Oscillation Frequency Shifts Observed in Vertical Cavity Surface Emitting Lasers Exposed to Magnetic Fields

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1. Introduction

Much attention has been focused on diode lasers' oscillation wavelengths' susceptibility to fluctuations in injection current and temperature, among other things. As long ago as the 1960's, scientists were testing to see what, if any, changes might be brought about, by exposing them to magnetic fields of varying strengths. At that time, they revealed their findings, indicating that oscillation wavelengths shifted to the shorter (high frequency) side, at extremely low temperatures (<80K) and strong magnetic fields (<4T). While we were fully aware of their work, our experience differed in that, when we exposed Fabry-Perot type diode lasers oscillating at 780nm to weak magnetic fields (<1.4T), at room temperature (300K), we observed that the oscillation wavelength shifted to the low frequency side[1]. This result is explained by temperature rises in the active region, and this means that this effect is too slow for applications.

In this work, we applied a magnetic field to the Vertical Cavity Surface Emitting Laser (VCSEL), because when the magnetic field applied to the direction of its current flow, carrier density increased in the active region, thereby causing a rapid shift to the shorter wavelength side; results that differed markedly from those obtained using a Fabry-Perot type laser.

2. Experiment

Figure 1 shows our oscillation frequency shift observation optical setup. An Electromagnet or a permanent magnet applied a magnetic field to the VCSEL. The output laser beam from the VCSEL is reflected by a mirror. The VCSEL beam passes through an optical fiber and arrives at a monochromator with 0.02nm resolving power. The VCSEL beam is resolved in the monochromator and then introduced to a data logger by means of a Photomultiplier Tube (PMT).

The VCSEL is temperature controlled within 1/100K.

3. Results and Examination

We show the result obtained using a permanent magnet (Fig2). We observed that oscillation wavelengths were shifted to a shorter wavelength side by an applied magnetic field, but the laser output change was not observed clearly. We believe that the oscillation frequency shift is explained by a current pathway change and an increase of current density in the active region of the VCSEL.

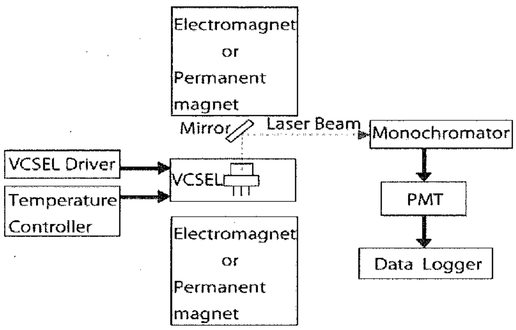

Fig1. Optical setup

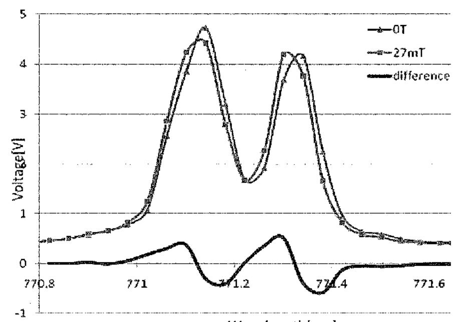

Fig2. Oscillation wavelength shift

References

1. T. Sato, T. Nakagawa, A. Nishiie, Y. Ohsawa, M. Ohkawa, T. Maruyama, and M. Shimba, "Oscillation wavelength shifts of laser diodes with or without a package in Magnetic Field", SPIE, **3945B**-28, 2000.