Electro-thermally Wavelength Tunable VCSELs for 3D Imaging

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1. Introduction

Optical Coherence tomography (OCT) as one of 3D imaging technology has been gathering concentration for years. Swept Source OCT(SS-OCT) is more attractive and colorful for various fields for its high imaging speeds, wide imaging ranges, precise resolutions As the light source, vertical cavity surface emitting laser (VCSELs) has shown superiority over other option. In this report ,we have conducted OCT system applied with Electro-thermal tunable VCSELs which is tuned the wavelength by on-chip heater integration.

2. Principal and Proposal

In OCT application, axial resolution is the key parameter which is majorly dominated by wavelength tuning range of the VCSELs. The axial resolution could be derived by $R=(\lambda^2*2\ln 2)/\pi\Delta\lambda$ [1] where λ represents the central wavelength and $\Delta\lambda$ is tuning range. To obtain large wavelength tuning range with single mode, high SMSR operation, based on self -heating effect, on-chip heater integration structure was proposed as Fig.1. The mesa is a bowtie shape whose left part serve as VCSEL for lasing while right part is function as heater. The neck region in the middle has been ion implanted and completely oxide for electrical and optical isolation respectively [2].

3. Measurement and Discussion

Wavelength tuning performance of our proposal are shown in figure 2 and figure 3. In figure, the heater was injected current form 1mA to 25mA, while the VCSELs side was holding the driving current of 1.22mA. Applied with DC bias at heater, the wavelength tuning range could reach 8.7 nm. Figure 3 illustrates the averaged dynamics wavelength tuning under different frequency when applied injected current is from 3mA to 25mA, the tuning range decreasing as the driving frequency raise as 1kHz, 2kHz, 5kHz, 10kHz, 20kHz, 50kHz, at tuning range of 8.5nm,7.3nm, 5.5nm,4.1nm, 2.7nm,1.5nm. The bandwidth of our devices is around 5kHz.

4. Conclusion

Electro-thermally wavelength tunable VCSELs were demonstrated for OCT applications, including VCSELs integrated with on-chip heater. The result shows the proposed device could be a promising alternative for SS-OCT tunable light source.

Reference

[1] Optical Coherence Tomography, Mark Brezinski, Academic Press.

[2] Seong-Seok Yang,Photonics Technology Letters IEEE, vol. 21, no. 11, pp. 748-750, 2009.

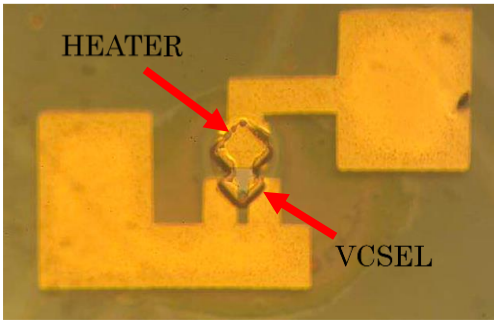

Fig. 1 Top view of proposed VCSELs structure integrated with heater

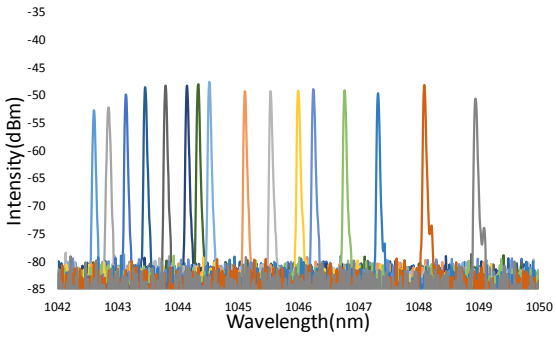

Fig. 2 Wavelength dependence on heating driving current form 1mA-25mA

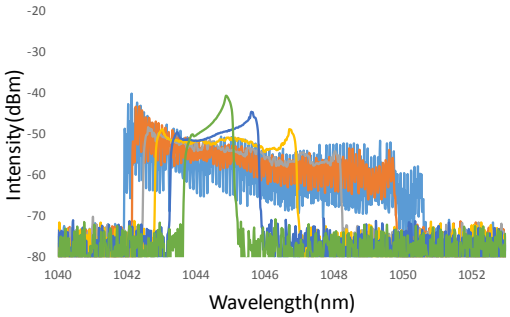

Fig. 3 Wavelength tuning range under various of heating operation frequency