Narrow-Linewidth DBR Laser Using Open-Access High-Precision Grating in InP PIC Generic Foundry Platform

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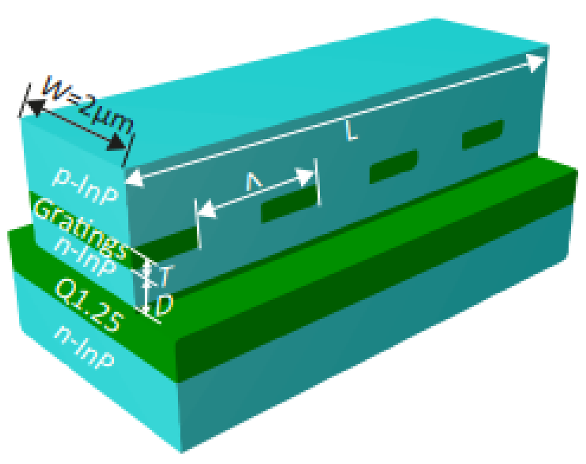
Abstract

- We present DBR lasers using DUV lithography in a generic InP-based photonic integration platform (SMART Photonics).
- The DBR lasers exhibit side mode suppression ratio (SMSR) > 45 dB and laser linewidths (LW) < 100 kHz.

Motivations

- CW lasers in PIC with narrow linewidth and high SMSR are key components for coherent transmission.
- Digital supermode (DG) DBR lasers:
  - 200 kHz LW and 40 dB SMSR [1].
- Sampled-grating (SG) DBR lasers:
  - 300 kHz LW and 40 dB SMSR [2].
- SGDBR laser with intra-cavity spectral filter and SOA:
  - 70 kHz LW and 50 dB SMSR [3].
- Simple and open-access DBRs are needed.

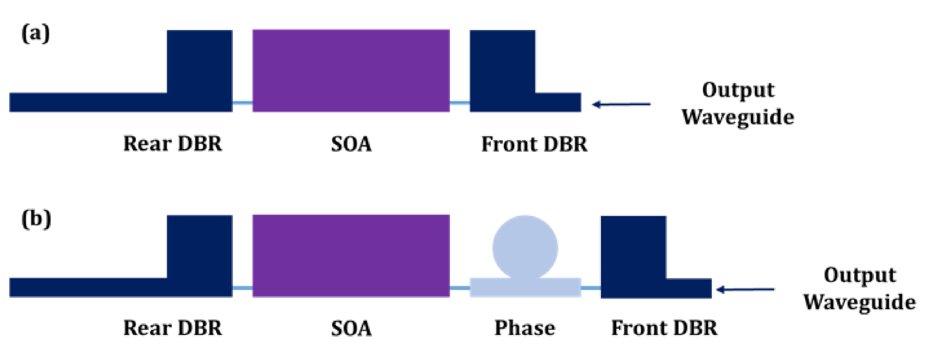
Grating

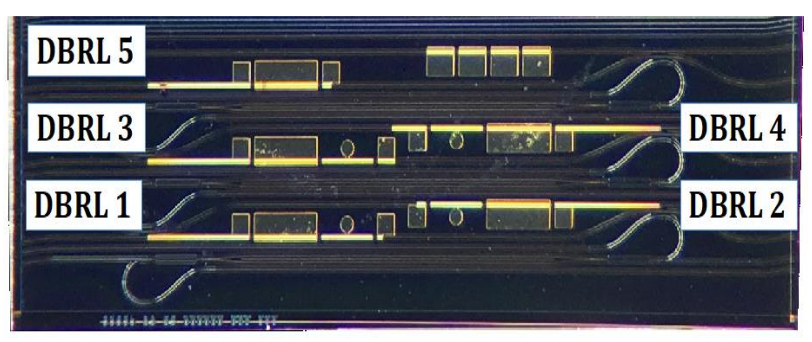


Schematic of DBR.
Zhao, D. (2018). High-precision distributed Bragg reflectors in a generic photonic integration platform. Eindhoven: Technische Universiteit Eindhoven.

- Grating structure patterned by deep ultraviolet (DUV) scanner featuring advantages of both e-beam and holographic lithography [4]
- Such a grating can be integrated with other active and passive building blocks in the platform to create a composite building block, e.g., distributed Bragg grating (DBR) laser.

