CHAPTER 6

Packaging and Testing of High-Power Laser Diode Assembly

6. Packaging and Testing of High-Power Laser Diode Assembly

After facet-coating and preliminary testing, the laser diode must be mounted in an appropriate package depending on the application. Packaging is last but one of the most crucial steps of fabrication that considerably affects the performance of high-power laser diode, especially in continuous-wave (CW) mode. The packaging of laser diode includes bonding of laser diode chip or bar on the package, called die-bonding, and connecting the top metallization of the diode to a contact-lead using gold wire, called wire-bonding. This chapter discusses optimization of bonding process for laser diodes. The packaging of facet-coated high-power laser diode is demonstrated.

The packaging of laser diode includes die-bonding and wire-bonding of laser diode chip. Bonding processes greatly influence electrical and thermal properties of laser diode assemblies [1] and need to be optimized in order to meet the requirements, like high output power, long operational life and high reliability. The electrical resistance of the laser diode assembly should be as low as possible to reduce the Joule heating at high current density. The heat produced in the active layer of laser diode should also be dissipated efficiently by achieving low thermal impedance. Further, the thermo-mechanical stresses generated at the interfaces of dissimilar materials during packaging are a big challenge to the realization of a durable system [2]. Thus, the overall efficiency and reliability depend largely on packaging techniques.

Laser diode must be bonded and sealed in a suitable package, which can be hermetic or non-hermetic, depending on the application. Hermetic packages utilize a sealed environment that is impervious to moisture and gases to protect the device. Hermetic packages are very robust and provide long term reliability to the laser diode. However, hermetic packaging is quite an expensive technique, which increases the manufacturing cost significantly. Non-hermetic packaging, though not as reliable as the hermetic counterpart, is used extensively in a plenty of applications due to ease of implementation and cost-effectiveness. Thus, selection between hermetic and non-hermetic packaging can be seen as a compromise between cost and performance.

There are two basic configurations in which a laser diode chip can be mounted on the package; junction-up and junction-down configuration. The junction-down configuration, also referred to as flip-chip configuration, is more efficient in removing heat from the device since the heat source, i.e. the active region of laser diode chip, remains closer to the heat sink as the epitaxial layers containing the active region are typically much thinner than the substrate [3,4,5]. The reliability of a laser diode bonded in junction-down configuration, however, is significantly impacted by electromigration in the die attach solder [6]. The electromigration can create and enlarge voids as well as accelerate the propagation of preexisting voids [7], which leads to the device failure. Moreover, this technique is quite complex and the difficulty in bonding process as well as requirements of special die-bonding tools are some of the discouraging factors in the adoption of this technique [8]. Considering these facts and the unavailability of specific tools for die-bonding, we have employed the conventional junction-up method, which is relatively simple and provides sufficient heat dissipation up to moderate power. We experimented with different solder materials to die-attach identical laser diode chips on specially design packages [9].

6.1 Die-Bonding

The term 'die-bonding' describes the operation of attaching the semiconductor die (chip) to its package. The die is placed at an appropriate position on the package (at the edge in case of an edge-emitting laser diode), aligned, and then permanently attached. There are some important requirements which have to be taken into account while optimizing the die-bonding process. These are:

- Destructive stresses should not be transmitted to the fragile chip.
- High electrical and thermal conductivity are essential.
- high adhesion, void-free contact between chip and the package materials

A wide range of solder types and techniques are available for the die-bonding.

6.1.1 Adhesive Bonding

An adhesive bond is formed by adhering the die to the package using some type of adhesive material. It can be electrically insulating or conductive depending on the types of application. Adhesive bonds are conducted at room-temperature. Adhesive epoxies are widely used for die-bonding of semiconductor chips. It is, basically, suspensions of metal particles in a carrier. The particles are several μm in size, usually in the form of thin flakes of silver. The carrier provides adhesion and cohesion to make a bond with the correct mechanical strength, while the metal particles provide electrical and thermal conductivity. The carrier is most frequently a solvent-free, high-purity epoxy resin, for it gives reduced incidents of voids underneath the die, with better heat transfer, leading to enhanced device-reliability [10].

6.1.2 Soldering

Solder attachment is performed utilizing a reflow process during which the solder preform or paste is brought to its melting temperature and the die is attached to the package. Because of its metallic properties, the solder attachment alloy provides optimum electrical and thermal continuity between the two surfaces as well as mechanical integrity. The heat can be produced by various techniques, and the simplest of these is a hot plate. Typical reflow of materials on a hot plate in air usually requires flux. This is a rosin-based material that promotes wetting by cleaning the two surfaces to be mated, thus removing oxides and contaminants, and inhibiting oxidation of the mating surfaces during the attachment-operation. Use of fluxes, however, is questioned in the case of laser diode bonding since fluxes may cause electrical and mechanical degradation [11]. Fluxes may be eliminated through the use of nitrogen (N_2) gas blanket over a hot plate. The N_2 atmosphere provides an adequate environment to inhibit oxide formation during the reflow operation. The soldering can be achieved by eutectic bonding or soft-soldering depending on the solder material used.

