

# 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.

## 1. Motivation

- CW lasers in PIC with narrow linewidth and high SMSR are key components for coherent transmission.
- Digital supermode (DS) 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.

## 2. Grating

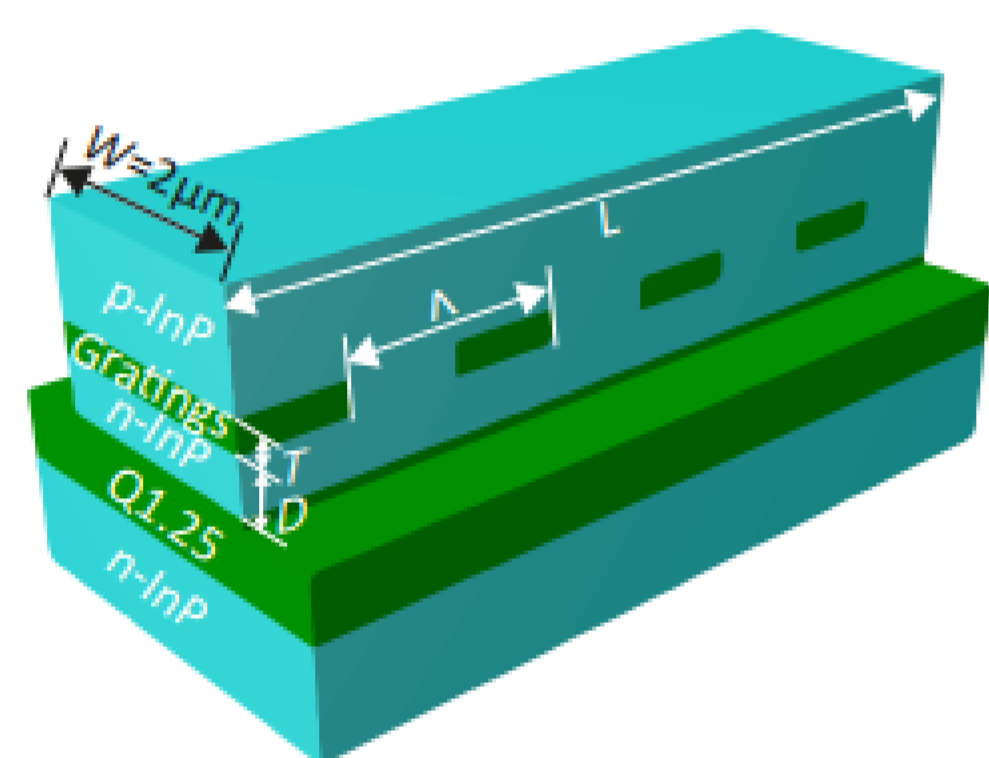


Fig. 1 Schematic of grating. Credit: Zhao, D., PhD thesis (2018). High-precision distributed Bragg reflectors in a generic photonic integration platform. Technische Universiteit Eindhoven

- 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.

