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TAIWAN TECH
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Highly Residual Facet Reflection Immune EML Devices by Using Partially Corrugated Grating Laser

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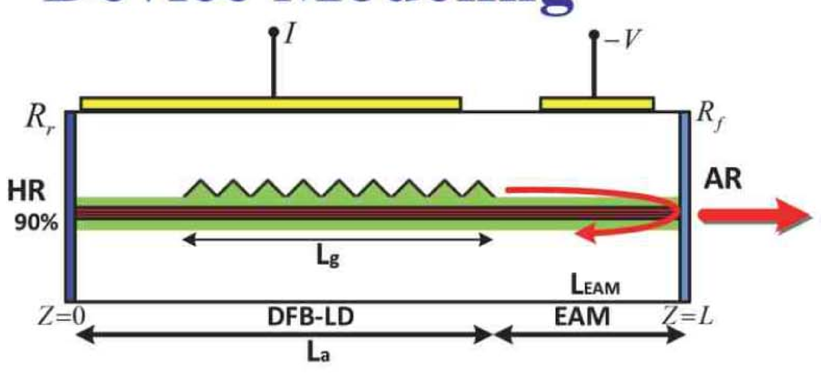
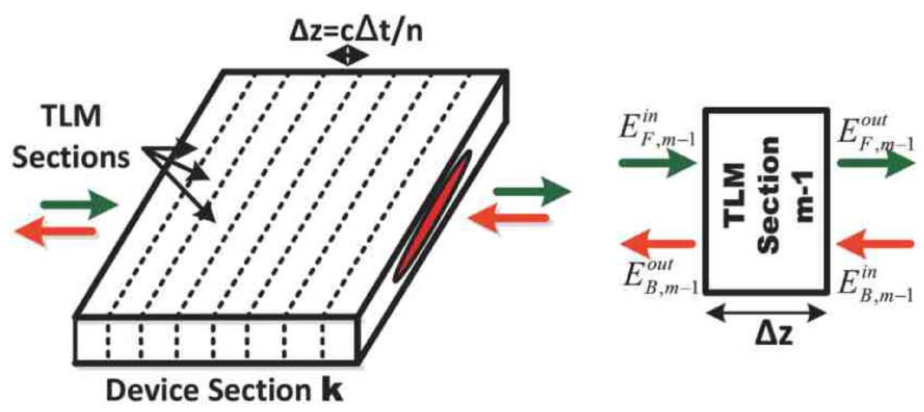
Abstract: Residual facet reflection can significantly degrade the performance of electro-absorption modulated lasers (EMLs) operating at high data rates. This issue also complicates the fabrication and characterization of the highly demanded light sources for optical interconnects and transmission. It is desired to optimize the device structure to make EMLs robust and immune to residual facet reflection. EMLs with a partially-corrugated-grating (PCG) DFB section are designed and optimized to have much improved tolerance to the residual optical reflection from the modulator output facet. By designing the laser section with an appropriate grating length and linear gain coefficient, the EML can have good tolerance to residual facet reflection.