DBR Laser

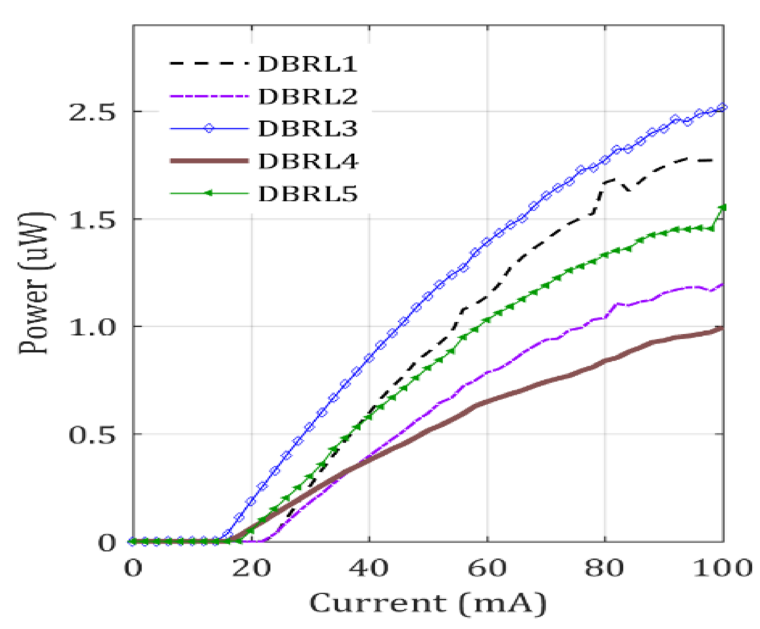


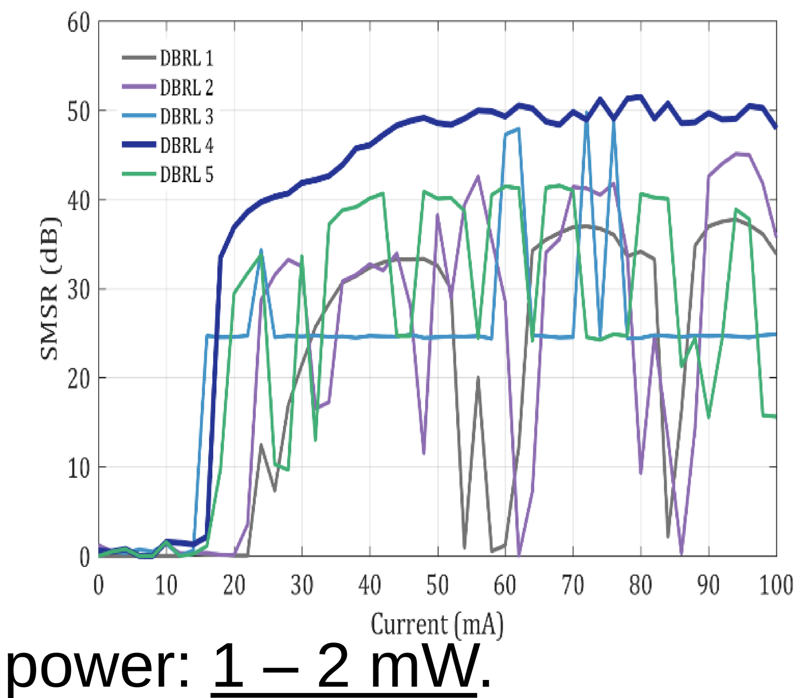


	DBRL1	DBRL2	DBRL3	DBRL4	DBRL5	
Front DBR	30	50	100	200	50	µm
Rear DBR	600	600	600	600	600	µm
Grating Pitch	237	237	237	237	237	nm
SOA (gain)	370	370	370	370	370	µm
EOPM (phase)	300	300	300	300	-	µm
DBRL Length	1.39	1.41	1.46	1.56	1.08	mm