6.1.2.1 Eutectic Bonding

Eutectic bond is formed by melting a eutectic mixture or alloy of two or more dissimilar metals in the joint between the die and the package. The eutectic alloy is one which melts and solidifies at the same temperature. The melting point for the eutectic composition is sharp and much below that of the constituent elements. In the eutectic bonding, preform and die are properly aligned on the package, which is fixed on a workstage with a plate heater. The temperature is raised quickly to the eutectic point where the preform melts.

As soon as the perform melts, the die is lightly scrubbed and the temperature is reduced quickly, which solidifies the melted solder material, thereby creating the bond. The process is carried out in an inert atmosphere with N_2 as a cover-gas in order to prevent oxidation at high temperature. Eutectic bonding gives very good electrical and thermal contact and high mechanical strength. However, temperature control and mechanical stability of the experimental setup are very important in eutectic bonding because the sharp melting point and abrupt solidification of the eutectic may lead to cracks and voids in the bond. Moreover, the eutectic bond is brittle and the thermal mismatch may also cause the chip to crack during the bonding process or during thermal cycling later.

6.1.2.2 Soft Soldering

Soft soldering is used for high-power devices, particularly in power electronics, where good thermal and electrical conductivity is important. Alloys like PbSn, AgPb, and SnAgIn are used as solder materials. They are softer than the eutectic, the temperature in the process is lower and they can withstand the thermal mismatch by plastic deformation. Although soldering made with such 'soft solders', containing materials like indium, lead, and tin, does not create risk of die-fracture due to thermal stresses as in the case of gold-based 'hard solder', it may suffer from thermal-fatigue within the joint [12]. Plenty of new materials and alloys with better mechanical strengths as well as resistance to thermal-fatigue are being developed for all the above mentioned bonding techniques, die-bonding is, yet, the source of a large fraction of the faults in the laser diode assembly during fabrication as well as the field-life of the device, and requires lots of process-optimization.

The solder bond must be as free of voids as possible to give minimum thermal and electrical resistance. Large solder voids would yield bond with high thermal resistance, which, in turn, increases the junction temperature and create hot-spots. High electrical resistance also causes thermal roll-over due to heating of laser diode chip by supplied electrical power. Solder voids near the front facet are especially unfavorable as they can significantly raise the facet temperature and cause catastrophic optical mirror damage (COMD) [6]. However, it is almost impossible to achieve void-free bonds, since air-films are invariably trapped at the interfaces. The solder does not flow sufficiently to displace all this air to the die periphery and much of it remains trapped after soldering as voids within the bond. Thus, quality of void-free soldering depends on the wettability of the surfaces, the accuracy of the solder volume, and on protecting the process from oxygen.

In addition, since electrical current passes top to bottom through the laser diode, care must be taken not to electrically short the laser diode, and to isolate it properly from the heat sink. Structural degradation or damage may also occur to the laser diode chip while mounting and bonding it on the package. Thus, mounting and die-bonding of a high-power laser diode on a package must be optimized to ensure satisfactory thermal and electrical coupling between the package and the laser diode chip.

6.1.3 Solders Used for Die-bonding

A wide variety of solders are available for die-bonding of semiconductor components on the heat sink. However, selection of the most appropriate solder material is very important and involves many parameters such as die and package materials, operating conditions and environmental and reliability requirements. We have used four different types of solders for die-bonding of laser diodes in this work.

6.1.3.1 Silver (Ag) Epoxy

Silver epoxy is used in a variety of electronic and optoelectronic applications as a conducting paste and die-bonding solder. We have used PD 3223 silver epoxy for our experiment. The epoxy contains 70% silver. It is suitable for use in lead and discrete component die-attachment where thermal stability up to 200 °C is desired. It exhibits good conductivity, adhesion and excellent resistance to abrasion.

The curing time for this epoxy is very important and must be optimized in order to achieve the desired performance. Though, curing may take place at room-temperature, elevated temperature gives better adhesion in lesser time. After applying the epoxy on the package and aligning the die on it, we use the curing time of 20 minutes at 80 °C for complete degradation of organic system in the epoxy.

