ANOMALOUS DISPERSION IN THE REGION OF SELF-ABSORPTION OF ELECTRON-HOLE PLASMA OF A HETEROSTRUCTURE LASER

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The Cauchy extrapolation of the dispersion coefficient of electron-hole plasma to the region of self-absorption frequencies used by certain authors is not well-grounded. From experimental measurements of the emission spectrum of stripe-geometry heterostructure lasers based both on a GaInPAs solid solution and on a GaAs compound, the authors established an anomalous dependence of dispersion, which corresponds to fundamental notions about the exciton nature of this phenomenon occurring precisely in the frequency region of the self-absorption band [1].

Semiconductor lasers have found wide use as modulated radiation sources in information systems for transmitting data in optical communication networks based on optical-fiber lines. Modern communication lines of the optical-fiber type become economically competitive compared with the usual ones (radio and telephone) at modulation frequencies above 40 MHz. The information signal is formed by direct modulation of the pumping frequency, which, eliminating special devices, simplifies the scheme of the optical transmitter, but leads to a change in the width of the emission spectrum [2]. In such a scheme, gain modulation related to a decrease of the carrier density is carried out by pumping the laser by a strong sinusoidal current or short current pulses, which are superposed on the constant bias current of a superthreshold or zero level.

The authors investigated stripe-geometry heterostructure lasers based on a GaInPAs quaternary solid solution, the width of the active region of which was $W = 16\ \mu m$. To measure the spectral characteristics of the radiation being generated by the heterostructure laser, optimal matching of the wave impedances of the test specimen with a high-frequency excitation oscillator was investigated.

The potentially attainable degree of matching of the input impedance of the laser diode with the wave impedance of the high-frequency excitation oscillator in the frequency band is determined by the integral relation [3]

$$\int_0^\infty \ln \left| \frac{1}{\Gamma} \right| d\omega = \frac{\pi}{R C_q},$$

where Γ is the complex reflection coefficient from the input of the laser diode.

The use of laser diodes in high-frequency modulation schemes requires an accurate idea about the structure of the impedance of the laser. Elements of the equivalent circuit are derived from velocity equations [4], which describe the density of injected carriers and photons for one longitudinal mode. The equivalent circuit of a laser diode can be modeled by means of a series-parallel R, L, and C connection [5].

It follows from the authors investigations that the active value of impedance of a semiconductor laser at frequencies 96-100 mHz reaches Z = 8.9-9.5 ohms. Therefore, the design of a modulator based on a microstrip serving for matching the complex impedance during transmission of the necessary power from the microwave generator to the investigated specimen was developed. The width of the microstrip was calculated by the formula given in [6].

Spectra of axial models of radiation of various specimens were obtained under the condition of fulfillment of the aforementioned requirements imposed on electrical matching of the parameters of the injection heterostructure laser, scheme of excitation, and design of the modulator. Figure 1 shows one of the characteristic experimental results: a) spectrum of the stripe-geometry heterostructure laser based on the GaInPAs quaternary solid solution in a subthreshold excitation mode; b) oscillation spectrum of the same heterostructure laser during operation in a continuous mode with modulation of the pumping current by a 134-mHz sinusoidal signal.

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