MINIMIZING THE INFLUENCE OF TEMPERATURE CHANGES IN THE ENVIRONMENT ON THE PERFORMANCE CRITERIA OF THERMO-OPTICAL PROCESSOR BASED ON FABRI-PEROT AND SMITH MICRORESONATOR

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I. INTRODUCTION

The main disadvantage of using Fabry-Perot and Smith microcavities in thermo-optical converters is their sensitivity to environmental conditions (changes in its temperature) [1-3]. As a result, due to the energy absorbed by the resonator, its temperature increases and, consequently, its optical base changes, which leads to a shift in the spectral characteristics and deterioration of performance criteria [4-6].

II. MATERIALS AND METHODS

In this work, a mathematical model was created with the help of which the conditions were obtained under which the dependence of the light flux of the readout radiation reflected by Fabry-Perot and Smith microcavities minimally depends on the initial temperature of the resonator.

III. RESULTS

The main thermosensitive element of a thermo-optical converter is a matrix of film resonators (Figure 1), in which both Fabry-Perot and Smith microresonator can be used. It was found that the light modulation characteristics of the microresonator of the matrix under consideration are determined by the change in their temperature, the value of the spectral shift of the transmittance or reflection of each of the resonators, and the wavelength of the readout radiation.

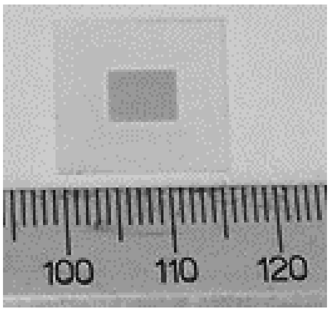

Figure 1. Matrix of microresonator

The dependences of the change in the luminous flux on the change in the initial temperature of the microcavities have extrema, near which the value of its change in absolute value is maximum and for the resonator under consideration practically does not change. Therefore, to obtain a more temperature-stable operation, it is necessary that their initial temperature corresponds to the extremum of the dependence of the change in the luminous flux on temperature. This can be realized by obtaining an appropriate value of their optical base or by technological formation of a dielectric layer between the mirrors, or by heating to an appropriate temperature. In this case, the dependences of the luminous flux and the change in the reflected light flux of the readout radiation without and under the influence of IR radiation on the change in the initial temperature of the resonator will have the form shown in Figure 2.

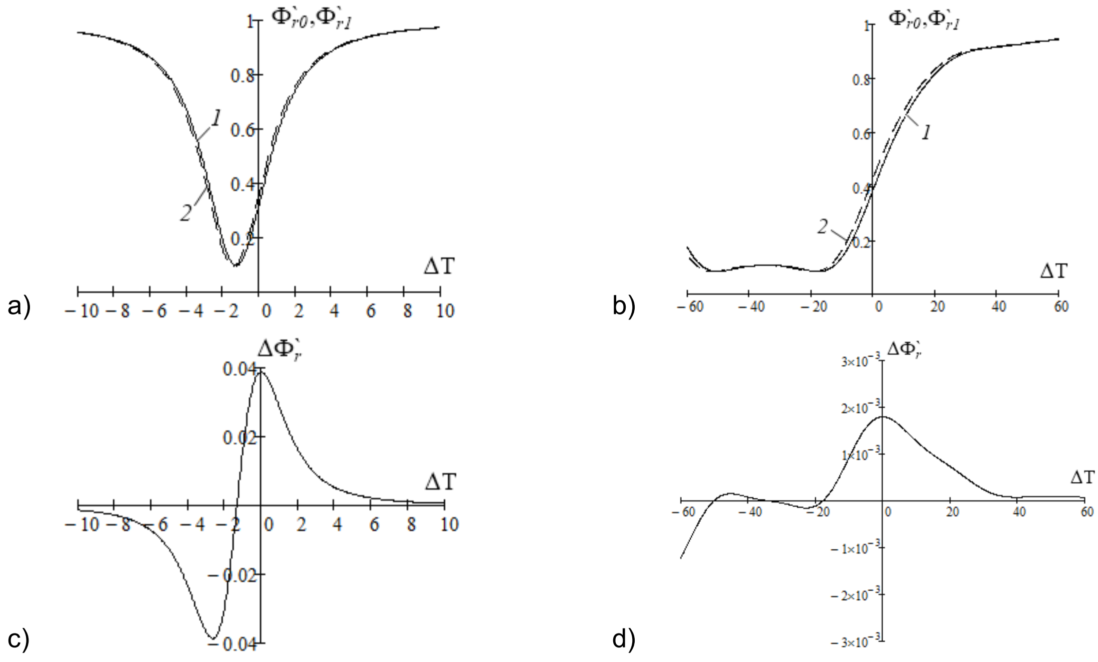

Figure 2. Dependences of the light flux of the readout radiation, reflected a) - Fabry-Perot microresonator; b) - Smith microresonator with a corrected initial temperature, without (Φ_{r0}`) and under the influence of IR radiation ($\Phi_{r1}$`); dependence of the change in the luminous flux $\Delta\Phi_r$`, reflected c) - by a Fabry Perot microresonator, d) - Smith microresonator, under the influence of IR radiation on the change in the initial temperature of the resonator ΔT

According to calculations, in order to increase the temperature stability of Fabry-Perot and Smith microresonator for their use in devices for converting information from the IR region of the spectrum to another, a prerequisite is that their initial temperature matches the extremum of the function of the dependence of the change in the luminous flux on temperature. In this case, the dynamic temperature range of the Fabry-Perot microresonator is 0.3 ° C, which is 20 times less than that of the Smith microcavity (6 ° C). In this case, the change in the light flux under the influence of IR radiation at the output of the Fabry-Perot microcavity will be 20 times greater than after the Smith microresonator.

IV. CONCLUSION

Thus, in order to obtain a more temperature-stable operation of both a Fabry-Perot microinterferometer and a Smith microresonator, operating in the mode of converting information from the IR spectral region to another, for example, a shorter wavelength, it is necessary that their initial temperature corresponds to the extremum of the dependence of the change in the light flux on temperature. In this case, the dynamic temperature range of the Fabry-Perot microinterferometer (0.3°) will be 20 times less than that of the Smith microresonator (6°). In this case, the change in the luminous flux under the influence of IR radiation at the output of the Fabry-Perot microinterferometer will be 20 times greater than after the Smith microresonator.

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