Device Modeling

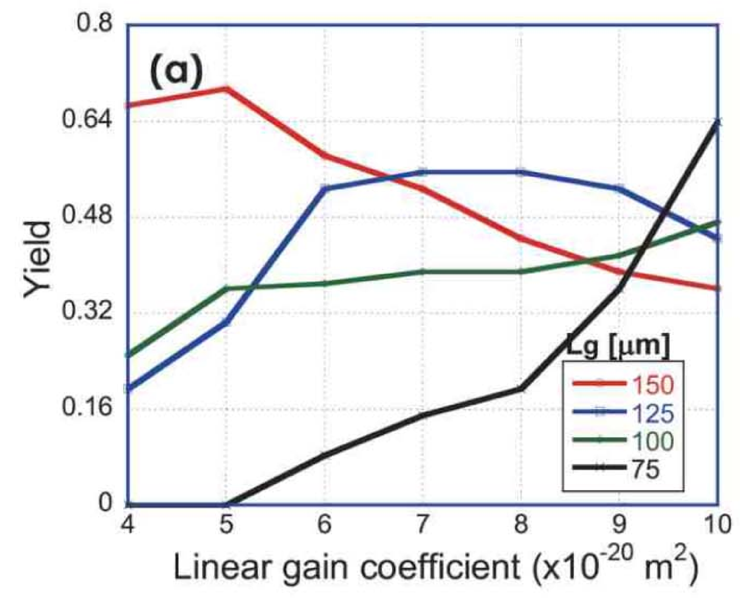


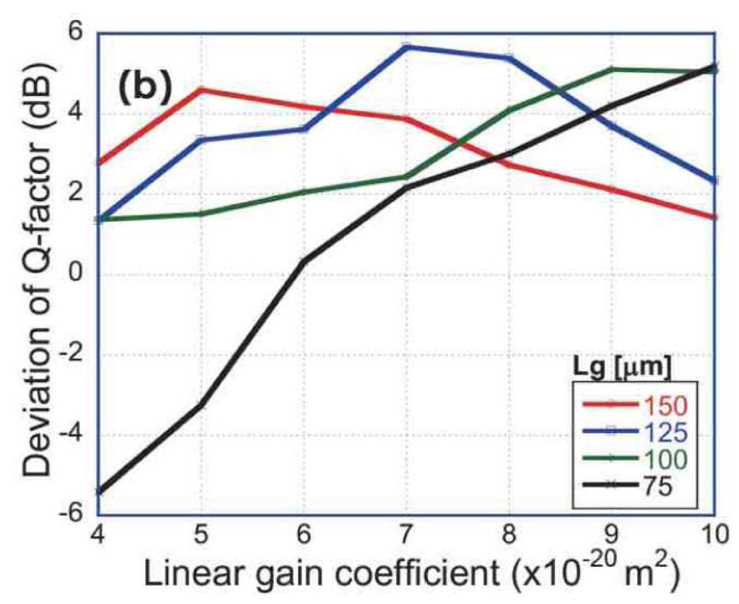
Schematic of EML with PCG



Transmission-Line Laser Model (TLLM)

Research Results





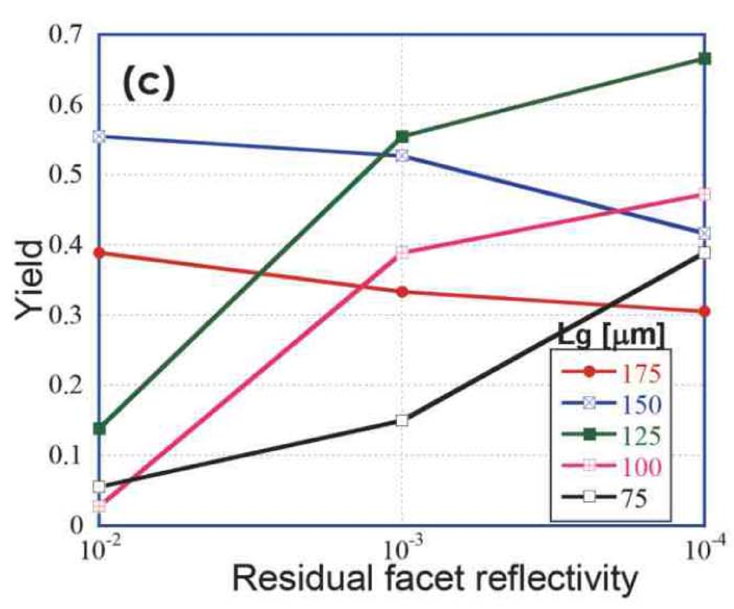
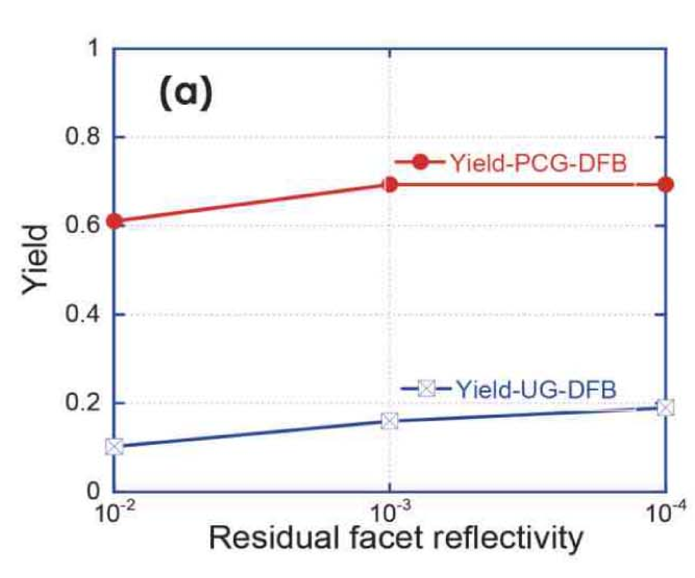


Fig.1. Effect of linear gain coefficient on a) yield and b) ΔQ with residual reflectivity of 10^{-3} c) Effect of residual facet reflectivity for PCG-EMLs as L_a is 200 μm.