6.1.3.2 Lead-Tin (Pb-Sn) Paste

The microstructure of a typical lead-tin alloy depends upon composition and the phase diagram. We have used lead-tin paste (RMA-020-T-322) with the eutectic composition of 36 % lead - 62 % tin, which melts at 179 °C. Alloys on either side of this composition have higher melting points. The paste also contains 2 % silver in order to achieve better electrical and thermal conductivity. Addition of silver in the paste significantly reduces the resistivity of the paste. The paste consists of spherical solder powder in 9 % flux content. The solder powder mesh size is 38 to 45 μm.

6.1.3.3 Indium (In) Preform

Indium preform is one of the most widely used solders in die-bonding of high-power laser diodes. Indium solder has some advantages in laser die-bonding. Indium, being a soft solder, relaxes stress caused by mismatch of coefficient of thermal expansion (CTE) between the chip and package material effectively. Moreover, it is a low cost material with low melting point of 157 °C. It also has some concerns, however, especially in terms of reliability [6]. The thickness of the In-preform used in our experiment is 55 μm.

6.1.3.4 Gold-Tin (Au-Sn) Preform

Gold-tin (Au-Sn) is the alloy most commonly used in the industry for GaAs assemblies due to its compatibility with gold-based components and its long-term reliability. The composition of the alloy used for the experiment is 80 % gold - 20% tin, which is a eutectic alloy and has a melting point of 283°C. Being a hard solder, Au-Sn overcomes the disadvantageous thermal-fatigue and creep-rupture properties of the soft solders, such as In, by staying in elastic deformation. However, the same property demands that the mismatch of CTE of the package material should be within the acceptable range. Large mismatch in the CTE may induce large strain and subsequently produce stresses during the thermal cycling, which may cause cracks in the die or detachment of the die.

6.2 Wire-Bonding

Once the laser diode chip is attached on the package, the next step in the packaging is assembly interconnection. The most common methods for electrical interconnections are:

wire-bonding and tape-automated-bonding (TAB). We have used wire-bonding to provide the electrical connection on p-type metallization of the laser diode. Thin metal wires are connected one by one between the contact stripe on the laser diode chip and the corresponding contact-lead on the package. For laser diode assembly, gold wires are normally used.

In standard wire-bonding techniques, depending on the bonding agent (heat and ultrasonic energy), bonding can be categorized into three major processes: thermocompression bonding (T/C), ultrasonic bonding (U/S), and thermosonic bonding (T/S). The most commonly employed technology is the thermosonic wire-bonding technique. In this case, the wire-bond is formed with pressure, heat, and ultrasonic energy. The heat is provided through the bonding stage, the bond head movement exerts pressure on the wire, and ultrasonic energy travels from the transducer through the bond-tool to the bond. All bonding parameters like pressure or force, bond time, ultrasonic power, loop configuration, and bond locations can be programmed in automated bonding and determine the bond quality. Force, time, and ultrasonic power are critical for reliability of the bonded device. There are two basic wire-bonding techniques: ball-bonding and wedge-bonding. In the case of laser diode bonding, one end of the wire on laser diode chip is bonded by a ball with a wedge at the opposite end of the wire on the package.

These commercial tools for both die-bonding and wire-bonding are, however, quite exorbitant. Hence, we performed wire-bonding simply by soldering the gold wire at both the end manually using Pb-Sn paste with 2% Ag. We have indigenously designed and developed the setup for die-bonding and wire-bonding of laser diodes and fabricated the laser diode assembly manually.

6.3 Experimental

We have used two types of uncoated laser diode chips with lasing wavelength of 650 nm and 808 nm respectively for process-optimization. The laser diode chips were die-attached on specially designed co-axial type gold-platted copper packages as shown in figure 6.1 [a]. Gold leads, flattened at the front edge as shown in figure 6.1 [b], were inserted and fixed in the packages through ceramic isolators to carry out wire-bonding. Such a package, ready to be die- and wire-bonded, is shown in figure 6.1 [c].

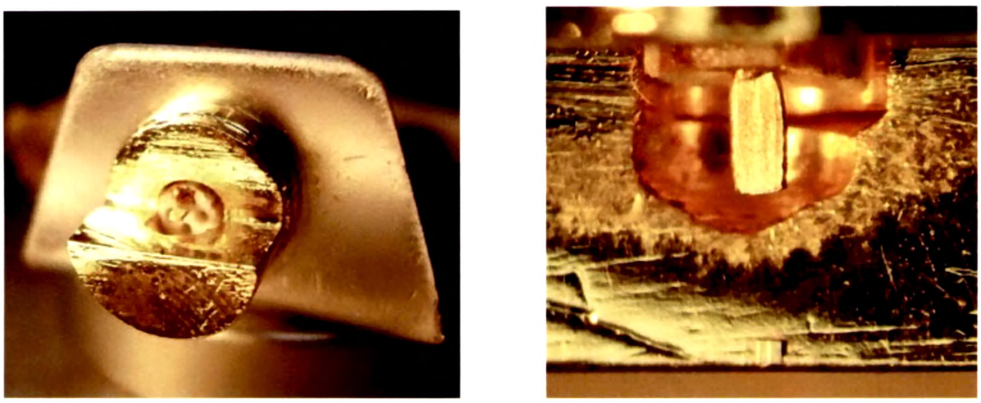
[a] [b] [c]

Figure 6.1: [a] Gold platted copper package, [b] flattened-ended gold lead and [c] package with gold lead inserted and isolated through ceramic.

