Spectral Characteristics of Alaser Dide

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INTRODUCTION : -

In recent years the number and variety of application of laser to military , industrial and medicine have been increasing rapidly . These new promising class of laser source for such applications are the semiconductor or coherent light emitting diodes C - LED's .

The development of semiconductor laser structure capable of generating high power C – LED'S in the near infrared region (NIR) and visble region (VIS) permits and will continue to permit revolutionary changes and important progress in the therapeutical applications of light [1] .

In the following sections , some experiments are set up to determine a threshold current and some physical processes associated with the operation of diode lasers in pluse mode . The plused operation produces several thermal effects and transient effect which can be observed during a single pluse these . These can be correlated with the temperature rise in the diode laser during the pluse . This will be manifested as changes in the spectrum and decrease in the output power .

In the practical it is common to use pluse length of 1 – 10 u sec at K and 0.1 – 1 u sec at room temperature [2] .

EXPERIMENT 1

DETERMINATION OF THE THRESHOLD CURRENT

This experiment is setup to measure the threshold current that has to be exceeded to achieve laser operation . A simple technique is used for the measurement of the threshold current . A wire of about 60 cm length is connected in parallel with the laser diode source type (LA 10 D – 02) , to make another path way of driving current I varying the length of this wire the driver current is increased in steps .

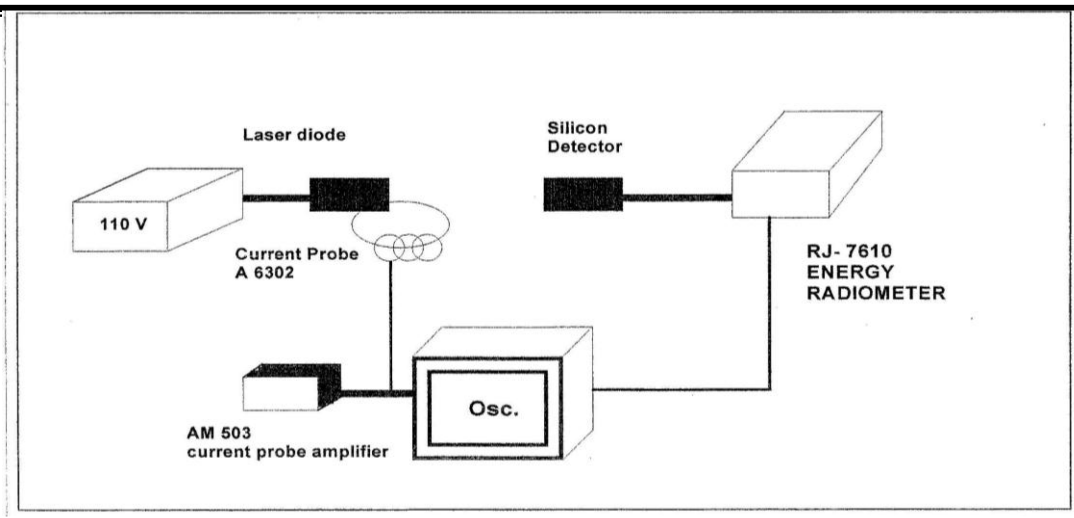


Fig (1) shows a laser system that is constructed in the laboratory and the detection unit which is consisted of a silicon detector , with an energy measurment limit within (20 PJ to 2 u J) . This detector is geared to a numeric measurment system energy radiometer . This whole system was connected to storage osiloscope .

Two channel of the osiloscope were used to display the light pulse and the current pulse . The current probe is connected to an amplifier , which is used to record the current (IF) passing through the diode laser it is varied until the laser pluse disappear at a certian current value which is represented the threshold current of the laser diode (I th) .

