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Analytical Studies on Reflectance Spectrum of a DBR of GaAs/AlGaAs VCSEL Operating at 0.85µm

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Abstract—The vertical cavity surface emitting lasers (VCSELs) have several advantages over LEDs and surface emitting lasers such as low threshold, small divergent angle, high density 2-D array, low cost of fabrication and packaging, low power consumption, better fiber coupling efficiency, circularly symmetric output beam and single longitudinal mode**.** In this paper, we present analytical studies, which have been carried out for reflectance spectrum of a Distributed Bragg Reflector (DBR) of a VCSEL structure based on GaAs/AlGaAs material system. The VCSEL is expected to emit the laser radiation at 0.85 µm wavelength which makes it suitable to be use as a source in local area interconnects and free space optical communication. The proposed structure of VCSEL consists of a 36.5-periods of $Al_{0.16}Ga_{0.84}As/Al_{0.9}Ga_{0.1}As$ bottom distributed Bragg reflector (DBR) with λ/4n thickness. It is supposed to be grown on n-GaAs substrate. The active region of three GaAs quantum wells and four $Al_{0.24}Ga_{0.76}As$ barriers are supposed to be sandwiched between two spacers of $Al_{0.30}Ga_{0.70}As$. The upper p-DBR consists of 20-periods of $Al_{0.16}Ga_{0.84}As/Al_{0.9}Ga_{0.1}As$ with λ/4n thickness. Where λ is the Bragg wavelength and n is the refractive index of the material.

The reflectance spectrum of the $Al_{0.16}Ga_{0.84}As/Al_{0.9}Ga_{0.1}As$ bottom n-DBR has been analyzed for the proposed structure of GaAs/AlGaAs VCSEL by transfer matrix method (TMM). Fig 1 shows the reflectivity as a function of wavelength at different number of $Al_{0.16}Ga_{0.84}As/Al_{0.9}Ga_{0.1}As$ periods of bottom DBR for obtaining reflectivity of the order of 99.9%.It is clear from fig 1 that the reflectivity of the DBR increases with increasing numbers of periods. After a certain no. of periods, reflectivity does not further increase with increasing no. of periods but the control on epitaxial growth become critical. So, it is clear from the study that to optimize the performance of a VCSEL the no. of periods of DBR has to be chosen very carefully.

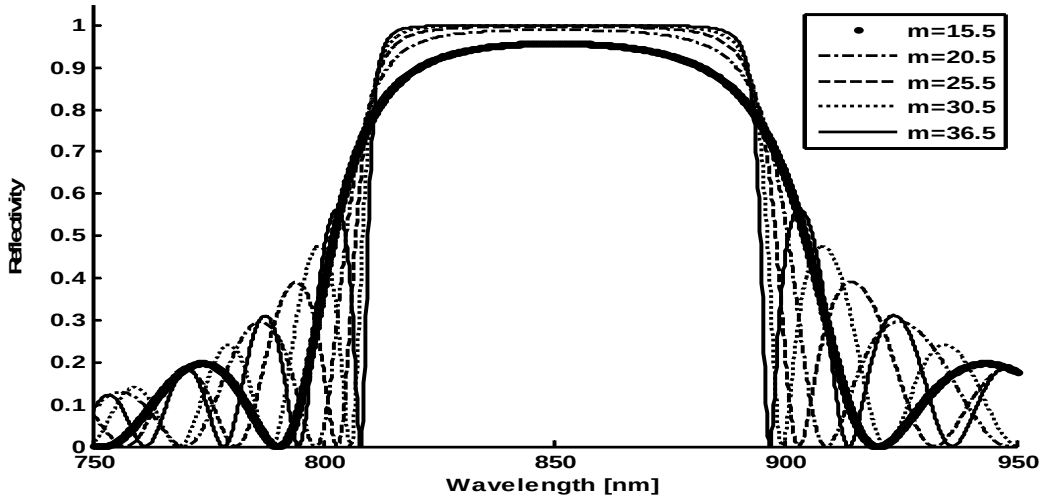

Fig. 1: Variation of reflectivity with the wavelength for bottom DBR for different number of $Al_{0.16}Ga_{0.84}As/Al_{0.9}Ga_{0.1}As$ periods of the proposed VCSEL

Keywords: - Distributed Bragg Reflector (DBR), Transfer Matrix Method (TMM), Vertical-Cavity Surface-Emitting Laser (VCSEL)