## 3. DBR Laser

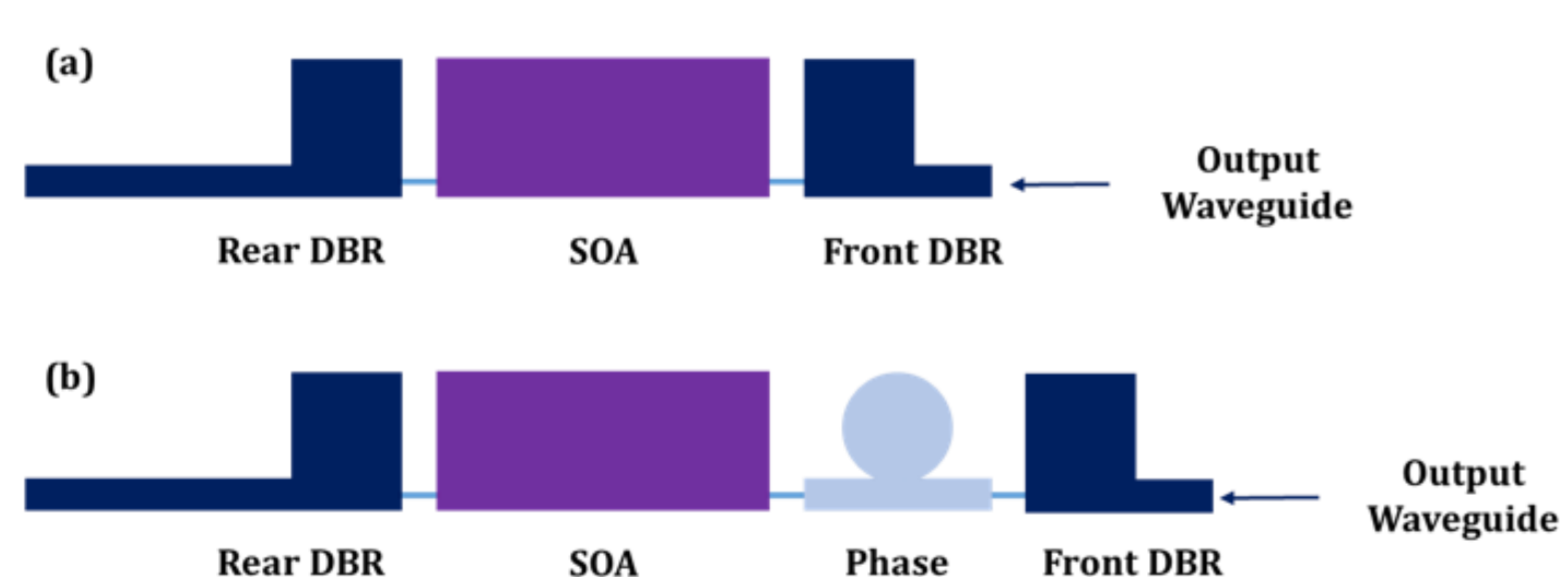
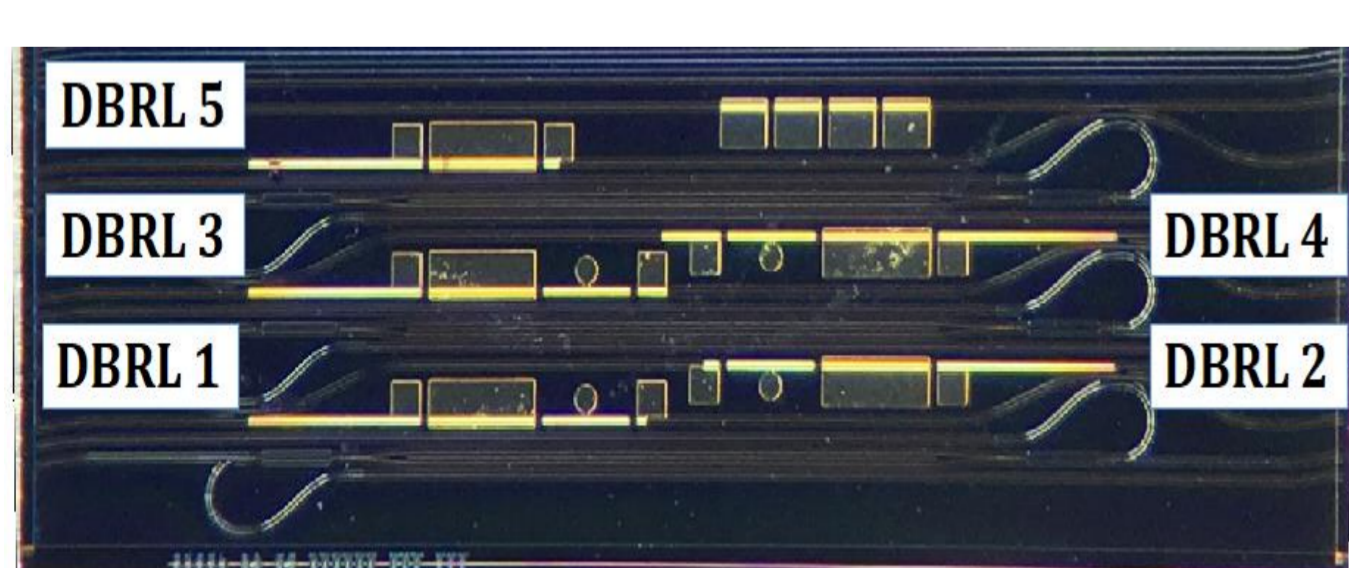