RESULTS : -

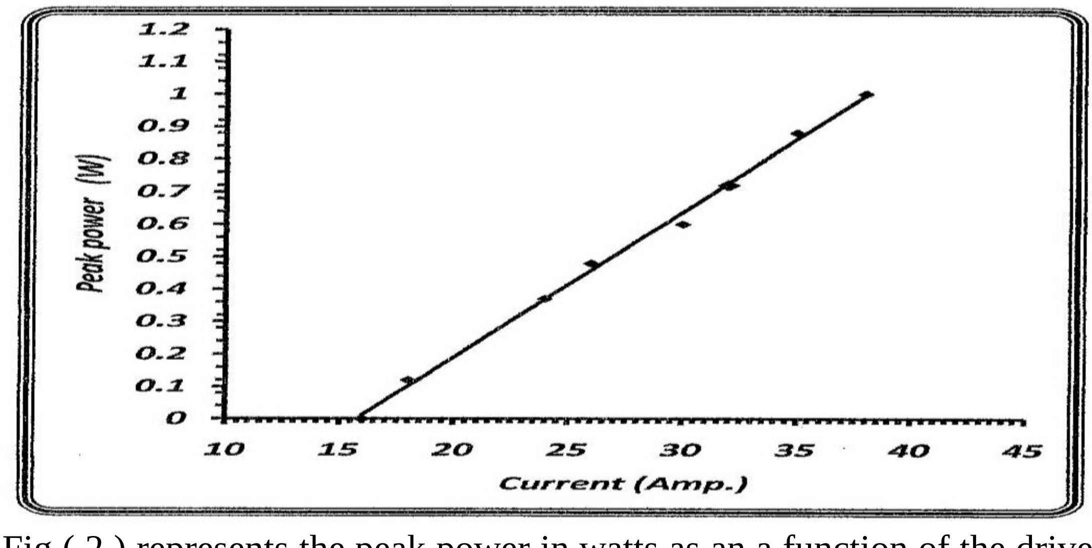


Fig (2) represents the peak power in watts as an a function of the drive current in (Amps) . It is clear from the relation between them is linear , and the minimum current value to operate the laser diode is 16 Amp . Since a lower value causes heating of the threshold current is wasted as heat .

In most laser application it is an advantage to have a low threshold current , both to reduce energy dissipation and to give a lower operating current . The threshold current increases with temperature operation as given by [3] .

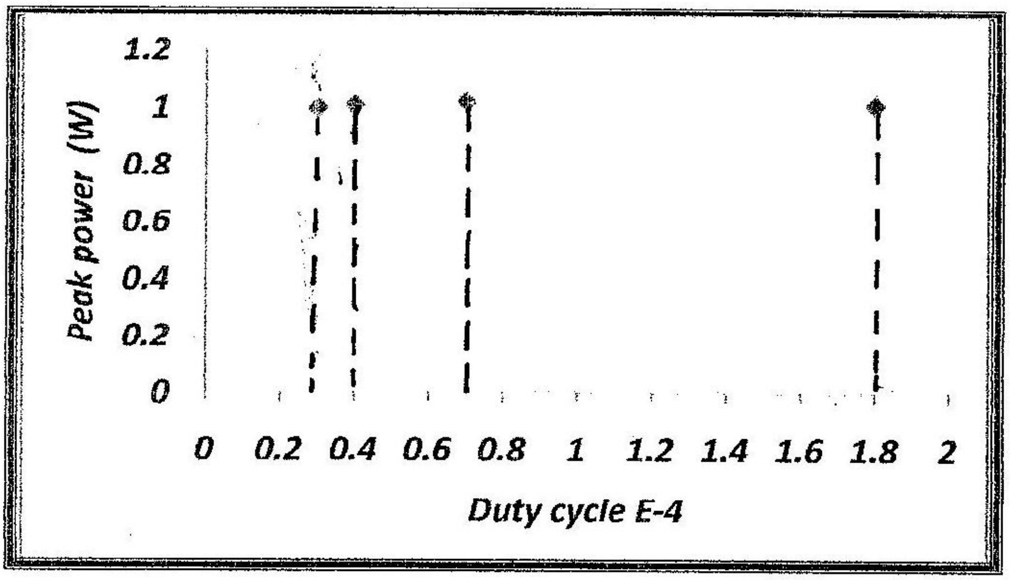
Where T is an equilibrium value above the ambient temperature T , which is the threshold current of the laser diode at T . Ith is the drive current could be explained due to that laser response procceds into two stages , a stage of electron accumulation (by injection) followed by a stage of photon accumulation when the laser diode reaches a condition under which fluctuation of the carrier pair density and photon density are eliminated then a steady state population are reached [4] .

A further result from the steady state that is linear dependence of photon density on current above threshold with neglecting the small spontaneous emission terms for I > Ith .

