Chirped DFB grating for narrow linewidth lasers

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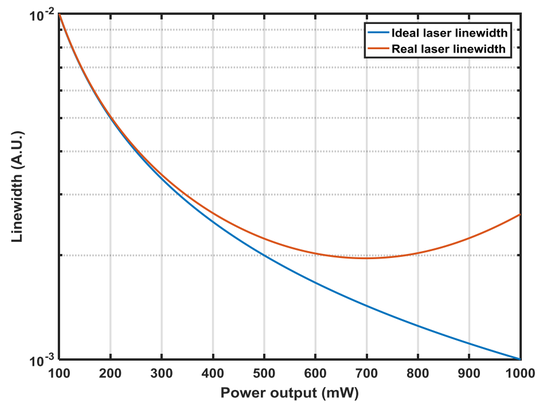
Laser Linewidth

- Theoretical laser linewidth in semiconductor lasers:

$$\Delta\nu = \frac{\Gamma_{active} R_{spont} h\nu(\alpha_i + \alpha_m)\alpha_m(1+\alpha_H^2)v_g^2}{8\pi P_{out}}$$

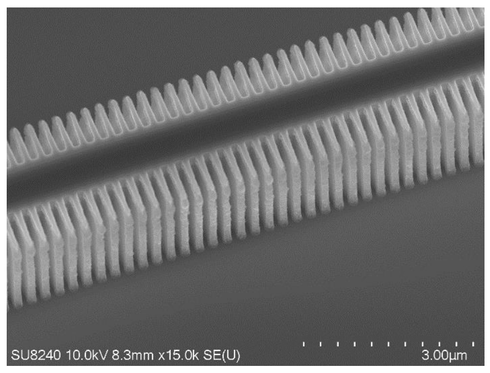
- Real laser linewidth



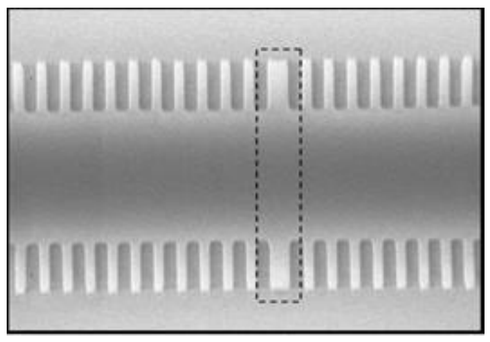
- Line broadening due to the α_H linewidth enhancement factor which takes into account nonlinear effects, i.e. Longitudinal Spatial Hole Burning (LSHB), at high power.

DFB Laser Design

- Sidewall Bragg Grating to generate the laser feedback; side mode suppression ratio (SMSR) exceeding $60dB$.

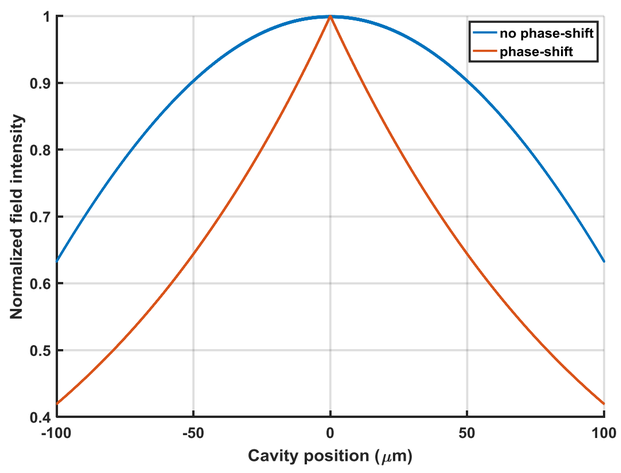


- Phase shift layer to solve mode degeneracy and allow single mode operation.



Longitudinal Spatial Hole Burning

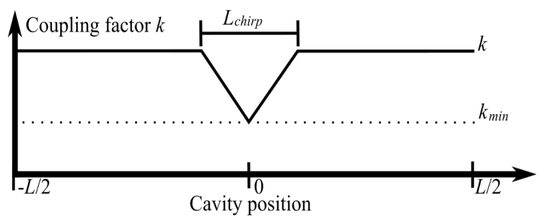
- Phase shift layer modifies the electric field distribution, i.e. field peaked at the phase shift position.