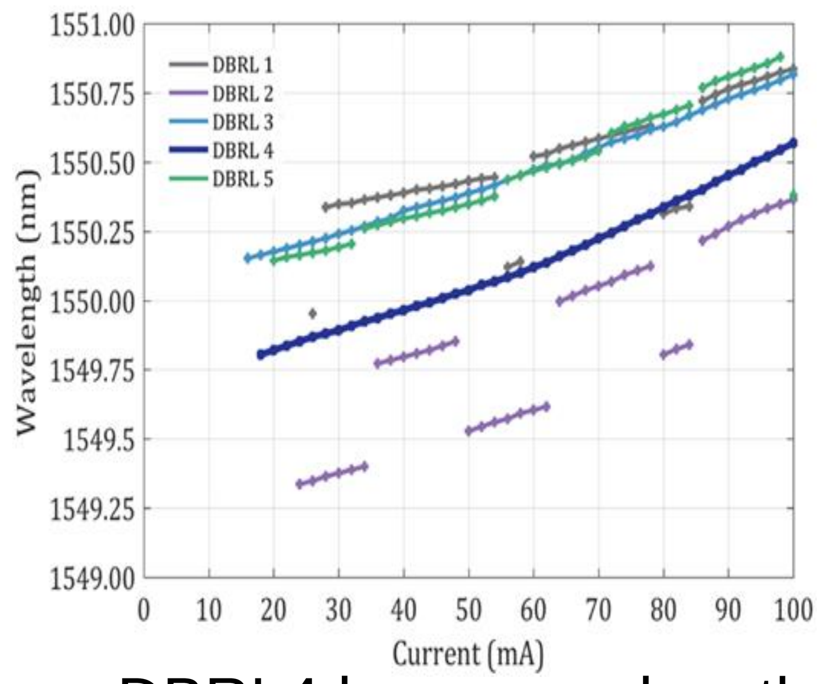
- 5 test DBR lasers made in SMART photonics technology.
- Microscope image of DBR lasers (PIC size: 4.6 mm x 1.6 mm) and the section lengths.

