（様式乙 1-3-2）

THE SUMMARY OF Ph.D. DISSERTATION

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Title

High performance of vertical-cavity surface-emitting lasers (VCSELs) for optical communication

Abstract

Vertical-cavity surface-emitting lasers (VCSELs) are promising as light sources for optical networks because they have the potential to lower the threshold current, electrical power consumption, and divergence angle, and to heighten direct modulation speed, compared to conventional edge emitting lasers.

In this paper, some improvements to the 0.85- and 1.55-μm VCSELs, whose emission wavelengths are suitable for optical communication, are studied.

Chapter 1 describes the background, history of VCSELs and the purpose of this work.

Chapter 2 describes the 0.85-μm top emitting VCSELs, their structure, growth and laser characteristics. The theoretical calculations and experimental results are discussed, and the 1-mW optical output power of the VCSEL is reported. Furthermore, the characteristics of the top-emitting VCSEL array are described and the problems of the two-dimensional VCSEL array are disclosed.

In chapter 3, a 0.85-μm bottom emitting VCSEL on an AlGaAs substrate, which has a particular advantage over the top emitting type in the case of the VCSEL array, is proposed. The buffer layer on an AlGaAs substrate is studied, and laser characteristics such as, the 4.6 mW optical power and 11.2% power conversion efficiency are demonstrated. Moreover, a 8 x 8 VCSEL array fabricated by a Flip chip binding are discussed, and 2.6 GHz direct modulation in all pixels is demonstrated.

In the latter section of chapter 4-6, the pioneering work of long wavelength VCSELs, which are suitable for silica optical fibers and promising as light sources for 10 Gbit Ethernet, Wavelength Division Multiplexing (WDM) systems and tunable wavelength lasers, are described.

Chapter 4 describes the wafer fusion process, which is a very important fabrication method for long wavelength VCSELs The characteristics of 1.55-μm VCSELs fabricated using this process are discussed.

Chapter 5 and 6 describe the buried heterostructure (BH) VCSELs to obtain a controlling transverse mode and high temperature operation.

In chapter 5, the thin-film wafer fusion process to fabricate BH VCSELs is proposed and their characteristics are discussed.

Chapter 6 describes the characteristics of BH VCSELs fabricated by thin-film wafer fusion.

Finally, the main results of this study are summarized in chapter 7.