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The Effect of the Thermal Temperature and Injected Current on Laser Diode 808 nm Output Power

Hassan H. Abuelhassan, M. Ali Badawi, Abdelrahman A. Elbadawi, Adam A. Elbashir

***Abstract*—**In this paper, the effect of the injected current and temperature into the output power of the laser diode module operating at 808nm were applied, studied and discussed. Low power diode laser was employed as a source. The experimental results were demonstrated and then the output power of laser diode module operating at 808nm was clearly changed by the thermal temperature and injected current. The output power increases by the increasing the injected current and temperature. We also showed that the increasing of the injected current results rising in heat, which also, results into decreasing of the laser diode output power during the highest temperature as well. The best ranges of characteristics made by diode module operating at 808nm were carefully handled and determined.

***Keywords*—**Laser diode, light amplification, injected current, output power.

I. Introduction

LASER is an acronym for light amplification by stimulated emission of radiation [1], [2]. Albert Einstein in 1917 established the theoretical foundations for the laser and the maser conceptually depended on Einstein coefficients for the absorption and emission of electromagnetic radiation [3]. The laser applications are becoming very important and interesting. These applications include the laser application in telecommunication, medical, and electronics industries [4]-[7]. So, we have found that the laser diode is becoming an attractive application in both academic research and electronic industries. Especially, the high power diode laser module operating at 808nm is considered as one of the most important and interesting applications, because it has the characteristics as being very small in size, together with high efficiency and the longest lifetime of the all existing laser today. The electrical and optical characteristics of the diode laser module operating at 808nm have been investigated by many researchers [8]-[10]. These characteristics have enabled the fields of the semiconductor laser to draw the attention and resources that are necessary for its development. Diode laser module operating at 808nm is the key component in the development of Diode Pumped Solid State (DPSS) laser [11]. Currently, the laser diode can efficiently pump Q-switched solid state laser, which in turn support the development of versatile lasers. On the other hand, stimulated emission in the semiconductor laser is more intense as compared to other types of laser. Therefore, the effects of temperature on diode laser output should be paid much attention as the variation of temperature results with changing of the spectrum intensity.

Significant ongoing research has been carried out experimentally on the high power diode laser module operating at 808nm [12], [13]. Unfortunately, there is a lack of information about the effects of thermal temperature and injected current on laser diode 808nm output power. In this work, the effects of the thermal temperature and the injected current on laser diode 808nm output power were investigated. Moreover, the best ranges of their characteristics were determined. The results obtained from our experiments depicted that the output power of laser diode 808nm was obviously changed by thermal temperature and injected current. In addition to that, the control of the laser diode 808nm output power was significantly important and it is useful in many applications.

II. Experimental Details

In order to study the effects on the output power of the laser diode 808nm by the injunction current and temperature, the experimental apparatus in Fig. 1 was connected.

Fig. 1 The setting-up circuit of laser diode experimentally used in the research

Firstly, the diode was exposed to different temperatures with different ranges and with different injected currents using the internal cooling system and external cooling source.

Secondly, the temperature was set at some specific degree values of 10 °C, 20 °C, 30°C, and 40°C. On the other hand, the injected current was also set at specific values 10 mA, 20 mA, 30 mA and 40 mA. After the laser safety and all basic

Hassan. H. Abuelhassan, Adam. A. Elbashir are with Department of Applied Physics in Electronics, Faculty of Science and Technology, Al-Neelain University, Khartoum City, The Republic of Sudan (phone: +249912685057; e-mail: hassanhamad130@yahoo.com).

Abdelrahman. A. Elbadawi and Badawi, M. Ali are with Department of Physics, Faculty of Science and Technology, AL-Neelain University, Khartoum City, The Republic of Sudan (e-mail: aboodydoody@hotmail.com).

facilities of experiments were maintained and rearranged, the experiment results were carried out.

Finally, the output powers were plotted as a function of temperature degrees at constant current injection to determine the best range for stability to get the maximum power. And then, the relationship between the injected currents and the output powers at certain temperatures were illustrated and demonstrated structurally as proceeding.