We used four different types of solder materials, as discussed in section 6.1.3, for die-bonding. Four chips of each type of laser diode, i.e. 650 nm and 808 nm, were die-bonded on four similar packages with different solder materials. Figure 6.2 shows experimental setup for bonding of laser diodes.

Figure 6.2: Experimental setup for laser diode bonding.

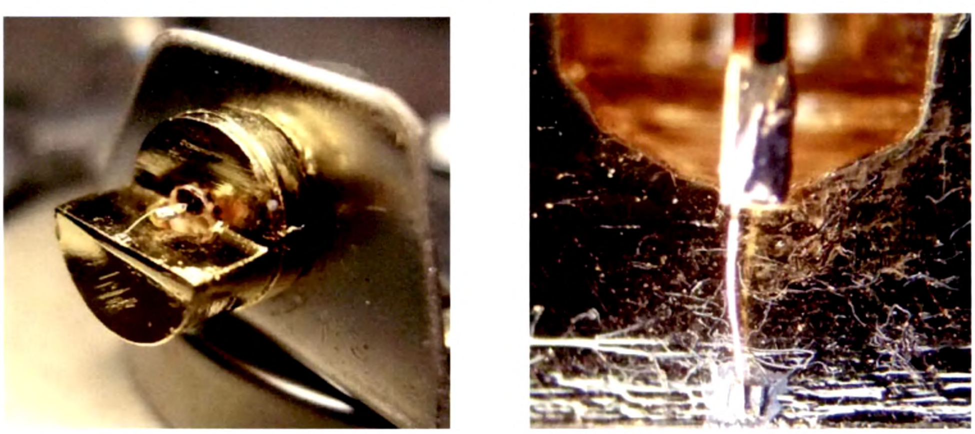
The bonding was carried out under Zoom Stereo Microscope (DSZ-70PFL). Heating and temperature profile were optimized using plate-heater for each of these solders on dummy packages. The bonding was performed under N_2 flow to avoid oxidation at high temperature. Figure 6.3 [a] shows such a laser diode package with a 650 nm laser diode chip die-attached on it. A closer top-view of the package is shown in figure 6.3 [b].



[a] [b]

Figure 6.3: Laser diode package with die-attached 650 nm laser diode chip.

After the laser diode chip had been dye-attached on the package, the top contact on the chip was provided by soldering 1-mil (25.4 μm) diameter gold wire on the chip using Pb-Sn epoxy with 2% Ag. Again the heating was applied using plate-heater. Another end of the wire was soldered manually on the flat end of the gold lead using Pb-Sn + 2% Ag epoxy and a small soldering-iron. Figure 6.4 [a] shows a wire bonded laser diode package. A closer top-view is given in figure 6.4 [b].



[a] [b]

Figure 6.4: [a] Wire-bonded laser diode package, [b] close-view of wire-bonding.

6.4 Results and Discussion

The bonded laser diode assemblies were tested using automated laser diode characterization facility [13]. Pulse-width and duty-cycle of current, in case of pulsed L-I characteristics measurement were, respectively, 400 ns and of 0.25%. Both pulsed and continuous-wave (CW) measurements were carried out at 25 °C constant temperature, unless specified, with the help of a thermoelectric cooler (TEC).

6.4.1 Optimization of Solder Material

I-V characteristics of 650 nm and 808 nm laser diodes bonded with different solders, i.e., Ag Epoxy, In-preform and Au-Sn preform are shown in figure 6.5 [a] and [b] respectively.

