To Analysis of Amplification Coefficient of Optical Planar Amplifier

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Abstract – **In article the results of modeling of amplification coefficient of optical planar amplifier based on liquid crystal with dye mixture are carry out.**

Keywords – **optical planar amplifier, amplification coefficient.**

I. INTRODUCTION

One of important unit of modern fibre-optic system of communication with canal spectral compression (WDM- i DWDM-systems) is the optical amplifier. This device directly amplifies the optical signal without the transformation in electrical signal.

II. EXPERIMENTAL PART

We propose the construction of planar optical amplifier based on planar waveguide. In our case as a planar waveguide is liquid crustal mixture.

This investigation was carrying out for liquid crystal nematic mixture 4-metoxibenziliden-4butilanilin (MBBA) with such parameters $\Delta\varepsilon$ =-0.46 and Δn=0.24 moreover $\Delta n_{||}$=1.73. The cross section such structure shown on figure 1.

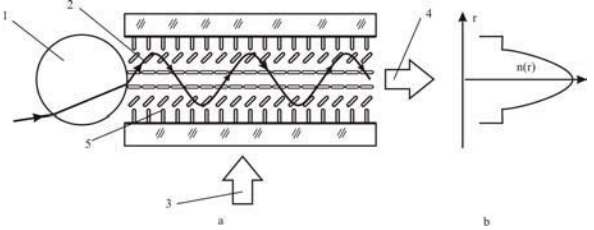

Fig.1: The beam passed in planar waveguide at applied electrical field (E_2) moreover $E_2 > E_1$: 1- cylindrical lens for the inputting of radiation in waveguide; 2 - beam trajectory; 3 -source of pumping radiation; 4 - output radiation; 5 - liquid crystal mixture with dye

By means of applied electrical potential betweens conductive surfaces, which it's deposited on the surfaces, the change of optical properties of liquid crystal layer are occurred. In this case in gomeotropic layer of liquid crystal mixture the range with high, concerning to edges, the value of refraction coefficient is created, and in liquid crystal layer the planar waveguide is formed (fig.1). But during of LC material reorientation at the electric field action the clearly border between the gomeotropic oriented edge layers and planar oriented kernel is not occurred. Between those two extreme states of orientation the zone with intermediate state of orientation of long molecule axes is formed. That is the obtained such planar waveguide the gradient distribution of value of refractive coefficient in way of allaying field is possess.

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The amplification of optical signal based on the induced radiation, which is arisen by interaction of dye molecule with pumping radiation, and it`s leads to excitation of dye molecule.

The calculations of amplification coefficient of optical planar amplifier are fulfilled. According to [1] the amplification coefficient on frequency ν is equals:

$$k_{21}(\nu) = \chi_{21}(\nu)\left[\frac{n_2}{n} - \frac{n_2}{n}e^{-h(\nu_{||}-\nu)/kT}\right] \quad (1)$$

were $\chi_{21}(\nu) = n\sigma_{21}(\nu)$ – the amplification coefficient limit, which are fulfilled if $n_2 = n$; σ_{21} (ν) – cross section of amplification limit, $n = n_1 + n_2$ – the common particle concentration. From the equation (1) are follows, that the amplification on frequency ν is arisen, if:

$$\frac{n_2}{n_1} > e^{-h(\nu_{||}-\nu)/kT} \quad (2)$$

For the frequency $\nu > \nu_{el}$ the performance of that condition is linked up with creating of inversion occupation of levels 2 and 1. But for frequency $\nu < \nu_{el}$ such requirement not is necessary, the amplification will be realized even if n2 < n1. The more $\nu - \nu_{el}$ the less value n_2/n_1 we needed, and easier the amplification are obtained.

When the mathematical calculation are fulfilled and the values are re-count, as shown, that the particles concentration are $0.5 \cdot 10^{16}$ sm^{-3} for the length of planar amplifier are 0.02 m, the amplification coefficient are equal 0.87 ÷ 40 dB (Fig.2).

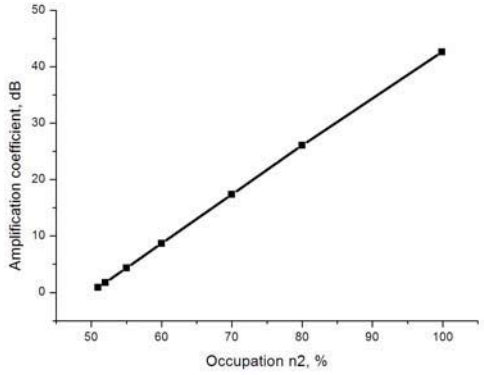

Fig.2. The inversion occupation of excitation of singlet state of dye dissolved in nematic liquid crystal

III. CONCLUSION

The results of modeling are show, that if the inversion occupations of excitation of singlet state of dye are increased then the amplification coefficient up to 40 dB is increased.

REFERENCES

[1] Степанов В. И., Рубинов Л.И. Оптические квантовые генераторы на растворах органических красителей // Успехи физических наук. –1968. – Т. 95, вып.1. – С.45 – 74.