Frequency-Stabilized External Cavity Green Diode Laser

Ming-Hui Chen, Hong-Zhi Chen, and Hsiang-Chen Chui

1Department of Photonics, National Cheng Kung University, Tainan 70101, Taiwan
E-mail: hcchui@mail.ncku.edu.tw

Laser diodes are widely used in our daily life due to their light weight, low cost, high luminous efficiency, and easy adjustment of power through driving current. However, their laser frequencies are easily affected by the environment temperature and the injection current, hence it cause them to be unstable, in addition, the laser gain curve often has a large linewidth, these characteristics make the research and application so inconvenient.

In the past, a single longitudinal mode green laser can be obtained by using the intra cavity frequency-doubled design. But such lasers are often larger and more energy-consuming. In recently, the diode lasers based on indium gallium nitride compound semiconductors can directly emit green laser beam and are expected to replace the traditional diode-pumped solid-state lasers.

In this work, a diode laser based on indium gallium nitride compound semiconductors combined with a Littrow structure is used to construct an external cavity type green diode laser. The first-order diffracted light generated by the grating is used as a feedback signal, and coupled back to the laser diode, besides, the zero-order diffracted light is used as an output signal. With this simple design, we can chase down a narrow linewidth and adjustable laser, and compare the spectral changes of different operating currents between the two kinds of cavity length external cavity laser structures, explore the wavelength tunable range and the luminous efficiency under the change of polarization, moreover, we try to seek the shorter linewidth.

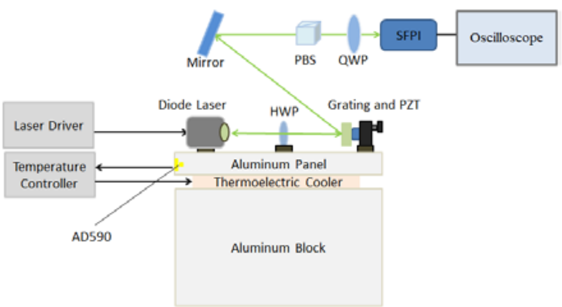

Figure 1 *The experimental setup of external cavity green diode laser*

We remodel the structure of the 3 cm ECDL produced by Chen and his coworkers[1], and then successfully construct a 6 cm temperature-controlled green ECDL, and successfully reduce the line width from 10.3 MHz to 5.32 MHz by increasing the external cavity length The wavelength of this 6 cm ECDL is 517 nm, and the output power is 20.5 mW under the two times of the threshold current. In Fig. 2, we showed The relations of the output power with the injection current for laser diode, 3-cm cavity length ECDL, and 6-cm cavity length ECDL.

Finally, we attempt to stabilize laser frequency of green ECDL with locking it on an iodine transition line [2]. In the experiment, PID controller is used to feed back the error signal to the piezoelectric actuator. And we adjust the laser output frequency with voltage make the error signal zero, and then we make the frequency stable. At last, we use Allen variance to quantify the stability of lasers.

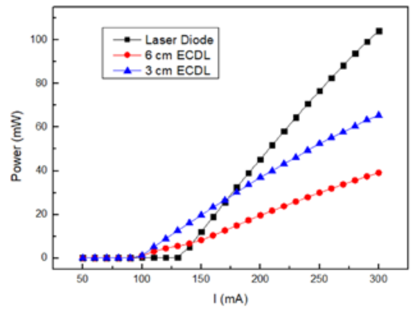

Figure 2 *The relations of the output power with the injection current for laser diode, 3-cm cavity length ECDL, and 6-cm cavity length ECDL*

References:
1. Y. H. Chen, W. C. Lin, H. Z. Chen, J. T. Shy, and H. C. Chui, "Single-Frequency External Cavity Green Diode Laser," Ieee Photonics J **9**, 1-7 (2017).
2. Y.-H. Chen, W.-C. Lin, J.-T. Shy, and H.-C. Chui, "Iodine-stabilized single-frequency green InGaN diode laser," Opt Lett **43**, 126-129 (2018).