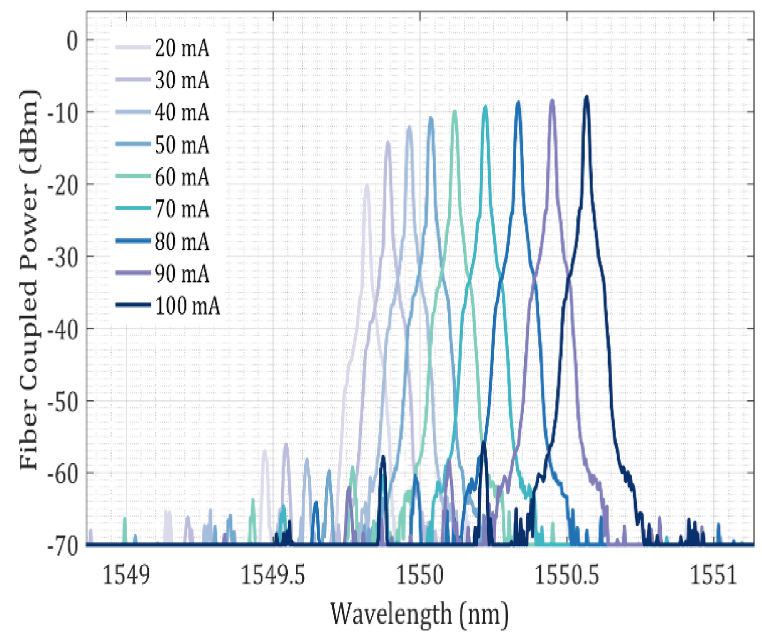
Characterization Results



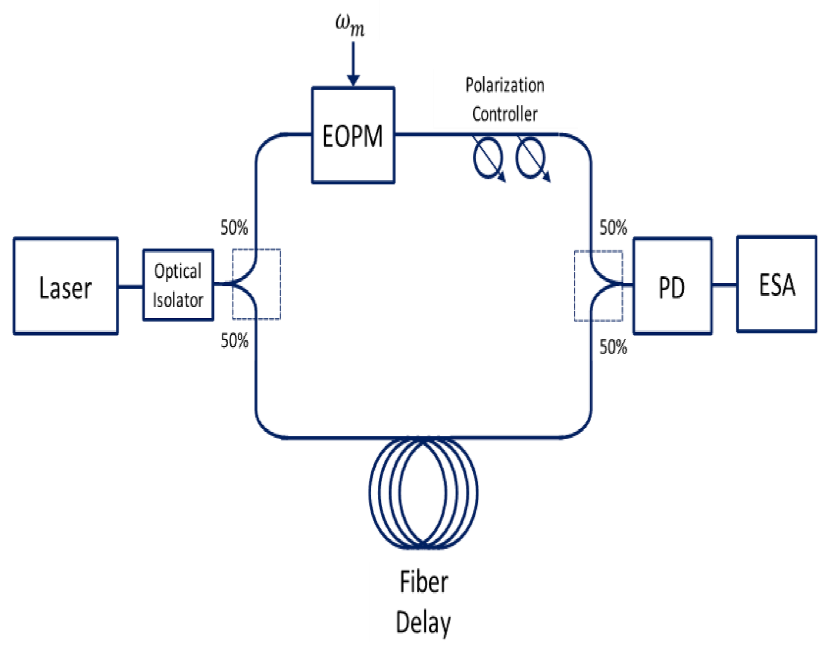


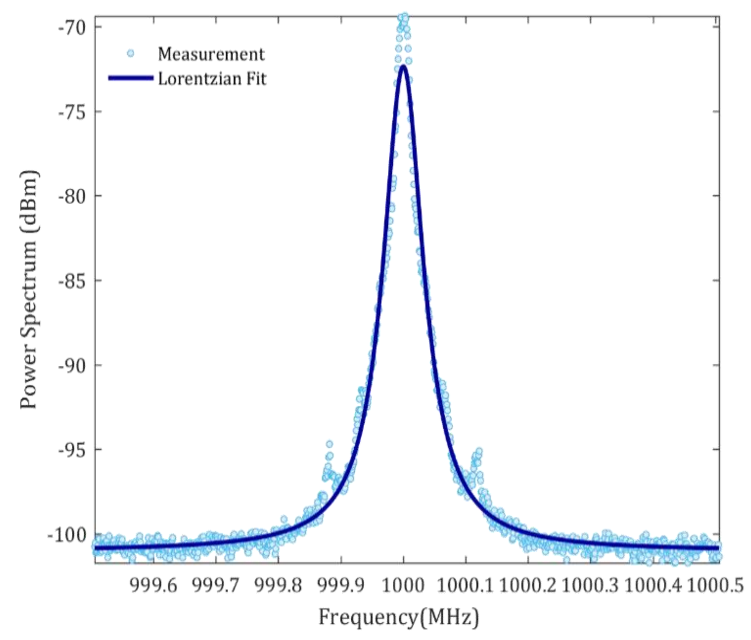
- Maximum fiber-coupled power: 1 – 2 mW.
- Threshold currents: 14 – 22 mA.
- DBRL4: 40 – 50 dB SMSR.
- Other lasers: multimode and mode hopping observed.





- DBRL4 laser wavelength:
  - < 1 nm tuning range: 1549.8 – 1550.6 nm for 20 – 100 mA.
  - ~ 0.0091 nm/mA.
- Other lasers: multimode and mode hopping observed.





- LW measured using delayed self-heterodyne method.
- 6.8-km optical fiber -> 35-µs time delay -> 10-kHz resolution.
- Measurement: full width at half maximum (FWHM) beat-note LW of 200 kHz (Lorentzian) -> Laser LW ~100 kHz.

Conclusions

- Simple DBR lasers using DUV-defined gratings in generic foundry approach have been demonstrated:
- SMSR > 45 dB and laser LW < 100 kHz.
- insufficient output power, wavelength tuning range and multimode/mode hopping need to be improved.
- Open-access technology enables monolithic integration of DBR, SOA, and passive components for forming composite lasers with narrower LW [5].

European Union's Horizon 2020 Marie Skłodowska-Curie grant agreement No.642355 and No.713694. Spanish Ministerio de Economía y Competitividad through Programa Estatal de Investigación, Desarrollo e Innovación Orientada a los Retos de la Sociedad (grant iTWIT, TEC2016-76997-C3-3-R).

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