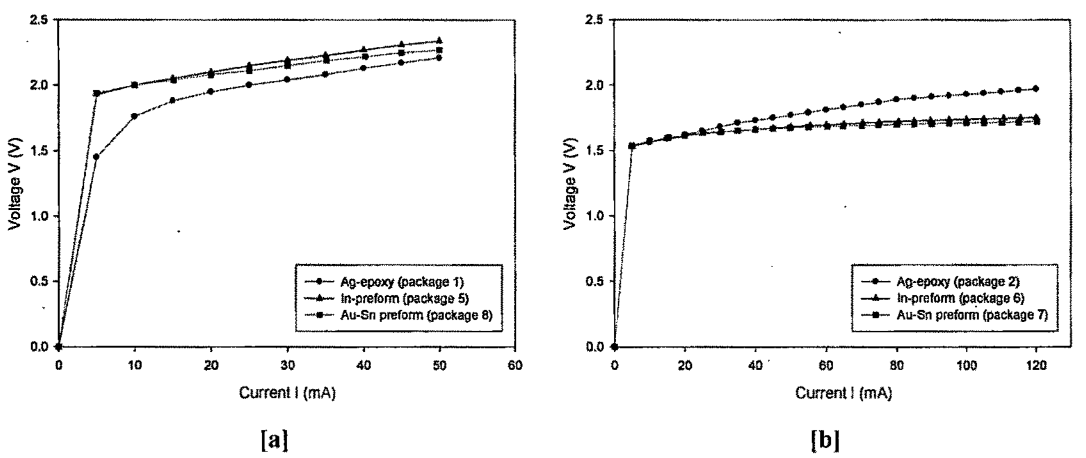
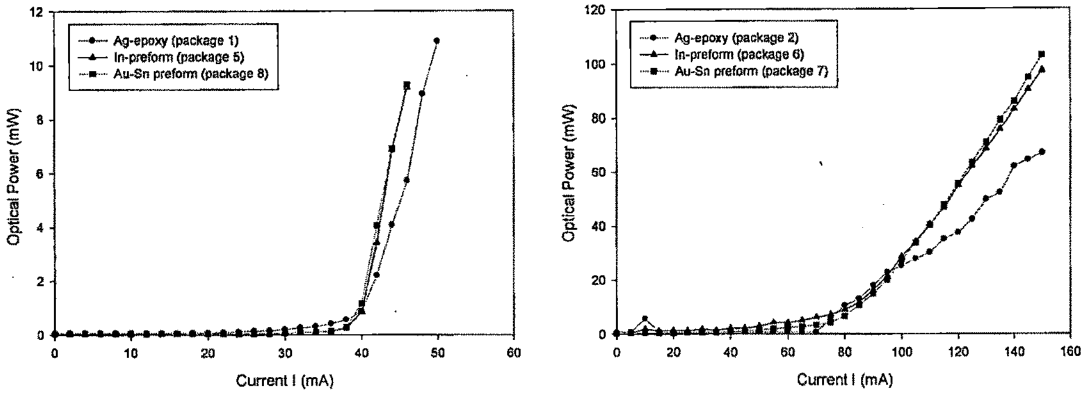


Figure 6.5: I-V characteristics of laser diode assemblies bonded with different solder materials; [a] 650 nm [b] 808 nm.

Results of I-V characteristics shows that the series resistance, i.e the slope of I-V curve above the turn-on voltage [14], in the case of Ag-epoxy bonded laser diode is higher than that of laser diodes bonded with In and Au-Sn preform. The minimum series resistance was obtained in the case of Au-Sn bonded laser diodes. These results are consistent in both types of laser diode assemblies, i.e. 650 nm and 808 nm. Unfortunately, both 650 nm and 808 nm laser diode, die-bonded with Pb-Sn epoxy, were inadvertently damaged during testing and we could not characterize them further.



[a] [b]

Figure 6.6: L-I characteristics of laser diode assemblies bonded with different solder materials; [a] 650 nm [b] 808 nm.

Figure 6.6 [a] shows L-I characteristics of bonded 650 nm laser diode assemblies. L-I characteristics of 808 nm laser diode assemblies are shown in figure 6.6 [b]. As shown in the figures, in both 650 nm and 808 nm laser diode cases, the L-I characteristics for laser diodes bonded with In-preform and Au-Sn preform are almost similar. However, the laser diode bonded with Ag-epoxy shows some kinks and sign of degradation. This is in agreement with the higher series resistance observed in I-V characteristics.

Measurements of L-I characteristics in CW mode were also carried out for both 650 nm and 808 nm laser diode assemblies bonded with different solders. The differences in the threshold current between pulsed and CW L-I characteristics were used to calculate the thermal impedance of these assemblies as discussed in previous chapter (section: 5.5.3). In case of CW mode, 650 nm laser diodes did not show lasing in any assembly. This is due to very high series resistance, around 8 Ω, offered by the laser diode chip itself, which produces large amount of heat during CW operation. Moreover, the dimensions of 650 nm laser diode chip are comparatively smaller than that of 808 nm laser diode chips. The surface area of 808 nm laser diode chip, in contact with the heat sink, is 0.15 mm^2 (length of cavity L=0.5 mm, width of chip W=0.3 mm) whereas that for 650 nm laser diode chip is only 0.0625 mm^2 (L=W=0.25 mm). Thus, heat dissipation is not as efficient for 650 nm laser diode as for 808 nm laser diode. We also measured the characteristics temperature of 650 nm and 808 nm laser diode chips before bonding. The characteristics temperature for 650 nm laser diode chip is found to be 62 K whereas that for 808 nm laser diode chips comes out to be 144.5 K. Lower characteristic temperature of 650 nm laser diode indicates that the structure of 650 nm laser diode chip is more sensitive to the temperature. These factors, altogether, increase the threshold current drastically, which consequently leads to the degradation of laser diode structure. Thus, 650 nm laser diodes were unable to lase in CW mode. However, we got lasing in all bonded 808 nm laser diode assemblies. Figure 6.7 shows L-I characteristics of bonded 808 nm laser diodes assemblies in CW mode.

