Effects of Optical Feedback in InAs/GaAs Monolithic Quantum Dot Passively Mode-Locked Lasers

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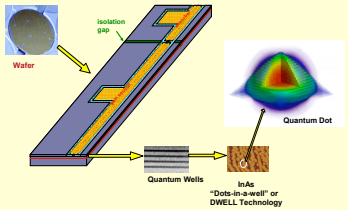
- In various practical situations, mode-locked laser may be subjected to optical feedback generated by discrete reflections
- These perturbations are induced by discontinuities in the optical waveguide of the monolithic chip or at the device-package interfaces from other optical devices placed along an optical fiber

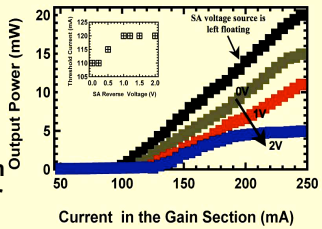
Device description



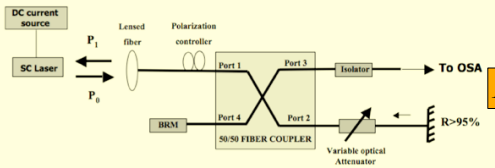
- Dots-in-a-well (DWELL) technology of six-stack QD active region grown by SSMBE on GaAs
- Total cavity length of 4.1-mm with a saturable absorber (SA) length of 0.8-mm
- HR coating (~ 95%) applied to the mirror facet next to the SA while the other facet is cleaved (~ 32%)

Light-current characteristic

- SA voltage source left floating: I_{th}=90mA @ RT
- I_{th} smoothly enhances from 110mA to 122mA when the SA reverse voltage is varied from 0V to 2V
- The maximum output power drops from 20mW down to 5mW because of a higher internal loss level in the cavity

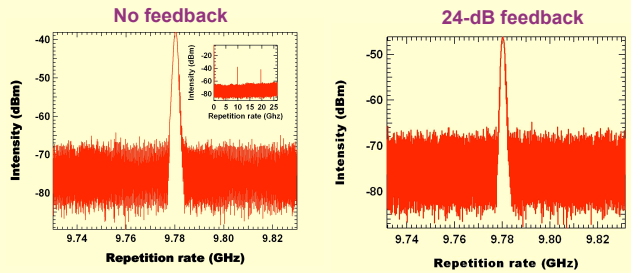


Optical feedback loop

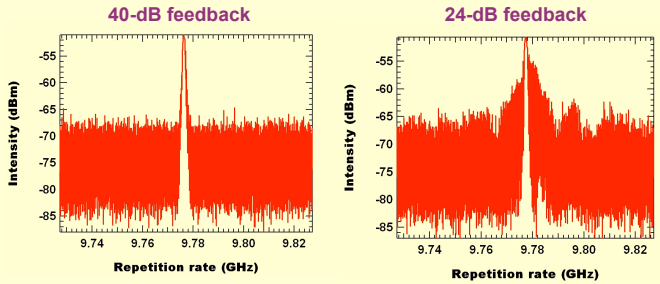


$$\Gamma_{dB} = P_{BRM} - P_0 + C$$

RF spectrum Experimental results



- Full span: the mode-locking regime exhibits peaks at the fundamental frequency (~10GHz) and at a harmonic component
- 200mA/0V: the mode locking condition is not destabilized even under 24-dB optical feedback
- The optical feedback generates a positive shift of the fundamental peak of ~2MHz as reported in QW MLLs [4]



- 200mA/1.2V: the laser remains mode-locked despite a slight increase in the noise level. This effect is strengthened for the highest feedback rate for which severe instabilities arise
- The linewidth broadening is the signature of the coherence collapse [5] regime, which affects the phase locking condition

The results experimentally show that mode-locking conditions are significantly affected when the feedback rate is strong enough to bring the laser within the coherence collapse regime

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[5] D. Lenstra et al., "Coherence collapse in single mode semiconductor laser due to optical feedback", Journal of Quantum Electronics, 21, pp. 675-680, 1985

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