Fig. 2 Schematic of DBR lasers



	DBR Laser 1	DBR Laser 2	DBR Laser 3	DBR Laser 4	DBR Laser 5
Front grating (μm)	30	50	100	200	50
Rear grating (μm)	600				
Gain (μm)	370				
Phase (μm)	300				

Fig. 3 Microscope image of DBR Lasers PIC. Table 1. Specs of DBR lasers.

- Grating pitch : 237 nm.
- 5 on-chip test DBR lasers (DBRL 1-5).
- PIC area: 4.6 mm x 1.6 mm.
- Fabricated by SMART Photonics.



## 4. Characterization Results

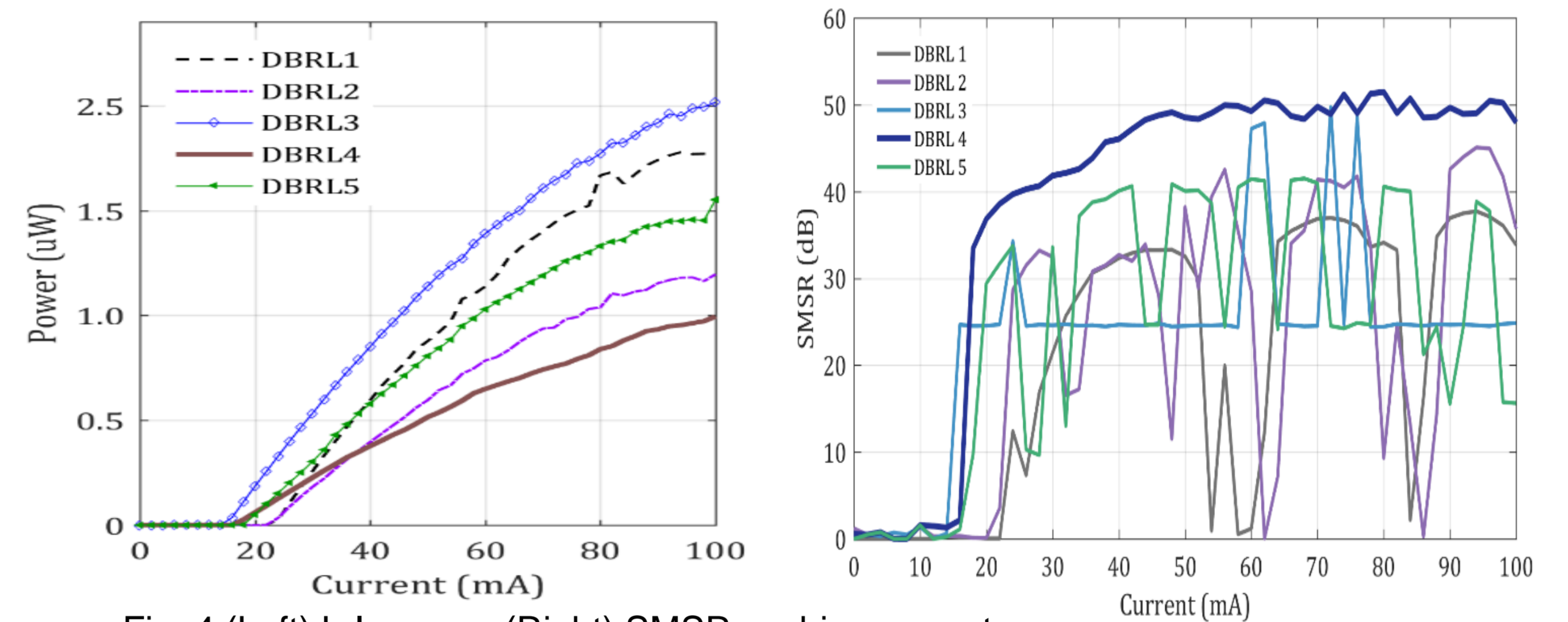


Fig. 4 (Left) L-I curves. (Right) SMSR vs. bias current.

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

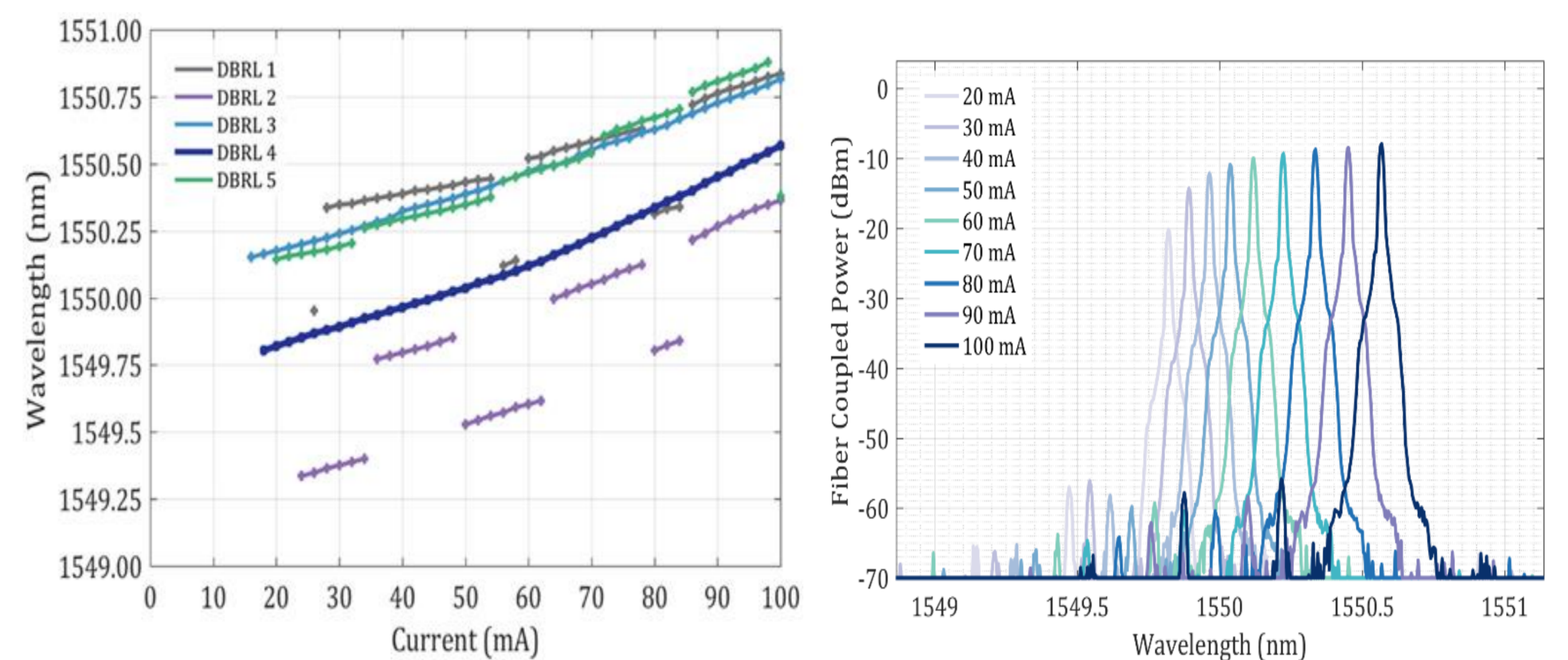


Fig. 5 (Left) Wavelength vs. bias current (Right) Spectra of DBR Laser 4.

