SOA designs for MEMS-VCSEL based swept sources

Dixon Sajan[*a], Alexander Chamorovskiy[b], and Kresten Yvind[a]

[a] *Technical University of Denmark (DTU), Denmark*
[b] *Superlum Diodes Ltd, Ireland*
[#] *corresponding author email: disaja@dtu.dk*
[*] *Presenting author*

1. Motivation

Optical Coherence Tomography (OCT) is a fast, non-invasive deep tissue image generation technique used for generating 3D images which in turn find its application in ophthalmology and other medical fields [1]. Micro-electro-mechanical system (MEMS) vertical cavity surface emitting lasers (VCSELSs) have the potential to deliver better performance than the other swept source light source technologies [2]. However, as the input power increases, the gain of the SOA becomes compressed due to the depletion of the free carriers. This limits the maximum output power that can be achieved. The high finesse of the MEMS-VCSEL resonator results in optical power inside the cavity being orders of magnitude higher than the output power, limiting the available output power for OCT imaging [3].
So, our primary focus is to amplify the output power for OCT. The amplifiers are Indium Gallium Arsenide (InGaAs) - Gallium Arsenide (GaAs) double quantum well Semiconductor Optical Amplifier (SOA) provided by Superlum Diodes Ltd.In this work our primary focus is to determine the optimal SOA design to amplify the light from MEMS-VCSELs for OCT applications. As an initial step, we have measured the amplified spontaneous emission as a function of wavelength for different currents.The results are illustrated in Fig.1. We also developed a Lumerical model of the amplifier which will be compared with the measurements and used to guide the analysis. The model was used to focus on the theoretical approach of the SOA. For example, the material gain as a function of carrier density was studied (Fig.2.). Further steps involve the experimental study of the SOA samples and comparison between the theoretical model and experimental values.

2. Results

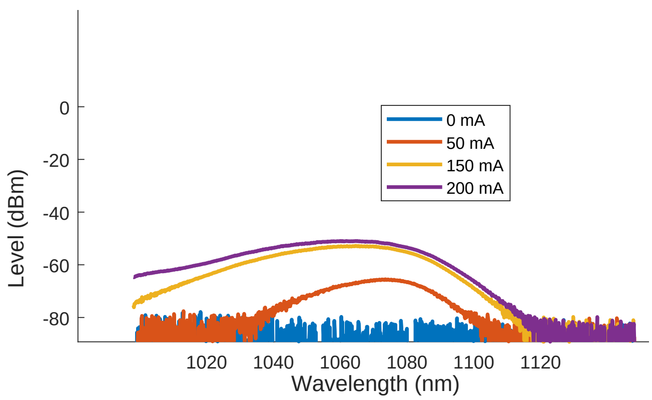

Fig. 1. Measured spontaneous emission Vs. wavelength for a 1.6 mm long amplifier

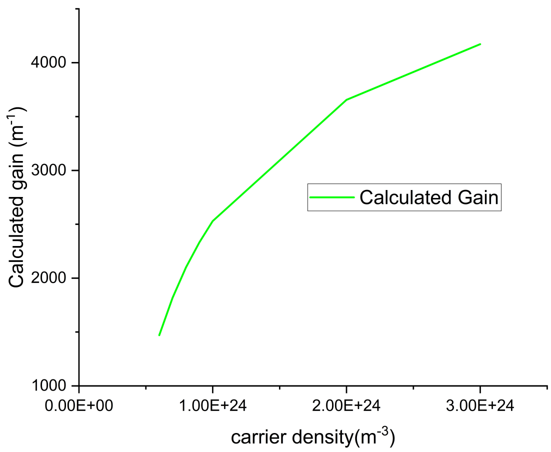

Fig. 2. Calculated gain Vs. Carrier density

3. Funding

NExt Generation of Tunable LASers for Optical Coherence Tomography (NETLAS) ; Marie Skłodowska-Curie Actions

References

[1] Jie Wang, Shuo Yuan, Jingjing Qi, Qinggao Zhang, and Zheng Ji. Advantages and prospects of optical coherence tomography in interventional therapy of coronary heart disease. *Experimental and Therapeutic Medicine*, 23(4):1–19, 2022.

[2] Hitesh Kumar Sahoo, Thor Ansbæk, Luisa Ottaviano, Elizaveta Semenova, Ole Hansen, and Kresten Yvind. Wavelength tunable MEMS VCSELs for OCT imaging. In *Vertical-Cavity Surface-Emitting Lasers XXII*, volume 10552, pages 89–94. SPIE, 2018.

[3] Thomas Klein and Robert Huber. High-speed OCT light sources and systems. *Biomedical optics express*, 8(2):828–859, 2017.