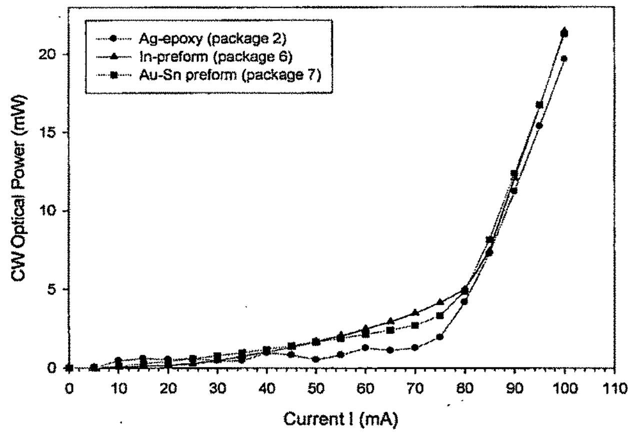


Figure 6.7: CW L-I characteristics for 808 nm laser diode assemblies.

In CW mode, too, we observed almost similar L-I curves for the laser diodes bonded with In and Au-Sn preforms. The laser diode bonded with Ag-paste also showed quite sharp threshold current, although slightly higher than the other two. The slope-efficiency was also found to be somewhat lesser in the case of Ag-paste bonded laser diode than that in the case of laser diodes bonded using In and Au-Sn preforms. These differences can be explained by the higher series resistance of the Ag-paste bonded assembly. Moreover, the thermal impedance was found to be 107.32 (°C/W) in Ag-paste bonded laser diode, whereas that for In and Au-Sn bonded laser diodes come out to be 75.72 (°C/W) and 61.36 (°C/W), respectively. The higher thermal impedance in Ag-paste bonded assembly was also reflected in the form of larger difference between pulsed and CW threshold current in the case of Ag-paste bonded laser diode as compared to that for laser diodes bonded with In and Au-Sn preforms. The higher electrical and thermal resistance can be attributed to voids and discontinuities in the solder bond that arise from the flux present in the silver epoxy [15,16]. Table 6.1 summarizes the characterization and results of bonded 650 nm and 808 nm laser diodes assemblies.

Table 6.1: Parameters of 650 nm and 808 nm laser diode assemblies bonded with different solders.

Laser Parameter ⇒	**I_{Th} (pulsed) (mA)**		**I_{Th} (CW) (mA)**		**Electrical Resistance R_S (Ω)**		**Thermal Impedance R_{Th} (°C/W)**	
Solder Material ⇓	**650 nm**	**808 nm**	**650 nm**	**808 nm**	**650 nm**	**808 nm**	**650 nm**	**808 nm**
Ag-epoxy	39.6	69	-	76	8.6	2.3	-	107.32
In preform	39.4	72	-	77	8.1	1.2	-	75.72
Au-Sn preform	39.4	72	-	76	7.3	0.9	-	61.36

As the laser diode chips were identical and were handled very carefully during the bonding process, we assume that the variation in characteristics can be attributed to different solder materials. Thus, Au-Sn preform gives best bonding with lowest electrical and thermal resistance. The results of laser diode assemblies bonded with In-preform are also satisfactory. However, we choose Au-Sn over the In perform due to several reasons; X. Liu et. al. reported that Indium solder bonded lasers have much shorter lifetime and more possibility of COMD than Au-Sn solder bonded devices [6]. Further, the bonding condition, in case of indium solder, varies with age, particularly, the thermal resistance increases distinctively [17]. This significantly reduces the operating life of the relevant laser element. Thus, we opted for Au-Sn preform for the die-bonding of facet-coated high-power highly strained InGaAs Quantum-Well (QW) laser diode [18].

The facet-coated laser diode bar was manually scribed in to a single stripe. The single emitter was then aligned at the edge of package in such a way that anti-reflection (AR) film coated facet remains on the outer side of the package and the light emitted from that facet can be utilized. The laser diode is then die-attached using Au-Sn preform. Finally, the device was wire-bonded using Pb-Sn solder epoxy containing 2% silver. Figure 6.8 shows a picture of wire-bond on 150 μm stripe of facet-coated high-power laser diode chip.