Above Ith , the change in the photon density with respect to the current density is [4] :-

Where J is the current density and Jth is the photon life time , e is the electron charge and , d is the active thickness . This linear relationship results from the fact that each injected carrier produces a photon by stimulated emission The life time of the semiconductor lasers is linearly related to the duty cycle

F at constant pluse width and current amplitude . These lasers are designed to produce high peak power pluse with low duty cycle above 10-3 Hz , at this value, the device temperature is kept without any increase and no damge occurs [5 , 4, 3] .



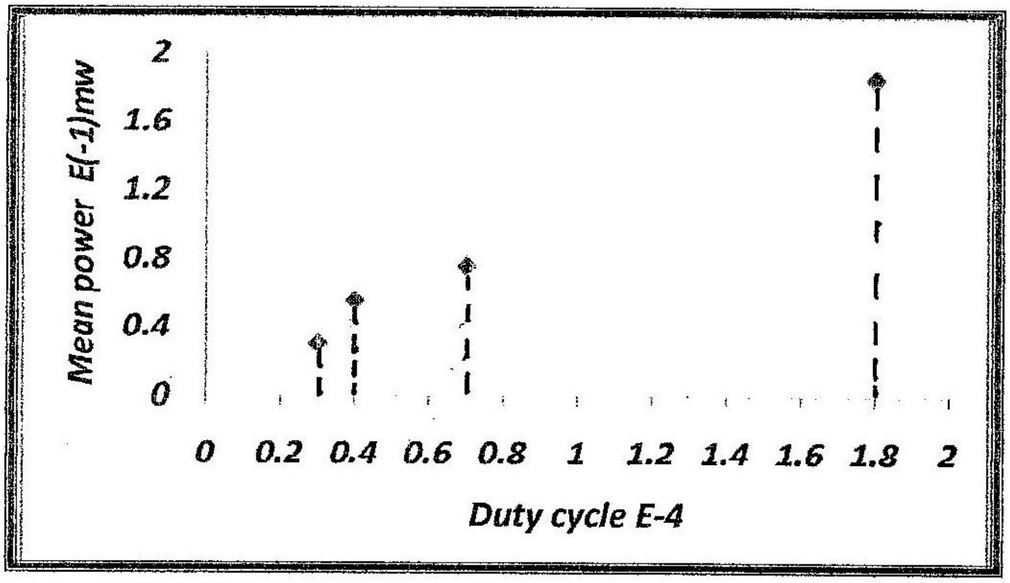


Fig (3) shows the relation between the peak power and the mean power which calculated from (Pmax = p peak) as a function of duty cycle . It is expected that the peak and mean power values becomes lower under higher duty cycle [3] . The output from the laser rises linearly with the current above threshold as shown in Fig (2) . The quantum efficiency of the laser can be calculated from the slope of the output characteristic Fig (2) , therefore :-

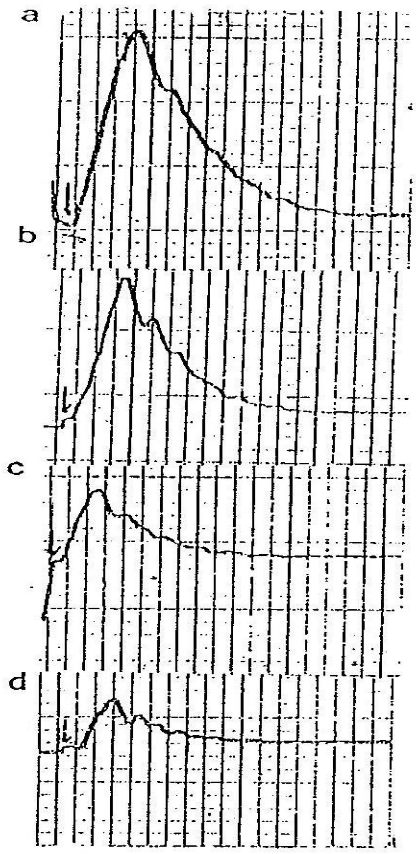


Fig (4) shows the effect of variation of current on shape of the laser pulse and it is clear , that pluse width decrease as the drive current decreases . Here since the photon density is increased ((sec eq .2)) , also , it is found from Fig (2) that the intensity of laser beam emission become higher with the increasing of the driving current .

