# Picosecond pulse generation by a gain – switched DFB lasers

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**Abstract.** This paper reports on picosecond pulse generation in a gain – switched DFB lasers, modeled by rate equation model. We study numerically the influence of material and geometrical parameters on pulse characteristics.

Recently, picoseconds optical pulses find applications in different fields like free-space communications, bio-analytics, sensing, distance measurements, material processing, and spectroscopy. Such short pulses, can be generated by diode lasers. In addition, the diode lasers connected with other types of lasers, as solid state and fibre lasers can improve the pulse energy and peak power of pulses. Therefore, the theoretical and experimental efforts have been performed to improve the performance (shape, magnitude, etc.) of pulsed generated by diode lasers [1]-[3]. With this in mind, we consider in this paper the generation of picosecond pulses by gain-switching of distributed feedback ridge-waveguide laser diode shown in Fig. 1.

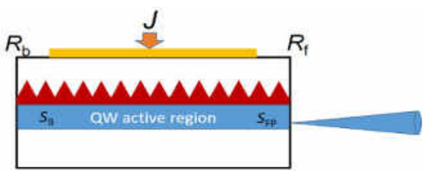


Fig.1. Schematic DFB laser. $R_b$=0.95, $R_f$=$10^{-4}$. Other parameters are as in [4].

The model investigated in this paper aims to simulate the mode competition between the Bragg-mode and the residual Fabry-Pérot modes during switch-on of a DFB laser [4]. The rate equation model for Fabry-Perot modes *FP* and Bragg mode *B* are treated separately coupled with one equation for charge carriers *n*

$$\frac{\mathrm{d}S_B}{\mathrm{d}t} = \frac{g_B(n)\Gamma S_B}{1+\varepsilon S_B} - \frac{S_B}{\tau_{S_B}} + K_B n^2, \quad \frac{\mathrm{d}S_{FP}}{\mathrm{d}t} = \frac{g_{FP}(n)\Gamma S_{FP}}{1+\varepsilon S_{FP}} - \frac{S_{FP}}{\tau_{S_{FP}}} + K_{FP} n^2, \qquad (1)$$
$$\frac{\mathrm{d}n}{\mathrm{d}t} = J - R - \frac{g_B(n)S_B}{1+\varepsilon S_B} + \frac{g_{FP}(n)S_{FP}}{1+\varepsilon S_{FP}}$$

We integrate numerically the equations (1) by studying the influence of different parameters on shape and energy of pulses, under pulse current (red line in Fig. 2). Figure 2 shows also the temporal behavior (black line) of the optical power at the front facet for different thickness and width of laser. One can see the almost symmetric shape and higher peak for small width of active region (Fig.2a). An increase of width leads to a deformation of pulse and lower peak, as well lower pulse energy (see Fig. 2b). We believe that our work provides a good basis for future experimental study of ps pulses generated by gain – switched DFB lasers.

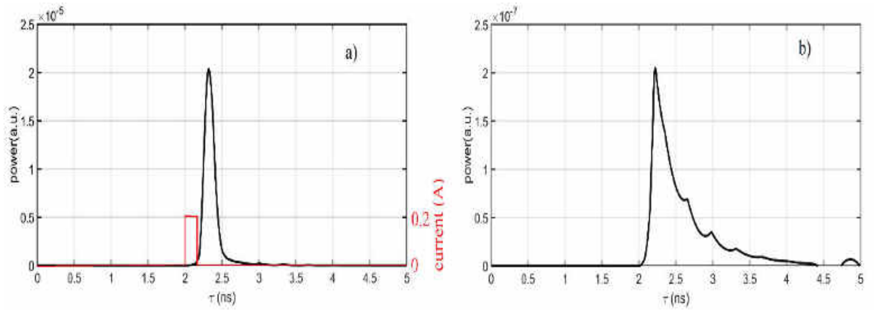


Fig. 2 Pulse generation. a) laser width-4.1 μm, laser thickness -20 nm b) laser width-5.1 μm, laser thickness -27 nm.

## References

[1] V. Tronciu, et al Semicond. Sci. Technol. 35 (2020) 045029 (10pp)
[2] H.Wenzel, et al. Proc. SPIE 8241 (2012) 82410V
[3] A. Klehr, et al Proc. SPIE 9767 (2016) 976705
[4] S.Riecke, et al IEEE J. of Quantum. Electron., 47(5) (2011) 715.