III. Results and Discussions

In investigating the effects of the injection currents and the temperatures with the output power of the laser diode, several readings of output power were taken. Figs. 2 (a)-(d) show the output power as the function of an injection current at various degrees of temperatures 10, 20, 30, and 40 °C. The output powers were measured after each driving current which was changing at constant intervals from 0 to 45 mA. The curves of Figs. 2 (a)-(d) obviously indicate that the results obtained by the measuring of the working temperature of laser head were cooled by heat sink only. In addition to that, the output powers measured at different temperatures were decreased when the laser diode is accompanied by the heat sink. Also, all the curves show a low value of pumping current and no stimulated emission obtained for the currents from 0 to 20 mA. Moreover, the threshold values of the current from 0 to 20 mA were unreadable and ill-defined, so it gave a low value of output powers. As the current was increasing up to 25 mA, a line appeared in each spectrum and this also showed that the output powers are linearly increasing as the pumping current is increased. Furthermore, Figs. 2 (a)-(d) also show that the data fittings of the output power versus the injunction current was matching with the obtained results and they also are in a good agreement with the measured data.

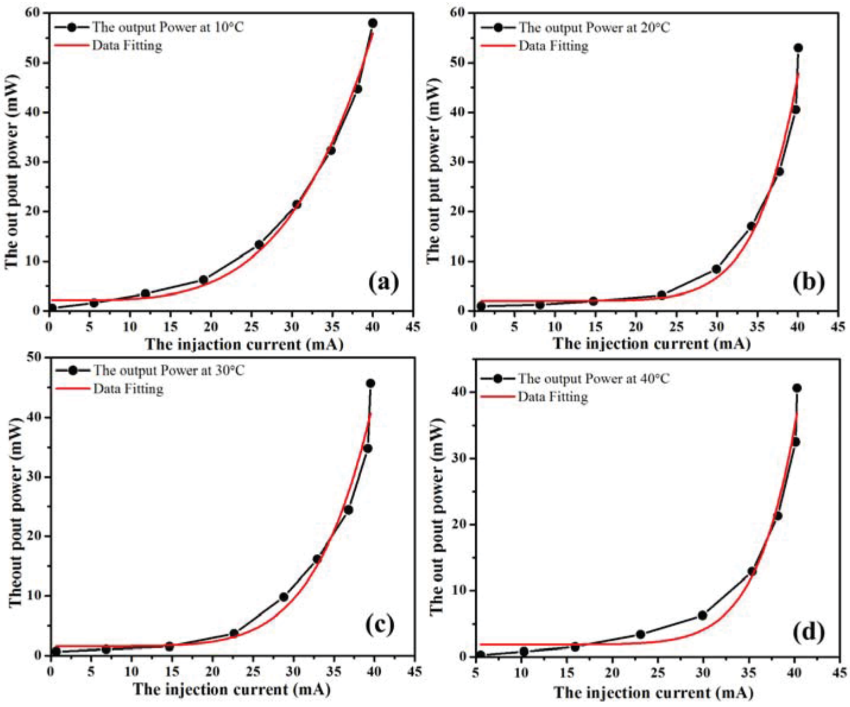

Fig. 2 Injected current (mA) versus thermal output power (mW) for sample annealed at different temperatures where (a) 10 °C, (b) 20 °C, (c) 30 °C and (d) 40 °C

Fig. 3 shows the comparison of the output powers as the function of injection currents measured at different temperatures 10, 20, 30, and 40 °C. The curves show that the output powers decrease when the injection currents increase. Moreover, a clear difference of the output powers appears when the measuring temperatures were changing. Furthermore, Figs. 4 (a)-(d) show the output power as a function of temperature measured at different injection currents with the data fittings. The laser diode output power was measured at 10, 20, 30 and 40 mA and the temperature ranged from 10 to 40°C. It can be clearly observed that the laser diode output powers of all the measuring temperatures at a certain injection current decreased when the temperatures increase from 10 to 20 °C. After 20 °C, as the temperature increases, the laser diode output power reaches the saturation point. Hence, when the temperature affects the output power, this means that the output power of laser diode is also affected by the injected current.