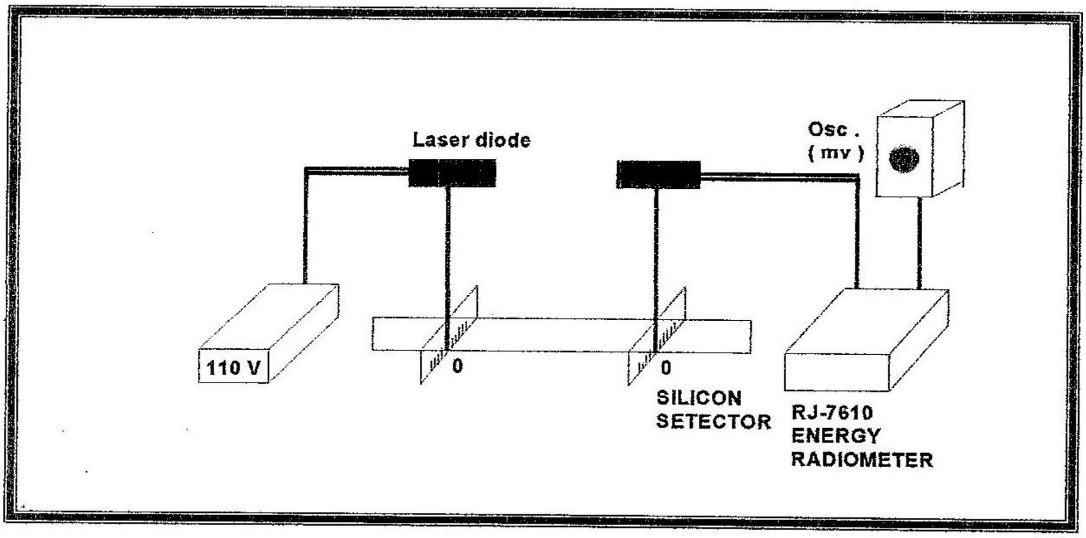
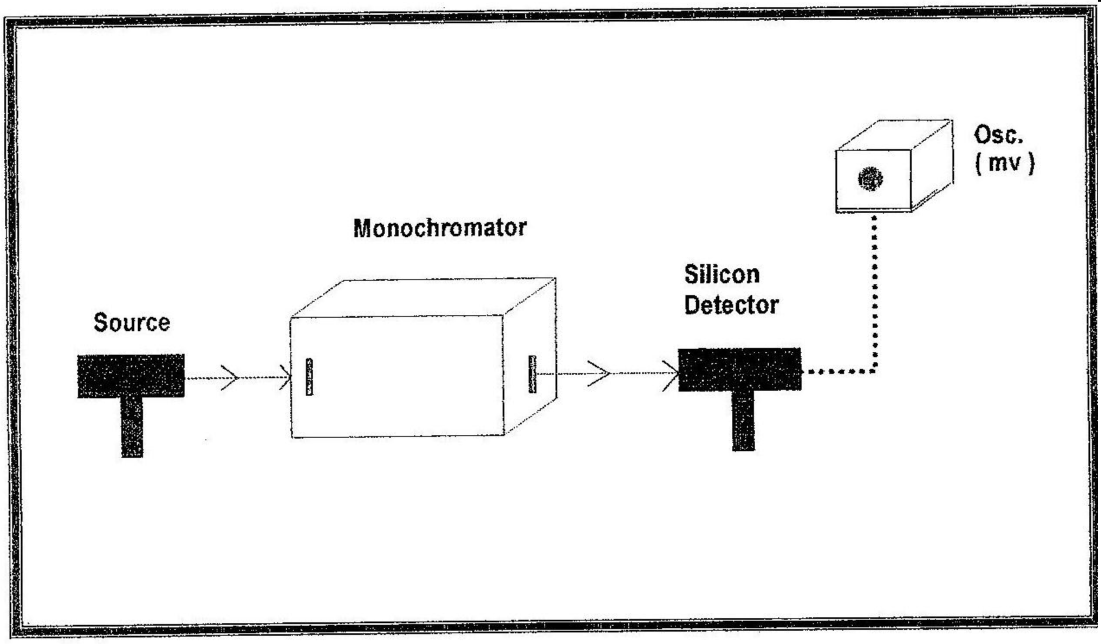


Fig (5) : Setup for energy distribution curve .



EXPERMENT 2
RADIATION PATTERN FOR LASER DIODE

In this experiment , the radiation pattern was detected without the use of lenses . As it is explained , the laser diode excited by 1 pluse / m sec . Each pluse of 200 n sec duration .

