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NEW TYPE OF DYE LASERS: POLYCHROMATIC SUPERBROADBAND TUNABLE LASER

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Abstract - The new polychromatic superbroadband tunable dye laser is investigated. Main spectral features of such laser are presented. The possible application field is described.

1. Introduction.

The new type laser with polychromatic beforehand given spectrum radiation was suggested in /1/. In this paper spectral properties of such laser are investigated and main its characteristics are described.

2. Description of the characteristics of a new laser.

In respect to the traditional lasers the main distinction of polychromatic ones is the modes competition violation. It is achieved by means of different wavelengths generation channels separation and ensuring of the positive feedback for all the expected wavelengths simultaneously. For these principals realisation the new type laser cavity was developed, which was called the cavity with self reconstructed points. Every point emitting the light and placed on the appropriate plane which is situated inside the resonator is reconstructed to itself after each full pass of radiation through the laser of such type. Theoretical investigation of the cavity with self reconstructed points was based on the method of matrix optics. Requirements for existence of points reconstruction to itself in the cavity were discovered.

red from which it is seen that it is possible to construct such cavities with conventional optical elements. Regions of such cavity stability was found also.

Different wavelength radiation is emitted by different parts of active medium in developed laser. It allows to violate the modes competition that gives the possibility to widen the laser generation spectrum and to obtain the several wavelengths radiation or generation in the several parts of continuum simultaneously, to tune independently generation lines, their relative intensities and to form an expected spectral distribution of lasing intensity. It is interesting to mention that in this laser dispersive element is used not for sharpening of the lasing spectrum but for its broadening.

The spectral region in which the several wavelengths lasing is possible is determined by the amplification band of used active medium and is situated in the interval of 400-700 nm. Under the necessity this spectral interval can be widened and shifted to the near UV or IR region.

The laser can generate in three wavelengths simultaneously or in three parts of continuum. (The number of simultaneous generation wavelengths depends on pumping power and can be increased by corresponding pumping power increase.) The generation lines can be grouped in the determinate spectral region or they can be distributed in all visible spectrum in arbitrary beforehand given way, i.e. can be coordinated with the spectra of atoms or molecules under investigation. The generation spectrum modification is realised without replacing of an active medium or any laser's elements or without realignment of its cavity.

The lasing with very broad continuous spectrum is also possible. Under the enough pumping power the generation continuum width can reach 0.6-0.8 of the active medium luminescence spectrum width. For instance, under the using excimer laser with power of 5 MWt ($\lambda = 308\text{nm}$) for pumping of active medium which is ethanol solution of rhodamine-6G and oxazin-17 mixture, the lasing continuum width can be up to 150nm. That is much broader than in the traditional dye laser with nondispersive cavity. The continuum width can be increased by usage of two active media and by means of the

pumping power increase. The measurement of the continuum width was fulfilled by method of heterochrome photometrie of polychromatic laser radiation /2/.

Under the necessity the laser's generation spectrum can be complicated. For example we have got the linear and continuum simultaneous lasing or linear spectrum in the background of continuum. Particularly with the help of such lasers simulation of different light sources is possible: natural light modeling of solar, daylight; industrial sources.

The lasing linewidth (without the intracavity interferometre) is 0.1-0.3nm. By means of intracavity interferometre the further narrowing of generation linewidth is possible. Thus linewidth decreases up to the 0.005nm when lasing tuning is broadband (all the visible spectrum). The linewidth is up to 0.001nm in the case narrowband (100nm) tuning range (or in the case when generating lines lay in three respectively narrow (20nm) spectral intervals situated in the necessary spectral region).

The frequency stability during the working day is not worser than the monochromatisation degree of generating radiation. This concerns both the case of lasing with the intracavity interferometre and without it.

The pure dyes and the mixtures as well were used as an active medium. In the first case the higher generation power was obtained, in the second case the spectral region in which the simultaneous lasing in several wavelengths is possible can be widened simpler.

The active medium can be pumped by the conventional laser usually used for the active medium pumping in the traditional dye lasers, e.g. nitrogen or excimer lasers or UV harmonics of solid state lasers. The repetition rate of lasing pulses is determined by the pumping laser pulses repetition rate and can reach 10 Hz under the pumping power of 200 kWt without dye circulation or cooling; under the dye circulation - up to 10 Hz (the average pumping power is 2.5 Wt, the pulse power is 20 kWt - the copper laser pumping).

By means of balance equations decision the output radiation spectrum of such lasers is calculated. Calculations

were fulfilled both for linear and continuum lasing. In both cases calculated and measured spectral distributions of emitted energy are in satisfactory agreement.

3. Fields of Application of polichromatic lasers.

The possibility of the demanded generation spectrum formation in the broadband spectral region widens the opportunities of the laser and intracavity spectroscopy, photochemistry, multicomponent plasma holographic diagnostics. Such lasers application will allow to populate simultaneously several expected atomic or molecular levels, to carry out the absorption measurements in the broadband spectral region, to get the information about different atoms, molecules, ions concentration in the plasma simultaneously. The polychromatic lasers can be used for highly excited atoms investigation, in the stepwise and multiphoton processes researching, for information transfer, in medicine.

4. Conclusions.

Thus the new type of dye lasers is investigated. The possibility of the polychromatic tunable lasing in the extremely broadband spectral region is shown. Unusual spectral characteristics of developed lasers open new possibilities in different fields of laser application.

- /1/ Izmailov A.M., Smirnova I.A., Zhiglinsky A.G., Vestnik LGU, Ser.4, N2 (1991), 8.
- /2/ Izmailov A.M., Kund G.G., Smirnova I.A., Vorotnev P.A., JNPfK, USSR, v.36, N3 (1991), 249.