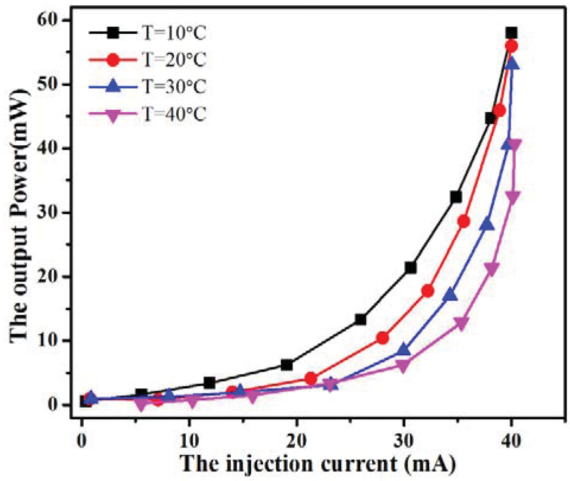

Fig. 3 The comparison of the output power as a function of injection current measured at different temperatures 10°C, 20°C, 30°C, and 40°C

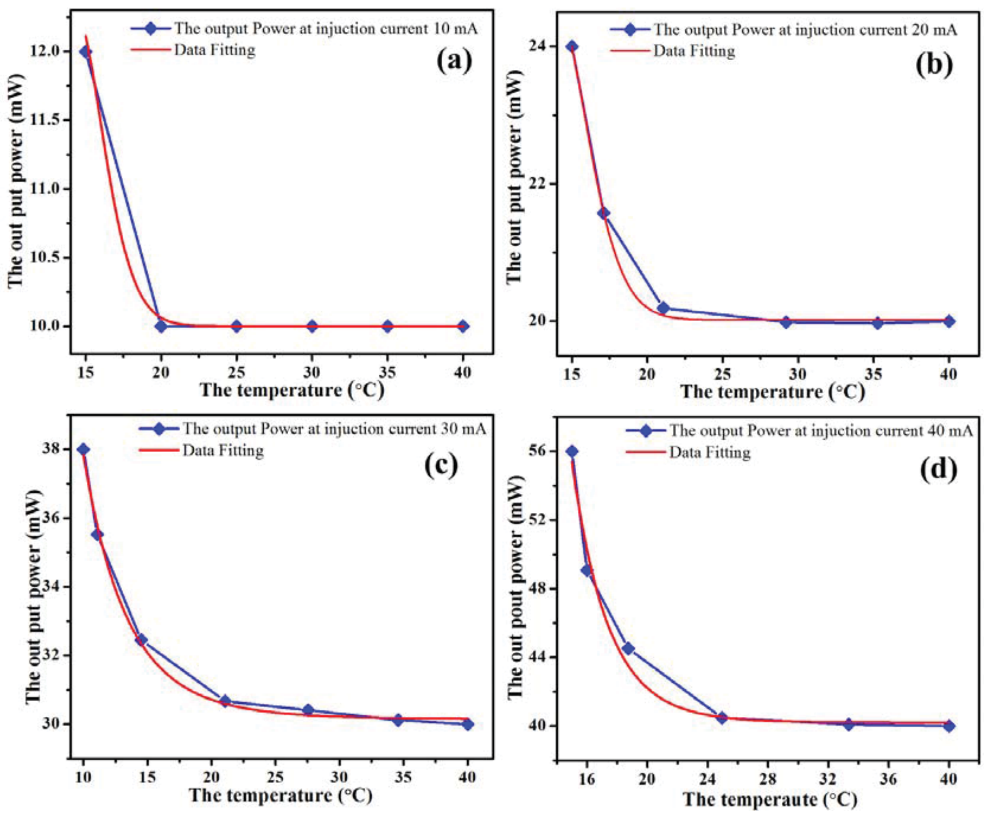

Fig. 4 Diode temperature versus the output power (mW) with different injection currents (a) 10mA, (b) 20mA, (c) 30mA and (d) 40mA

IV. Conclusion

We studied the effects of the thermal temperature and injected currents with the output powers of the laser diode operating at 808 nm. The experimental results of the injection currents as a function of the output powers measured under difference temperatures were demonstrated and, when the injection current's value increases, the output powers of the laser diode decreased. Moreover, the results of the temperature versus the output powers measured under different injected currents show that the output powers increased with the increasing injected currents. It can be concluded that the output powers of the laser diode operating at 808 nm were clearly affected by the thermal temperature and injected currents. Then, it is necessary and advisable to control the working temperature and the injection currents of the laser diode in order to obtain the most efficiency.

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