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

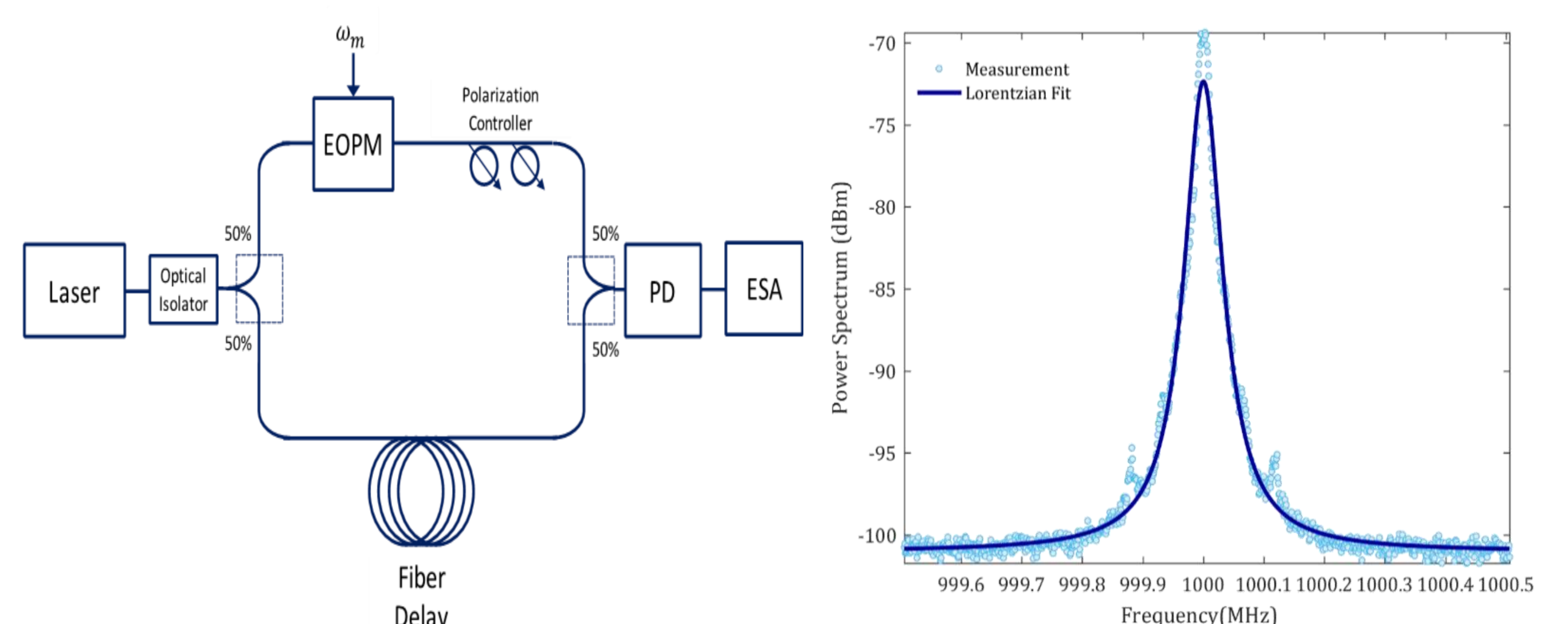


Fig. 6 (Left) Linewidth measurement setup. (Right) Line shape of beat note.

- 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.

## 5. 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].

