

很快,在130h左右就退化5%,而其他5只器件(3,4,5,6,7号)则比较稳定,约1700h开始退化。据此可以确定该批次器件老化筛选条件,即APC条件下80℃老化130h左右。根据3-7号件的各自寿命可求得该批器件的在80℃时平均寿命:

$\bar{L}_{[80\text{℃}]} = (L_3 + L_4 + L_5 + L_6 + L_7) / 5 = (1135 + 1680 + 1690 + 1700 + 1715) / 5 = 1584\text{h}$, 又根据(5)式可求得25℃时器件的平均寿命为

$$\bar{L}_{[25\text{℃}]} = 1584 \times 261.176 \approx 4.2 \times 10^5\text{h}$$

5 误差分析

由(3)式可知道,寿命L的测量误差,主要来自温度的测量精度,对(3)式求微分得L的相对误差

$$\left| \frac{\Delta L}{L} \right| = \frac{E_a}{kT^2} \Delta T \quad (6)$$

在上述测试中,加速寿命温度取 $T = 80\text{℃}$;取激活能 $E_a = 0.6\text{eV}$;温度测量精度 $\Delta T = 1\text{℃}$ (采用PID算法控制)。则 $\left| \frac{\Delta L}{L} \right| \approx 5.8\%$ 。其中温度的测量精度对误差的影响较大。

6 结论

由于半导体激光器的寿命较长,因此采用高温加速寿命测试方法,通过采集恒功条件下工作电流的变化或恒流条件下输出光功率变化的信息,绘制激光二极管的老化曲线,即 $\Delta I / I_0 - t$ 曲线或 $\Delta P / P_0 - t$ 曲线。得到高温下寿命后,再根据加速寿命数学模型得到器件常温或其它温度条件下的工作寿命。

寿命测试的结果是一个统计平均值,可以看成是一个预测结果。其准确度与抽样数量有关,但考虑到实验成本,抽样的数量也不确定,贵重样品可选5-10只,价格低的可选10-20只。在我们系统设计时,我们设计为64路,目的是兼顾产品的老化筛选。

通常测试寿命时,选用的器件为老化筛选后的器件,但考虑到各生产厂家器件的差异,如果都根据老化标准^[11]对器件筛选,则可能造成筛选结果不准确,即筛选应力(通常为温度)、老化时间选择的不合适而造成老化不够或老化过度,因此该寿命测试系统既可以检验老化方法的准确性,又可以确定某批次器件的老化条件,如在我们测试实例中得到

1.55μm InGaAsP/InP MQW-DFB激光二极管的老化条件是:80℃、130h。

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