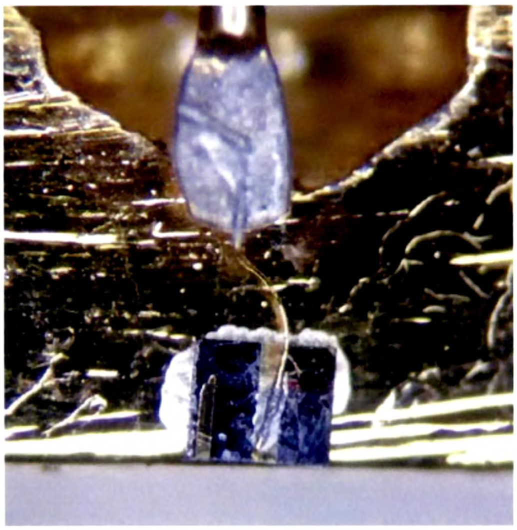


Figure 6.8: Wire-bonded, facet-coated high-power laser diode.

6.4.2 Characterization of High-Power, Facet-Coated Laser Diode Assembly

The packaged laser diode assembly was then tested using automated laser diode characterization facility to extract various laser diode parameters. The measurements of spectral response of laser diode assembly were carried out using Monochromator (CVI-CM110) with a band-pass of 2 nm.

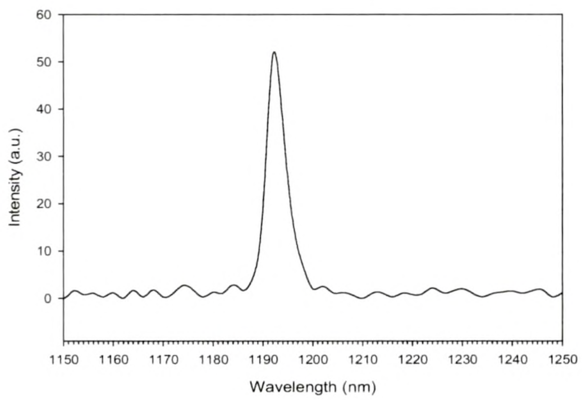


Figure 6.9: Laser spectrum of facet-coated laser diode assembly.

Figure 6.9 shows the emission spectrum of bonded and facet-coated laser diode at 500 mA input current. As shown in the figure, the peak of the laser spectrum lies at 1192 nm with the full width half maxima (FWHM) of about 4 nm.

The measurements of I-V characteristics of bonded facet-coated high-power laser diode assembly were carried out in CW mode. The I-V curve of laser diode assembly is shown in figure 6.10.

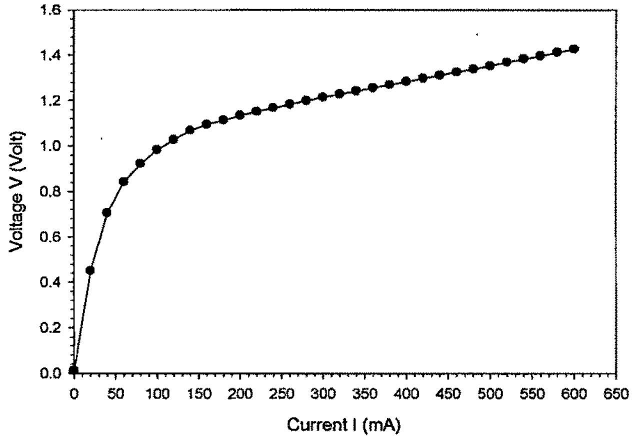


Figure 6.10: I-V characteristic of facet-coated laser diode assembly.

As seen from figure 6.10, the laser diode assembly has the series resistance as low as 0.7 Ω. Thus, less heat is produced by Joule heating due to low electrical resistance. This allows high current to pass in the assembly and consequently high optical power can be achieved from the laser diode. The turn-on voltage for this laser diode assembly comes out to be 1.03 V which corresponds to the lasing wavelength of 1192 nm.

The optical power was measured from the AR coated facet of the bonded, facet-coated high-power laser diode. Figure 6.11 shows pulsed and CW L-I characteristics of the laser diode assembly.

