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B—2—4 InGaAsP/InP laser diodes mounted on semi-insulating SiC ceramics

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InGaAsP/InP laser diodes are key devices for long-haul optical- fiber communications. To realize low threshold, stable mode operation of the laser, many kinds of laser structure have been developed. Among them, the buried heterosrtucture (BH) laser is considered to be one of the most suitable laser diode for practical uses because of the capability of high temperature operation [1,2]. Long term reliability of the devices is of the present concern.

To obtain high reliability, we should optimize the total device configuration including laser chip, heatsink and solder, but few papers are reported for InGaAsP/InP lasers in this respect [2,3]. In this work, we have introduced a new heatsink of SiC ceramics to implove laser reliability. The configuration of the device is shown in Fig.1.

The material for a heat sink is selected under such conditions as follows. First, a laser diode chip is to be bonded p-side up to avoid direct influences caused by the reaction between a laser chip and solder. P-side up bonding would prevent the accidental degradation sometimes observed in relatively long-lived lasers. Second, thermal impedance is to be small to guarantee high temperature cw operation. Third, the expansion coefficient of a heatsink is close to that of a laser chip to avoid residual strain. And last, it is desiable that the heat sink is an insulator, because we can then choose either polarity for the leads.

The thermal, electrical and mechanical data of several heatsink materials are listed in Table I. Judging from the thermal registivity and expansion coefficient, the ceramic SiC is one of the most adequate material for a laser heatsink. The high resistivity of SiC enables electrical isolation of the chip. Although its permittivity is as high as 40, a packaged laser with the top p-side grounded configuration is found to oprerate above 1 GHz. As shown in Fig.1, Pb-Sn was used as solder metal.

The lifetests of BH lasers mounted on SiC ceramics were performed under 5mW-output 60 °C operation. Some examples are shown in Fig.2. The mean time to failure of the lasers is estimated to be 2×10^5 hours at 60 °C. To our knowledge, it is the longest life ever obtained at 60 °C. No accidental degradations have occurred for more than 6000 hrs.

In conclusion, InGaAsP/InP lasers mounted on semi-insulating SiC heatsinks have been demonstrated. They have high device reliability and also a capability of flexible polarity selection of devices are shown.

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References

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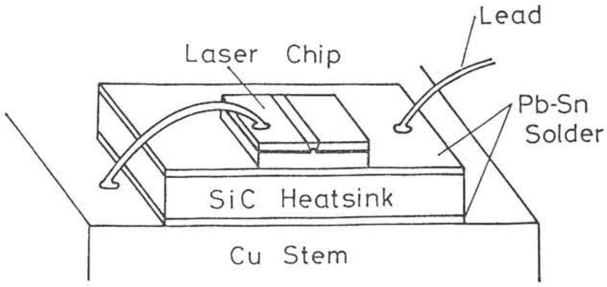

Fig.1 Schematic configuration of a device

Materials	Expansion coefficient	Thermal impedance	Permittivity
	$\times 10^{-6}\ deg^{-1}$	W/cm deg	(at 1 MHz)
InP	4.5	0.7	
SiC	3.7	2.7	42 - 20*
Al_2O_3	6.7 - 7.5	0.2	9.7
BeO	6.5	2.4	6.8
Diamond	1.0	6.6	
Si	3.5	1.25 - 1.5	
Cu	16.7	4.7	
Mo	5.0	1.4	

* at 1 GHz

Table I Parameters of InP and heatsink materials

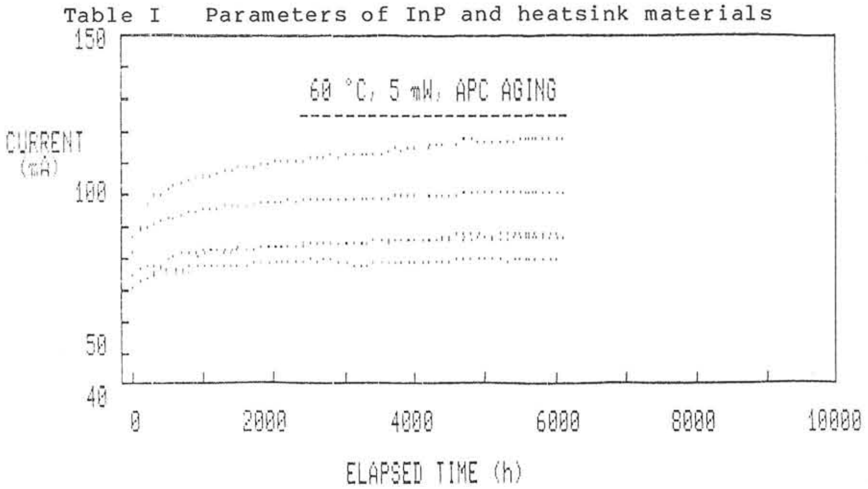

Fig. 2 Aging characteristics of BH lasers on SiC heatsinks.