With a modification of the biasing condition on the laser diode, period quadrupling is possible in the output pulses [4]. Thus, the output repetition rate can be divided up to a factor of four. For a given modulation signal at a frequency f, the divided output frequency will be f/4, f/2 or f as determined by the external optical injection level. The optical control on the multistage outputs of the FP-LD greatly enhances the flexibility in the applications of the scheme.

Conclusion: Reversible optical control of period doubling is demonstrated in a Fabry–Perot laser diode through the injection seeding approach. A CW injection level as low as 0.03 mW is sufficient to switch the pulse repetition rate between 2 and 10 GHz. The switching response of the laser is observed to be shorter than 100 ps.

© IEEE 2001
Electronics Letters Online No. 2001/02/07
DOI: 10.1049/el:2001/02/07
K. K. Chow and C. She (The Chinese University of Hong Kong, Department of Electronic Engineering, Shatin, N.T., Hong Kong)
E-mail: kkclee@ee.cuhk.edu.hk
H.F. Liu (Photonics Research Laboratory, Australian Photonics Cooperative Research Centre, Department of Electrical and Electronic Engineering, The University of Melbourne, Parkville, Victoria 3010, Australia)

References

Wafer-bonded 1.55 µm vertical cavity laser arrays for wavelength division multiplexing

A. Karim, P. Abraham, D. Lofgren, Y. J. Chiu, J. Pipek and J. Bowers

The first electrically pumped 1.55 µm multiple wavelength VCSEL array is demonstrated. The wafer-bonded array consists of four channels operating between 1560 and 1564 nm. Multiple wavelengths were defined using an etched intracavity superlattice prior to bonding. Threshold currents of 99 mA and peak output powers of 0.45 mW were measured.

Vertical cavity surface emitting lasers (VCSELs) have been studied extensively in recent years for use in fibre optic networks and as optical interconnects. The most recognized advantage of the VCSEL is compatibility with low-cost fabrication and testing methods. Additional benefits include high fibre coupling efficiency, high modulation bandwidths at low current levels, and the potential for producing integrated modules and arrays on wafer. Devices emitting in the 1.55-µm wavelength band [1-3] are particularly desirable for high bit rate and extended distance applications. Emerging standards such as 10 Gb/s Ethernet (10GEs)

are expected to drive the market for low-cost, high-performance transceivers in local area networks (LANs) and metropolitan area networks (MANs). 1.55 µm VCSELs satisfy these performance needs and offer the additional advantage of interoperability with the networks used for long haul transmission.

Wavelength division multiplexing (WDM) has evolved into a highly effective method for increasing the transmission capacity of optical networks. Integration of multiple wavelength sources on a single substrate reduces costs by eliminating the complex assembly of individual lasers in transmitter modules. Multiple wavelength VCSEL arrays are an attractive source for WDM transmission, particularly as WDM systems extend their reach to metropolitan and local area networks, where cost concerns are paramount. In this Letter, we report on the fabrication and operation of 1.55-µm VCSEL arrays for WDM applications.