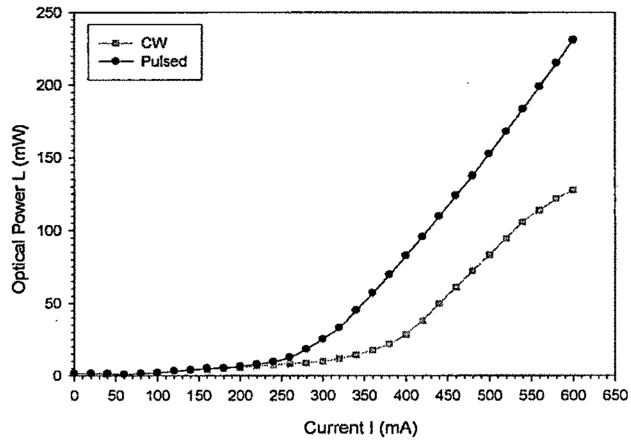


Figure 6.11: Pulsed and CW L-I characteristics of facet-coated laser diode assembly.

As seen from figure 6.11, the laser diode assembly shows good characteristics in the pulsed mode. Since duty cycle is very low (0.25%), the heating is negligible and the L-I curve shows linear rise in optical power after the threshold. The threshold current in the pulsed mode is 269 mA and we get as high as about 230 mW optical power at 600 mA current. However, in CW mode, the heating due to electrical current is significant, which results in considerable temperature rise in the active region, which in turn increases the threshold current to 354 mA. The slope efficiency is also reduced from 0.67 W/A in the pulsed mode to 0.56 W/A in CW mode. Moreover, the linearity of the L-I curve above threshold is lost after about 550 mA input current. The optical power starts getting saturated and the laser diode exhibits the thermal roll-over as shown in figure 6.11.

We also measured characteristic temperature of the bonded, facet-coated laser diode assembly by measuring pulsed L-I characteristics at different temperatures, as discussed in previous chapter (section 5.5.2). Figure 6.12 shows pulsed L-I characteristics of laser diode assembly at different package temperature.

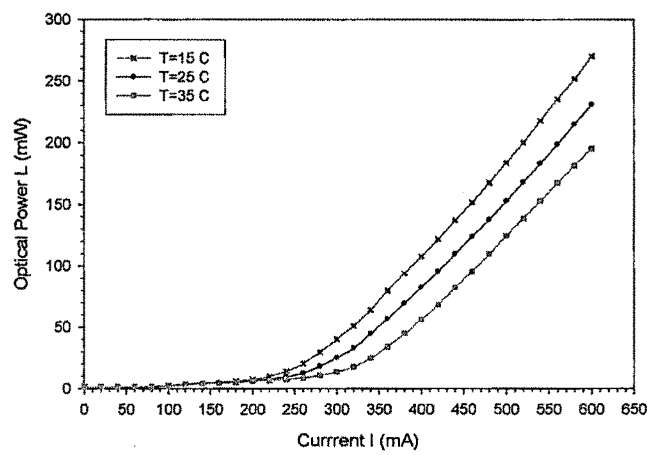


Figure 6.12: Pulsed L-I characteristics of laser diode assembly at different operating temperatures.

Pulsed measurements with very low duty-cycle ensure that there is negligible self-heating of the active region due to electrical current and the variation in the threshold current is purely due to change in the ambient temperature, i.e. the temperature of package which was controlled using TEC. The characteristic temperature of the laser diode assembly was found to be 89.62 K, which is relatively low and indicate more temperature dependence of laser diode properties. The thermal impedance of laser diode assembly was found to be 57.83 °C/W.

Various parameters for bonded, facet-coated high-power highly strained InGaAs QW laser diode assembly are summarized in Table 6.2.

Table 6.2: Laser diode parameters of facet-coated high-power highly strained InGaAs QW laser diode assembly.

Peak wavelength λ (nm)	1192 nm
Threshold current I_{Th} (pulsed)	269 mA
Threshold current I_{Th} (CW)	354 mA
Slope efficiency η (pulsed)	0.67 W/A
Slope efficiency η (CW)	0.56 W/A
Electrical resistance R_S	0.7 Ω
Characteristic temperature T_0	89.62 K
Thermal impedance R_{Th}	57.83 °C/W

6.5 Conclusion

We demonstrated the packaging of laser diode coated with AR and high-reflection (HR) films on the front and the back facet respectively. Bonding processes for laser diode viz. die-bonding and wire-bonding, were optimized on uncoated identical laser diode chips and different solder materials were examined. We found that Au-Sn eutectic provides good joint with the lease series and thermal resistance. Flux-containing solder materials offered higher resistance in the joint and should be avoided for bonding of high-power laser diodes. Finally, high-power, highly-strained InGaAs QW laser diode was bonded using Au-Sn preform and characterized. Though, we obtained high-power CW laser up to moderate current of about 550 mA with 100 mW CW power, the laser diode suffered from thermal roll-over at higher current. Appearance of the thermal roll-over suggests that the laser diode still requires better heat dissipation. This, in part of packaging, can be achieved by using junction-down configuration and better heat dissipation arrangements such as a finned heat-sink with a TEC for high-power laser diodes.

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