The laser diode source is sepreated from the slicion detector by a distance of 4 cm . The detector is connected to a numeric measurment system (radiometer) which is also connected to the storge osiloscope at the same time that the laser energy was recorded from the radiometer . The setup of this experiment is shown in Fig (5) .

As we can see in the setup , the laser source is centered in the front of the detector head which is fixed over a calibrated ruler . when the detector head was moved toward the left of the laser source in steps of 1 mm , the peak of a laser pulse changed and its energy become low until the laser pluse disappeared . This experiments determined the energy distribution for the laser diode .

RESULTS : -

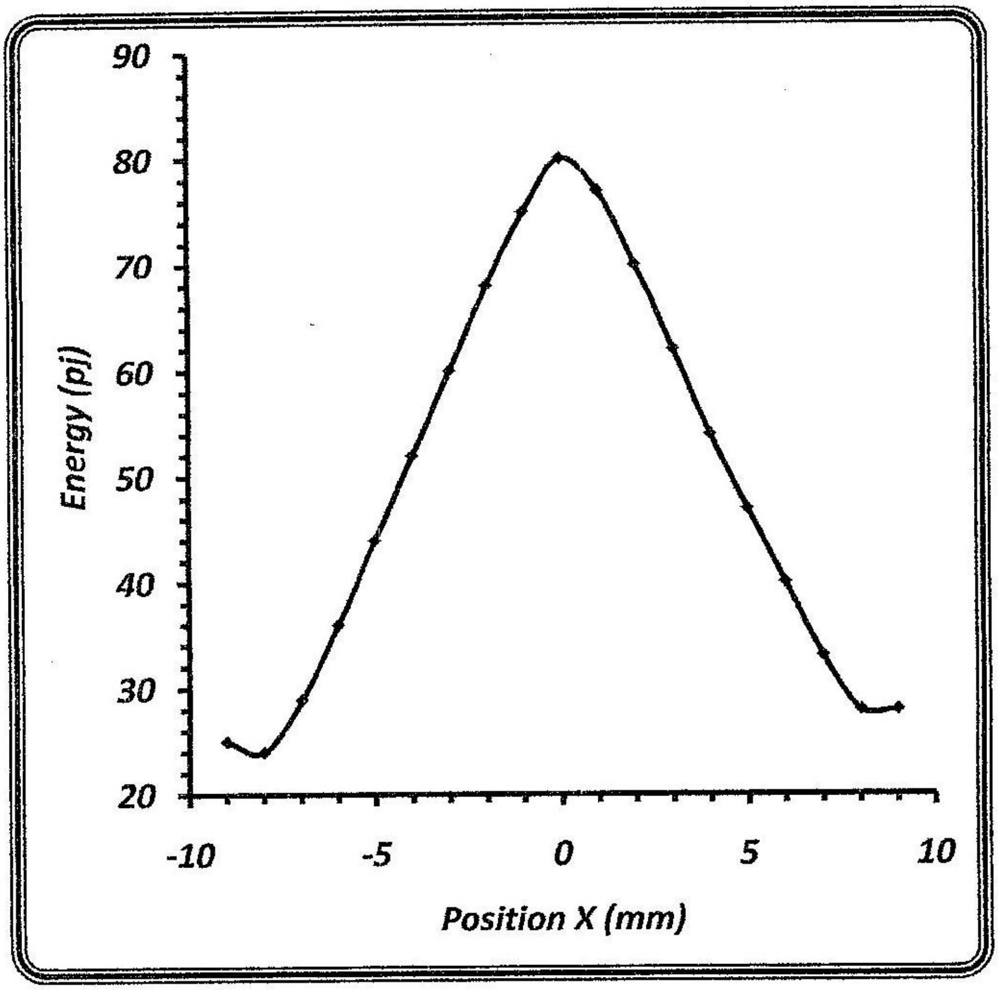


Fig (6) : Relative energy output as a function of the distance along the junction .

Fig (6) is a plot of the relative energy output of laser diode as a function of the distance along the junction length in cm . Most of the energy output contained in a measure loop and the curve is symmetrical in both sides of the centered point when the energy reaches the maximum value .

