O.13. Features of self-pulsating InGaN lasers

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In recent years, due to applications in medicine, blue and blue-violet light lasers (450 and 405 nm) seem to represent an interesting approach for several clinical treatments [1]. In this paper we present theoretical results of the influence of blue light laser parameters on self-pulsations. We studied the influence of the thickness of the saturation absorber, the length of the laser, as well as the lifetime of the charge carriers on the self-pulsation region in terms of several parameters. Figure 1 shows a setup of the investigated laser which consists of the InGaN active layer and a saturation absorber. Both the active layer and the saturation absorber are composed of 3 quantum wells of the InGaN type. The thickness of the active region and saturation absorber is 18 nm and the wavelength is 405 nm. The length of the active layer is 650 μm.

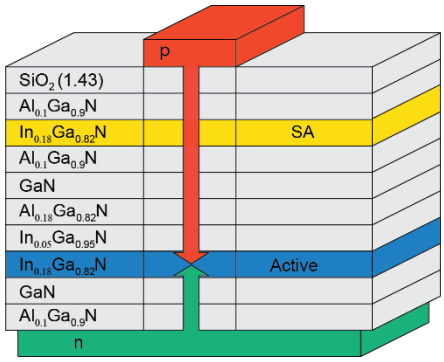

Figure 1. Schematic of the InGaN laser.

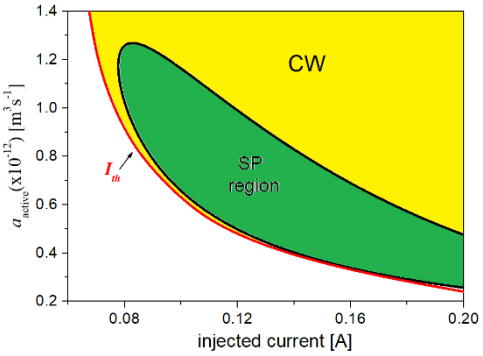

Figure 2 Self-pulsation region.

The theoretical model used to describe the laser dynamics is based on the model proposed in [2]. Fig. 2 shows the curve (black line) calculated for the region with self-pulsations in the plane: the differential amplification coefficient depending on the current injected in the active region. The red line in Fig. 2 represents the border between the operating regions of the laser in "off" and "on" mode. We discuss the possible variations of the differential amplification coefficient. The yellow region marked with CW corresponds to the operating mode of the laser with continuous waves. In the case when the parameter values correspond to green regions, the laser manifests self-pulsations. As mentioned above, the influence of absorber thickness, laser length, as well as the lifetime of the charge carriers on the performance of the self-pulsation regime was also investigated.

[1] Carlo Fornaini Reza Fekrazad Jean-Paul Rocca Shiying Zhang Elisabetta Merigo Use of Blue and Blue-Violet Lasers in Dentistry: A Narrative Review, Journal of Lasers in Medical Sciences, Vol. 12 (2021), p. e31.
[2] Yamada, M., A theoretical analysis of self-sustained pulsation phenomena in narrow-stripe semiconductor lasers, IEEE J. Quantum Electron., vol. 29, pp. 1330–1336, May 1993.