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Misalignment Effects in the Resonator of a Transverse RF Excited Ar-He-Xe Laser.

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A new continuous wave (CW) transverse radio frequency (RF) excited Ar-He-Xe laser was reported recently [1]. Because of its potential advantages (very high gain, lasing in an atmospheric transmission window near 2 μm and 4 μm) this laser has attracted the attention of several research groups. It soon led to a substantial improvement of the laser performance resulting in an output power in the order of 10 Watts [D.R.Hall and co-workers].

An important feature of the CW RF excited Ar-He-Xe laser is the strong inhomogeneity of its transverse gain distribution and of its refractive index. We have shown recently [2] that both these factors

(but predominantly the latter) contribute to the formation of a peculiar two-lobe output mode pattern, which seems to be typical for this laser. In this paper we describe a more general case including a laser resonator with strongly misaligned mirrors.

The laser mode patterns and output power were measured as a function of the tilt angle of the totally reflecting mirror. A laser resonator was formed

by two flat mirrors placed at the distance of 15 and 25.3 cm from the electrodes. The size of a discharge volume was as follows: 370x15x1 mm³. A typical experimental graph is shown in the figure. The 2-D numeric code used in our previous work [2] was modified to include the misalignment effects.

It is shown that with large gain and refractive index inhomogeneities the laser becomes rather insensitive to the mirror tilt angle. It is possible to measure the same laser output while having the mirror tilted by 10 mrad. However the laser field distribution is more sensitive to the mirror misalignment. One of the lobes in the output field pattern becomes stronger while the other one decreases. This proves the validity of the qualitative assumption concerning the spatial structure of the laser output radiation made by us in the previous publication [2].

References

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Selfdiffraction of the laser intracavity beams in the active rod.

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During the last years the promising results were achieved in the field of the phase conjugate oscillators and amplifiers while using the dynamical holographic gratings formed in the active media and passive Q-switches. At the same time the creation of the adaptive resonator for the free-running mode laser is also of great interest. To attain this goal we studied the intracavity beams diffraction and interference processes for free-running Nd-laser.

Schematic of the experiment set-up is shown in Fig.1. The polarization-coupled resonator is formed by two high-reflecting mirrors HR1 and HR2. Output coupling is produced by a waveplate/polarizer ($\lambda/4$ - PL) combination. The interference pattern is written in the active rod AR (Nd:YAG $\varnothing 8 \times 60$ mm) by the intracavity beam splitted by the additional mirror M1 ($R \approx 30\%$) in three nearly equal intensity beams. The angles between the beam axes falling in the plane of figure and the resonator axis are correspondingly -2α , 0 and 2α , where α is the angle of M1 mirror inclination. While using the semitransparent mirror M2 and objective lens L1 the arbitrary cross-section of the active rod may be projected to the plane of the detecting system VS1 for the detailed study of the parameters of the interference pattern inside the rod. Simultaneously the far-field intensity distribution is studied with the use of lens L2 ($f = 2\text{m}$) and detecting system VS2.

The results of the investigations demonstrate, that the highly contrast interference pattern is written inside the active rod as a number of the parallel layers, directed under the angles of $\pm\alpha$ with respect to the cavity axis. At the same time the far-field intensity distribution also possesses the fringe structure in all three spots. Arising of this fringe pattern is well explained by the selfdiffraction of the intracavity beams inside the active rod and the distance between the fringes depends on the distance between interference layers inside the rod (and correspondingly the angle α). The visibility of the far-field diffraction pattern in the plane VS2 is strongly dependent of the α value and decreases with the increase of this angle. The far-field diffraction pattern disappears while the magnitude of α exceeds some critical value when the intracavity emission starts to cross the bright and dark regions during the propagation through the active rod.

To determine the origin of the highly efficient intracavity interference and selfdiffraction we studied the spectral properties of the output emission. It was shown that the spectrum was formed by the wide enough pedestal with the width of $\sim 1 \text{ cm}^{-1}$ and narrow ($\sim 10^{-2} \text{ cm}^{-1}$) line. The intensity of the line was about 100 times more than the magnitude of intensity of the wide spectrum.

The results show, that even without special spectral selectors intracavity emission of the free-running laser is able to write an efficient interference pattern inside the laser rod. This effect may be used to create a phase-conjugate oscillator operated in a free-running mode.

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Fig.1. Schematic of the experiment.