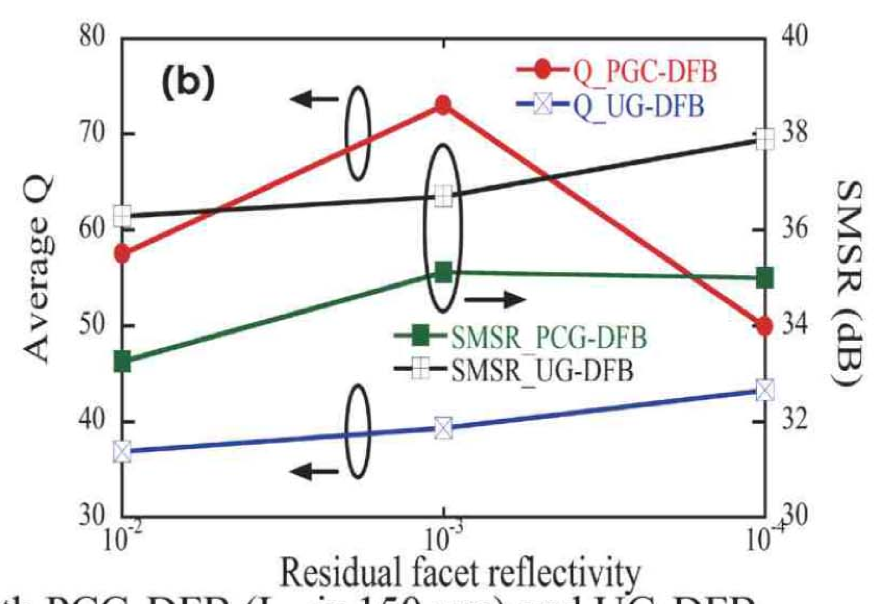


Fig. 2. Comparisons between EMLs with PCG-DFB (L_g is 150 μm) and UG-DFB (Uniform grating 300-μm long) for (a) Yield and (b) Q-value

A). Effect of linear gain coefficient on yield

1. To provide high yield, the PCG-EML needs to have a laser gain material with a linear gain coefficient no less than 6×10^{-20} m² Fig. 1(a).
2. The optimal gain coefficient depends also on the effective coupling strength (κL_g) of the laser section, which affects the SMSR.
3. For a greater L_g, the FP cavity is relatively short and the laser characteristic is closer to a conventional UG-DFB in which the photon and carrier densities are more sensitive to optical feedback. When L_g is as small as 75 μm, a large gain coefficient ($a > 9\times10^{-20}$ m²) is needed.
4. ΔQ is positive over the HR facet phase that gives a good SMSR for a PCG-EML for L_g of 125 and 150 μm, which can be considered as optimal condition Fig. 1(b).

B). Immunity to residual facet reflection for PCG-EMLs

1. Its yield Fig. 3(c), it increases slightly with reduced optical feedback, as expected, though is relatively insensitive to the residual facet reflection for L_g of 150 μm.
2. The yield drops from 66% to 55% when the residual reflectivity increases from 10^{-4} to 10^{-3}, and then degrades to only 14% for residual reflectivity of 10^{-2} when L_g is 125 μm.

C). Comparisons between UG and PCG EMLs

1. It can be clearly seen that the PCG-DFB EML can have much larger single-mode yield and average Q than the UG-DFB EML under the influence of modulated reflection Fig. 2(a).
2. The yield maintains >60% for PCG-DFB EML even if R_f is as high as 10^{-2}, while the yield for EMLs with UG-DFB is below 20%.

Research Interest: My area of research interest includes semiconductor optoelectronic devices, injection locked semiconductor laser, and optical networking technologies

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