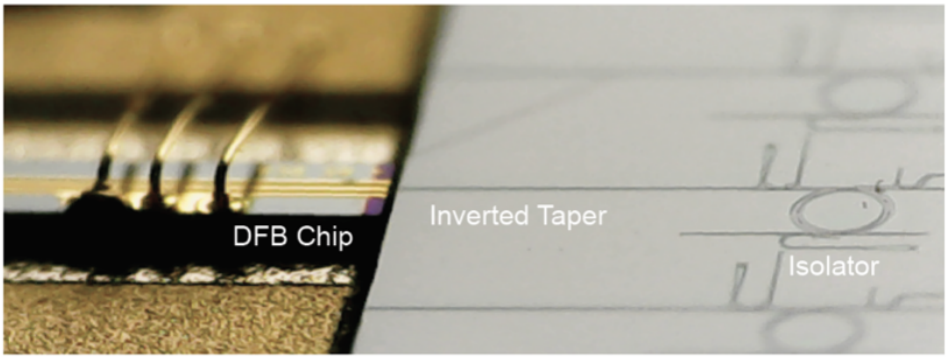

Figure 1 Optical image of hybrid integration of DFB laser with the isolator
Image courtesy the Nanoscale and Quantum Photonics Lab

Stage of Development – Proof of Concept
The Nanoscale and Quantum Photonics Lab prototypes performed well with insertion loss of only 1.8 dB with 17 dB isolation, and single ring isolation of up to 23 dB. Cascading two rings achieved 35 dB isolation with 5 dB insertion loss, which is competitive with state-of-the-art active and magnetic integrated isolators. Future research includes isolators for different frequencies of light, as well as further integration of components at chip scale.

Applications

- Integrated lasers for:
  - Data communications systems including the Internet
  - Lidar
  - Spectroscopy
  - Mobile optical computing

Advantages

- **Reduces bulk, complexity, and cost**
- **Simple**, combined **stabilization and isolation**
- Fabricated via **existing semiconductor processing** technologies and **well-known semiconductor-based material**
- **Passive and magnet free**, integrated high-performance chip-scale laser

Publications

- White, A. D., Ahn, G. H., Gasse, K. V., Yang, K. Y., Chang, L., Bowers, J. E., & Vu?kovi?, J. (2023). Integrated passive nonlinear optical isolators. *Nature Photonics, 17*(2), 143-149. https://doi.org/10.1038/s41566-022-01110-y
- Myers, A. (2022 December 1). New Stanford chip-scale laser isolator could transform photonics. *Stanford News*. https://news.stanford.edu/2022/12/01/new-chip-scale-laser-isolator/

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