LASER BASED ON MANGANESE CENTERS IN ZINC SULFIDE

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A new type of laser, using impact excitation of manganese centers in a zinc-sulfide lattice by carriers heated by an applied electric field, was reported in [1].

However, the experimental values cited by the authors for the current density j ($\sim 10^{-2}$ A/cm^2) and the electric field intensity E (10^6 - 10^7 V/cm) cannot result in a gain $\alpha \sim 10^3$ cm^{-1}, for the following reasons.

In the case of luminescence centers, the gain is connected with the spontaneous radiative time τ_r by the well-known relation:

$$\alpha = \frac{\Delta N n}{c\tau_r \rho_\lambda \Delta\lambda}, \qquad (1)$$

where ΔN is the inverted population, $\rho_\lambda \Delta\lambda$ is the number of radiating oscillators in the half-width $\Delta\lambda$ of the spontaneous emission line per cm^3, c is the speed of light, and n is the refractive index of the medium.

The power P_r per cm^3 of the spontaneous emission satisfies the relation

$$P_r \geq \hbar\omega \frac{\Delta N}{\tau_r}.$$

Expressing $\Delta N/\tau_r$ by means of (1), we obtain

$$P_r \geqslant \frac{16\pi^2 \hbar c^2 n^2 \alpha}{\lambda^4} \frac{\Delta\lambda}{\lambda}, \qquad (2)$$

where λ is the wavelength at the maximum of the spontaneous emission ($\lambda \sim 5900$ Å, $\Delta\lambda \sim 700$ Å).

Substitution of the experimental values of [1] in (2) yields $P_r > 10^9$ W/cm^3, whereas the pump power in the experiment was $jE \sim 10^4$ - 10^5 W/cm^3, i.e., it could in no way supply the spontaneous emission power at a gain $\alpha \sim 10^3$ cm^{-1}.

[1] N.A. Vlasenko and Zh.A. Pukhlii, ZhETF Pis. Red. 14, 449 (1971) [JETP Lett. 14, 306 (1971)].