EXPERIMENT 3

SPECTRUM PATTERN FOR LASER DIODE

To obtain the spectrum distribution curve , an experimental setup for this purpose is showen in Fig (7) . A monochromater type ((JOBINYVON)) is used for wave lengths analysis in the range (200 – 926) nm , with a resolution power of 10 A .

The laser beam is passed through a slit of 0.5 mm before entering the monochromater . The output beam exits through another slit of mm which is detected by a photodiode of 1 cm2 surface area with a radiometer filter covering this area to obtain a linear response .

The photodiode connected to oscilloscope for recording the laser pulse amplitude each time the dial is varied to change the incident angle of light inside the monochromater for a given wavelength to be read from this dial .

RESULTS

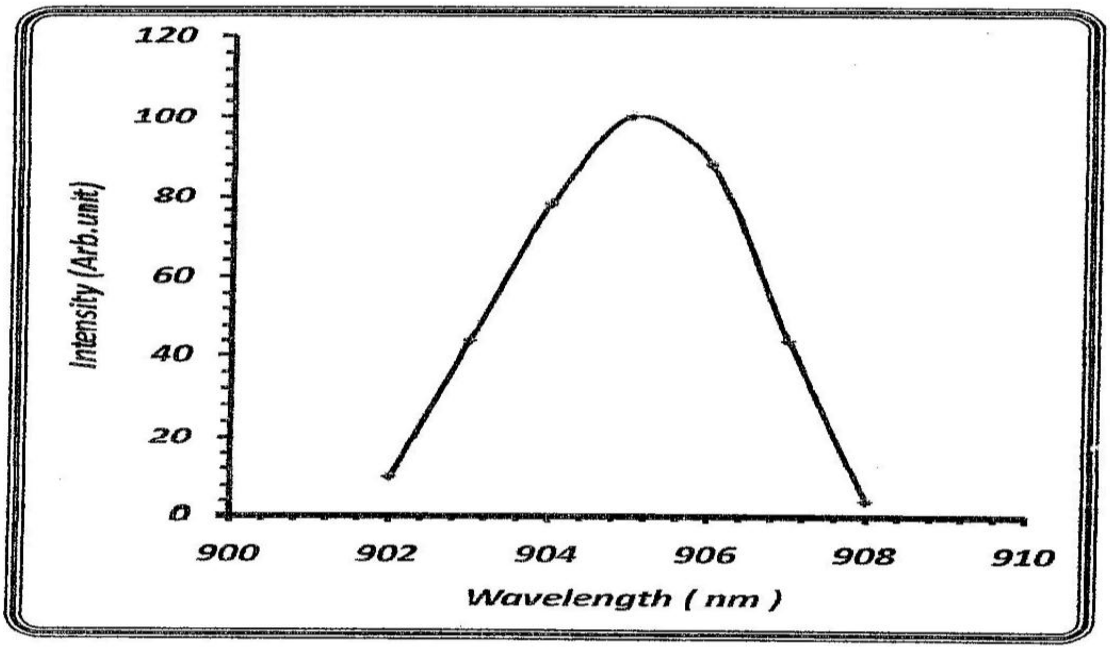


Fig (8) represent the intensity in Arb. Units as a function of the wavelength . It clear from this Fig., that the peak of the curve at 905 nm represented the maximum radition of the laser with this value . The lowset amplitude is appear with 902 nm and 908 nm lines . The sperctal bandwidth of the laser beam is 4 nm . These wavelengths lines agree with the laser diode wavelengths .

The wavelength of the diode laser depends primarily on the band gap of the material in which the electron recombine . Most often the active layer in CaAs in the diode laser , is sandwiched between two layers of different chemical composition typical (GaAs and GaAlAs) which have differnet bandgaps .

These lasers diode emits at 904 nm . So that the peak energy will decrease as the doping concentration incresase , whereas the spectral emission with broader .

CONCLUSION : -

This work deals with some experiments which are setup to determine a threshold current and some physical processes associated with the operation of a semiconductor laser in (NIR) region . It was found that the laser pluse has : 1 watt peak power , 180 n sec . Pluse width at a drive current of 38 Amp , with the thershold current of 16 Amps , and a band width of 6 nm .

The characteristics of output current (its amplitude , pluse duartion rise time) for this laser diode is compeard , also it is clear from the results that the laser diode has an efficiency of 0.2% and is working in repetition frequency up to 1 KHz . The emission curve was found also .

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