Fig. 1 Patterned active region prior to wafer bonding

Fig. 2 Device structure

Number of tuning layers varies between adjacent devices

The devices were fabricated with wafer bonded GaAs/AlGaAs mirrors and an InP/InGaAsP active region [4]. Prior to bonding, an intracavity superlattice of InP and InGaAsP was selectively etched in order to define multiple cavity wavelengths [5], as shown in Fig. 1. This method allows the array to be repeated across the wafer. The device pitch is 250 µm in order to facilitate fibre coupling using standard components. Each layer of the superlattice was 7.5 µm thick, leading to a change in cavity wavelength of approximately 1 nm for each layer removed. The wavelength spacing could be reduced to 2 nm by using thinner tuning layers, allowing for 16 channel transmission in the erbium-doped fibre amplifier (EDFA) C-band. The completed device structure is shown in Fig. 2. The top mirror is a 25.5 period p-type graded GaAs/AlAs, GaAs/AlAs DBR, with an oxide aperture for mode and current confinement. The n-contact region consists of three strained quantum wells. The 31 period GaAs/AlAs bottom mirror is undoped. The p-contact is on top of the n-DBR and the n-contact is on the p-cladding of the active region. Room-temperature light-current characteristics are shown in Fig. 3 for devices with 8 µm oxide apertures. Threshold currents are nearly uniform across the array. Variations in the curves can be attributed to the different mode-gain offsets of the channels.
Lasing spectra at a bias of 6mA are shown in Fig. 4 for adjacent devices with a 6µm oxide aperture. The lasing wavelengths are 1509.1, 1513.8, 1518.6 and 1524.4nm. The active region photoluminescence peak is at 1542nm. All four channels are on the short wavelength side of the gain peak. The higher numbered channels are located at longer wavelengths and are expected to have higher differential efficiencies. The exact wavelengths depend on the thicknesses of the tuning layers. Increased control over the channel spacing is expected with improved superlattice growth and etch conditions.

Fig. 3 Light-current characteristics of WDM VCSEL array

Fig. 4 Lasing spectra of WDM VCSEL array

Conclusion: Four-channel WDM VCSEL arrays were fabricated. The wavelength span is 1509.1-1524.4nm with a channel spacing of ~5nm. This is the first independently addressable, multiple wavelength 1.55µm VCSEL array. The simple testing and packaging of VCSEL arrays make them particularly well-suited for WDM applications. Future work will include optimisation of individual device performance, crosstalk measurements and transmission experiments.

References


Magnetising method for speed sensorless controlled induction motor drives

Th. M. Wolbank

In speed-sensorless controlled standard induction machine drives a start without torque is only possible if the rotor speed of the demagnetised machines is known. A new method is proposed, which allows a fast and accurate identification of the rotor speed of demagnetised machines without a speed or position sensor.

There are several industrial applications of induction motor drives where the mechanical speed or position sensor can be replaced by a sensorless control scheme. The elimination of this sensor not only leads to a reduction of the costs but also to an increased reliability of the drive. Present day industrial sensorless schemes allow high performance speed and torque control in the speed range some percent above the rated speed. In many applications the rotor speed cannot be assumed zero when the machine is magnetised and started. At the start up of the drive it is therefore necessary to identify exactly the rotor speed in order to magnetise the machine without any torque. However, commercially available sensorless drives are usually based on fundamental wave models of the machine and are thus unable to determine the rotor speed of the demagnetised standard induction machine during start up.

To identify the necessary speed without a speed sensor special algorithms have to be applied [1, 2]. These all require a DC or low-frequency stator current component to produce a small fundamental magnetisation in the rotor and then to identify the back EMF of the machine with a fundamental wave model of the machine. This impressed stator current component has to be as high as possible to allow a fast identification, but conversely should be kept low to minimise the torque when the rotor flux level is raised. In addition, a high current magnitude may lead to undesirable acoustic noise emission. This drawback can be overcome by applying the proposed method, which allows an identification of the rotor speed with a minimum stator current magnitude not needing to magnetise the rotor. Thus, a fast identification of the rotor speed is possible and no torque is produced during the identification and magnetising process.

The method is based on a transient excitation of the machine which is already used in sensorless controlled permanent magnet synchronous motor drives and which is under development for induction machines [3].

The basic principle is to apply short voltage pulses of some tens of µs to the armatures of the machine and to measure the transient current response. If a voltage phaser is applied to the terminals of a demagnetised machine for a short period, the change of current is influenced mainly by the three transient phase reactances. This current change can be expressed as a current change phaser, which should point in the same direction as the relative phase of the applied voltage pulse if the machine was symmetric. However, if there are saliencies present in the rotor, the transient phase reactances of the machine are modulated when the machine is turned, and this modulation can be seen in the results evaluated from the measured current change phasor.

To maintain a good fundamental wave performance, the rotor of standard induction machines is normally built as symmetrical