EPJ Web of Conferences **161**, 03004 (2017) DOI: 10.1051/epjconf/201716103004
PECS-2017

Determination of QW laser diode degradation based on the emission spectrum

Vladimir Bliznyuk[1,*], *Olga* Koval[1], *Elena* Vinogradova[1], and *Alexey* Rzhanov[2]

[1]Moscow Power Engineering Institute, 17 Krasnokazarmennaya str., Moscow, 111250 Russia
[2]Lomonosov Moscow State University, Physics Department, Leninskie Gory, Moscow 119991, Russia

Abstract. The possibility of laser diodes degradation control by monitoring of their spectrum is shown. For red and infra-red laser diodes, the time dependence of the radiation spectrum width was obtained.

Laser diodes of small and medium power (1-100 mW) are widely used as radiation sources in various complexes in metrology, medicine, optical transmission and information recording, and in many others. An important problem in the operation of these devices is the prediction of their service life and the determination of the operating time through which their substitution is required. To solve this problem, it is necessary to know which physical processes lead to the degradation of laser diodes. A study of degradation expressions and forms, carried out in [1-2], showed that its main cause is the gradual change in stresses in quantum-well semiconductor layers due to the difference in the parameters of the crystal lattices forming the active and emitter regions. Despite the efforts made by technologists to improve the quality of the layers by selecting suitable combinations of materials and improving their structure due to technological developments [3-4], defect formation processes in quantum-well active layers are difficult to predict. To predict laser operating time by the initial parameters, such as the output power, efficiency, wavelength and the degree of polarization of radiation specified in the instrument's passport is appeared to be impossible. Accelerated testing of the laser diode, conducted selectively, allow to detect changes in these parameters during the operation of the device, which, when generalizing the results of such measurements, makes it possible to predict the service life of a set of lasers. Therefore, it is very important for consumers to obtain techniques based on such a generalization. At present a number of methods for diagnosing the state of laser diodes have been developed. Despite that many of them are of interest from the point of view of physical or mathematical models, the question arises of their practical applicability. In our opinion, it is possible to obtain sufficiently complete information on the change in the state of the laser diode as the operating time increases, by its spectral characteristics analysis.

In this paper, we studied the spectral characteristics of two sets of eight and four laser diodes KLM650-5-5 and KLM980-5-15, respectively, generating red (650 nm middle wavelength) and infrared (980 nm) light. Laser modules were studied during the year and were exploited for 15 hours weekly. Every week during the single measurement, they were subjected to a three-fold heating to 70°C and cooling to -10°C. These temperatures were

* Corresponding author: 40595141@mail.ru

© The Authors, published by EDP Sciences. This is an open access article distributed under the terms of the Creative Commons Attribution License 4.0 (http://creativecommons.org/licenses/by/4.0/).

maintained in the climatic chamber for two hours each time, and the emission spectra of the lasers were measured the next day at room temperature and at an increasing pump current corresponding to a constant given value of the laser radiation power. It was recorded that the width of the spectral line of generation of the test laser diodes began to increase monotonically after the second month of investigations. It was found that the line broadening speed in the interval between two to seven months' lasers remains constant, and from seven to 10 months it gradually decreases, up to zero at the finish of the annual test.

In Fig. 1 and Fig. 2 the spectra of the tested lasers before and after the year of operating in the regimes described above are shown.

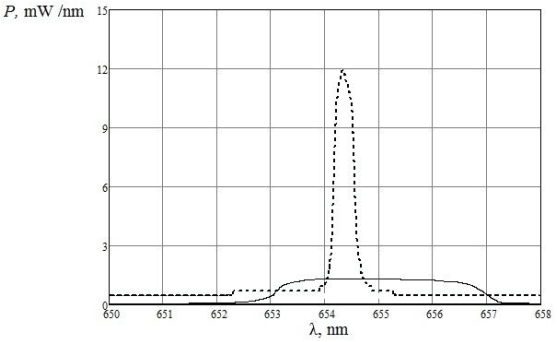

Fig. 1. Spectral characteristics of the KLM-D650-5-5 diode, measured at the beginning of the work (dotted curve), and after a year of operation (solid curve).

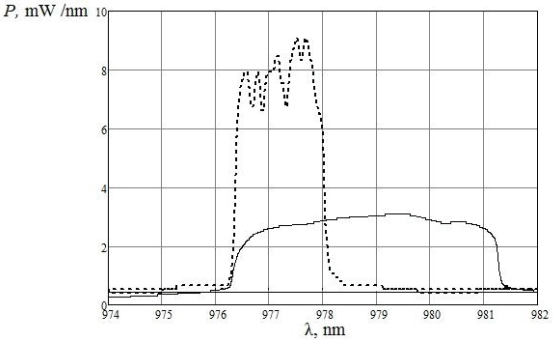

Fig. 2. Spectral characteristics of the KLM980-5-15 diode, measured at the beginning of the work (dotted curve), and after a year of operation (solid curve).

References

[1] V.V. Bliznyuk, M.A. Brit, I.S. Gadaev et al., Bull. RAS: Physics **79**, 12 (2015)

[2] O.I. Koval, A.G. Rzhanov, G.A. Solovyev, Phys. of Wave Phenom. **21**, 4 (2013)

[3] V.P. Duraev, A.A. Marmalyuk, A.A. Padalitsa et al., Quant. Electron. **38**, 2 (2008)

[4] S.O. Slipchenko, A.A.Podoskin, D.A. Vinokurov et al., Semiconductors **47**, 1079 (2013)