Parametrization of small-signal gain in multi-quantum-well optical amplifiers

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Understanding the behavior of optical amplifiers is the key to tailoring the laser performance and understanding laser behavior. Parameters such as small signal gain and gain saturation are of particular importance. Here we present the measurement results for small signal gain and gain saturation as a function of wavelength in InGaAsP/InP multi-quantum-well amplifiers as fabricated by SMART Photonics MPW run SP23. An analytical model is used to describe the small signal gain over the relevant wavelength range and injection current levels from 1.5 to 10kA/cm^2 with only a few parameters. The analytical expressions allow for faster modeling of steady state laser output spectra and more accurate time dependent modelling.

Measurement results of semiconductor optical amplifier (SOA) small signal gain and gain saturation are presented here. The structure under test consists of SOAs of variable lengths on a straight waveguide with angled facets and anti-reflection coating, as fabricated by SMART Photonics in a commercially available multi-project waver-run MPW SP23. The single pass gain from SOAs of different length is fitted according to the formula:

$$P = \frac{p_{sp}}{g}\left(e^{gL} - 1\right),$$

assuming no reflections from the facets, where P is the total amplified spontaneous emission power at a given wavelength, p_{sp} is the spontaneous emission power per unit length, g is the small signal gain and L is the amplifier length. The results obtained from this fit for g and p_{sp} are shown in figures 1 and 2 respectively. These measurement results are used for fitting a parametrized gain model presented in [2]. The same test circuits were used for measuring SOA gain saturation in transmission mode, and the saturation measurement is fitted using the model from [1]. We discuss the range of validity of the parametrized small signal gain model and how it can be improved, and discuss how additional important parameters for SOA modeling such as the current injection efficiency and the effective optical mode surface may be extracted from combining small signal gain and gain saturation data.

Fig 1. Small signal gain

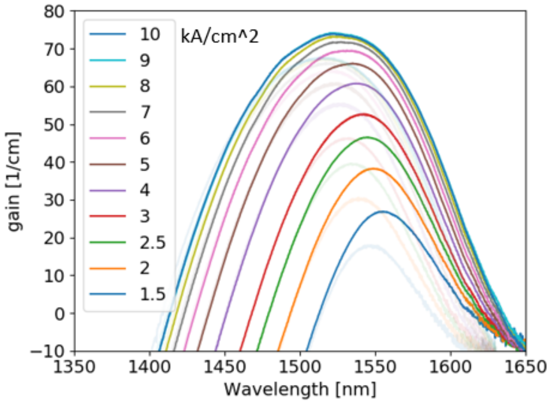
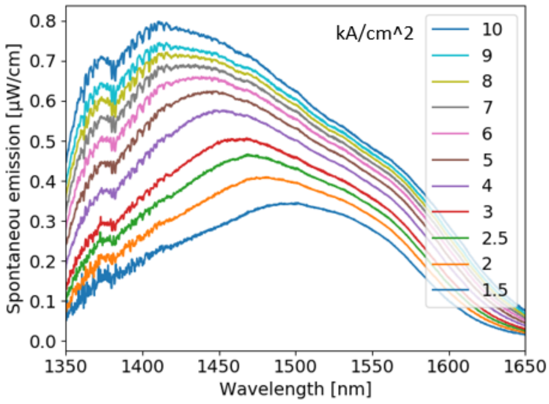


Fig 2. Spontaneous emission per unit length



References

[1] Davenport, M. L., Skendžić, S., Volet, N., Hulme, J. C., Heck, M. J., Bowers, J. E., "Heterogeneous silicon/III-V semiconductor optical amplifiers," IEEE Journal of Selected Topics in Quantum Electronics 22(6), 78–88, IEEE, 2016.

[2] Moskalenko, V., Pellacani, A., Javaloyes, J., Smit, M.., Bente, E., "Design of monolithically integrated InGaAsP/InP passively-modelocked linear quantum well lasers in an active-passive integration scheme," Proc. IEEE Photon. Soc. Symp., 283–286, 2012.