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PACS numbers: 42.55.Px; 42.60.Lh
DOI: 10.1070/QE2001v031n05ABEH001968

Service life of 1-W, 0.985-μm solitary heterolasers

A A Kochetkov, V P Konyaev

***Abstract*. The service life of solitary heterolasers at a temperature of 50°C ($P = 1$ W, $\lambda = 0.98 - 0.99$ μm) is studied. The maximum service life of heterolasers under such working conditions is 60000 hours for an average pumping current 1.5 A.**

Keywords: *reliability of heterolasers, service life, solitary heterolasers.*

Investigations of the service life of heterolasers with an enhanced radiation power under real lasing conditions, aimed at revealing the features of degradation processes, are of considerable interest in various fields of application. Moreover, an important aspect of the heterolaser reliability studies is the derivation of formulas for calculating the variation of basic parameters under gradual (slow) degradation, and the prediction of the onset of sudden failures due to catastrophic (rapid) degradation. It should be noted that the use of statistical methods for analysing degradation processes [1] provides reliable numerical estimates for the service life parameters of injection heterolasers.

The service life studies were carried out for 10 solitary 1-W heterolasers ($\lambda = 0.98 - 0.99$ μm, average pumping current 1.5 A) for 1500 h at a temperature $T = 50$°C, which is the highest working temperature in most applications of injection heterolasers.

The results of these studies indicate that the investigated samples can be divided into two groups depending on the nature of degradation. The first group comprises six heterolasers in which none single sudden failure was observed during 1500 h of operation at 50°C. Lasers of this group are characterized by a gradual (nearly linear) decrease in the radiation power with increasing testing time. The average degradation rate $v = t^{-1}\Delta P P_0^{-1}$ (where t is the testing time, ΔP is the decrease in radiation power, and P_0 is the initial radiation power) was found to be in the interval 5.1×10^{-5} $h^{-1} \leqslant v \leqslant 1.1 \times 10^{-4}$ h^{-1}.

The second group of four heterolasers is characterized by two stages of degradation (Fig. 1). In the first stage, degradation occurs gradually at a rate 1.1×10^{-4} $h^{-1} \leqslant v \leqslant 2.55 \times 10^{-4}$ h^{-1}, while four sudden failures were observed in the second stage: at $t = 400$ h (two failures), 750 and 1300 h. The distribution of sudden failures is in reasonably good agreement with the logarithmically normal law, whose properties were used to calculate the time of onset of failure in six heterolasers from the first group (Fig. 2): 1998, 2981, 4447, 8103, 18033, and 59874 h.

The peculiarities of degradation of all 10 heterolasers at the initial stage of operation show that the criterion for rejection of lasers with an early failure is a decrease of more than 4 % in the radiation power over 200 h at 50°C. When

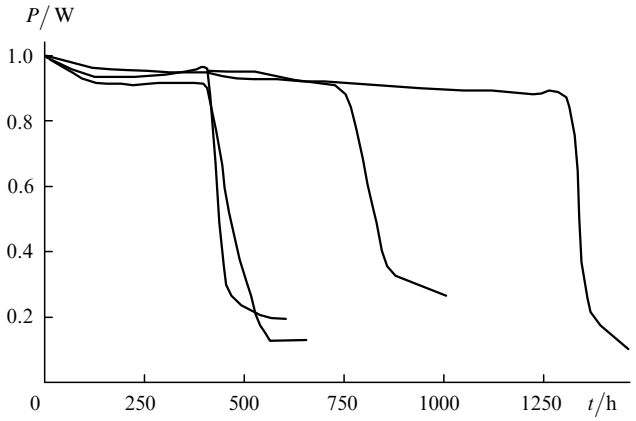

Figure 1. Dependence of the radiation power of heterolasers on testing time at $T = 50$ °C.

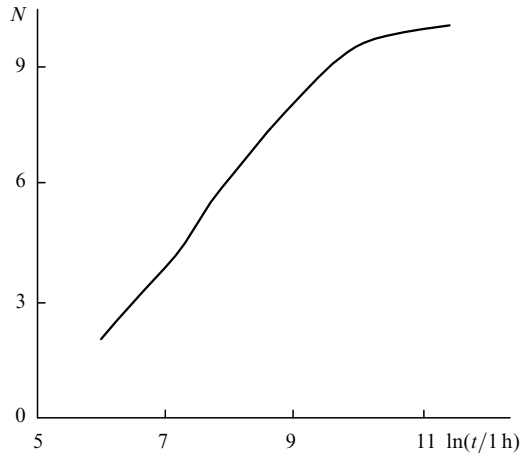

Figure 2. Time distribution of the number N of sudden failures of heterolasers for a standard deviation of 1.8.

A A Kochetkov, V P Konyaev Federal State Unitary Enterprise, M F Stel'makh Research Institute 'Polyus', ul. Vvedenskogo 31, 117342 Moscow, Russia

Received 6 December 2000
Kvantovaya Elektronika **31** (5) 417–418 (2001)
Translated by Ram Wadhwa

such a procedure is adopted at 50°C, no failures are anticipated during operation up to 1800 h.

Thus, an analysis of the experimental investigation of the service life leads to the conclusion that the degradation of heterolasers is manifested in a gradual decrease in the radiation power as well as sudden failures according to the logarithmically normal distribution. The maximum service life of 1-W heterolasers at 50°C is about 60000 h.

References

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