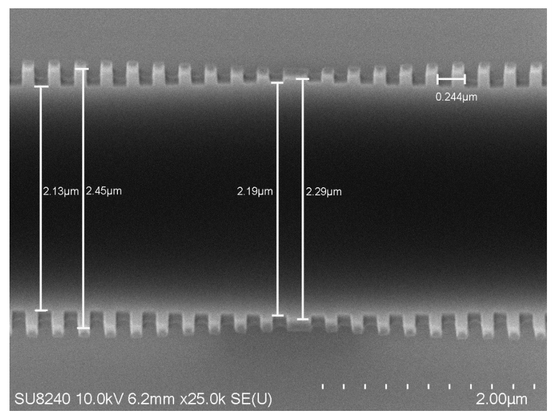


- Enhanced field non-uniformity which leads to LSHB and linewidth broadening.

Chirped Grating

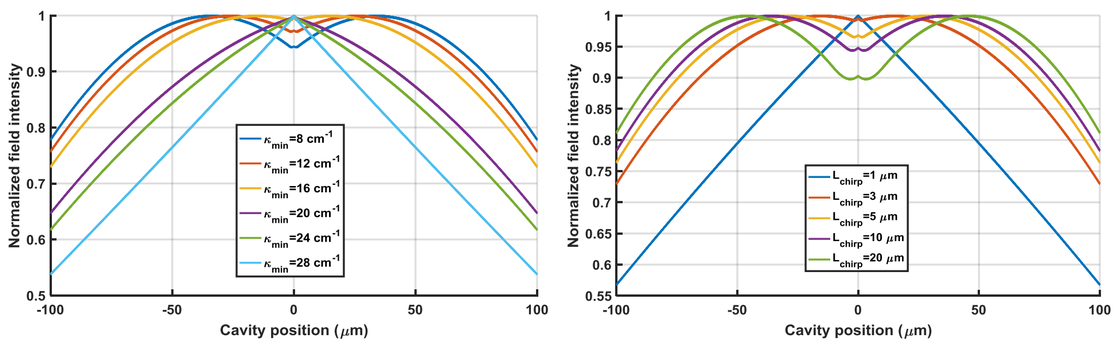
- Large fabrication tolerances for the chirp of the grating waveguide (i.e. $10 - 100\ nm$).
- Constant average effective index in the chirp region.
- Critical parameters: chirp length L_{chirp} and depth κ_{min}





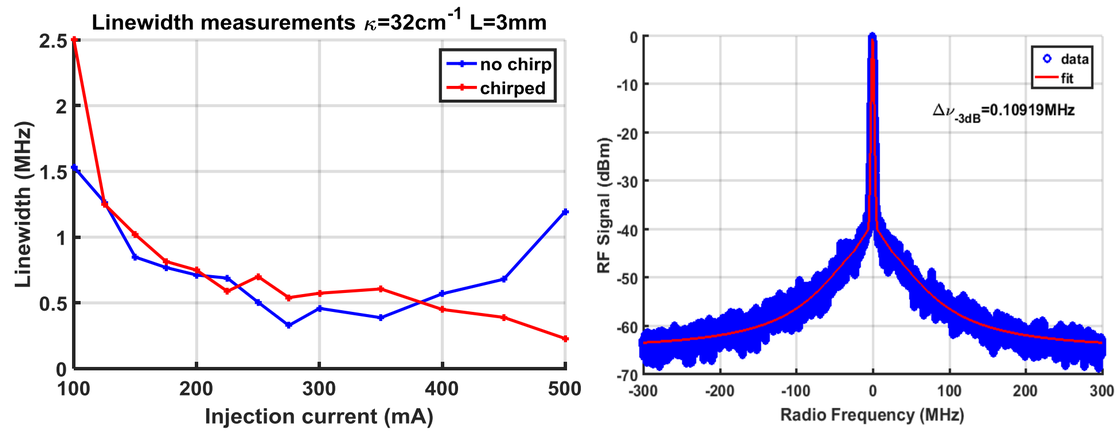
Chirped Grating Simulations

- Tuning of the two chirp parameters allows to shape the electrical field distribution inside the grating cavity.



- The configuration giving the most uniform distribution, i.e. closer to no phase shift grating, is the best for the narrow linewidth at high-power.

Linewidth Results



- Under the same fabrication conditions narrower linewidth for chirped device, as narrow as $109kHz$ at high-power operation.

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