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DIFFERENT WGM DISK MICRORESONATOR FILTERS

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ФІЛЬТРИ ПОБУДОВАНІ НА РІЗНИХ ДИСКОВИХ МІКРОРЕЗОНАТОРАХ З КОЛИВАННЯМИ ШЕПОЧУЧЕЙ ГАЛЕРЕЇ

Розраховані характеристики розсіювання хвиль лінії передачи на системах відмінних по розмірам та діелектричної проникності діелектричних мікрорезонаторів з коливаннями шепочучей галереї. Розглянуто різні структури зв'язаних мікрорезонаторів. Досліджені частотні залежності матриць розсіювання смугових та режекторних фільтрів, побудованих на різних формах мікрорезонаторів.

Whispering gallery modes (WGM) of the disk microresonators are being actively studied for purpose of their application in different devices of the optical and infrared wavelength ranges [1 - 5]. It's known that all microresonators have dense frequency spectrum of natural oscillations, leading to appearance of spurious bands in the devices in which they are used. The number of spurious bands can be significantly reduced if use a variety of microresonators made on different dielectrics. The goal of the present work is the analysis of the S-parameters matrix of bandstop and the bandpass filters, made on different disk microresonators.

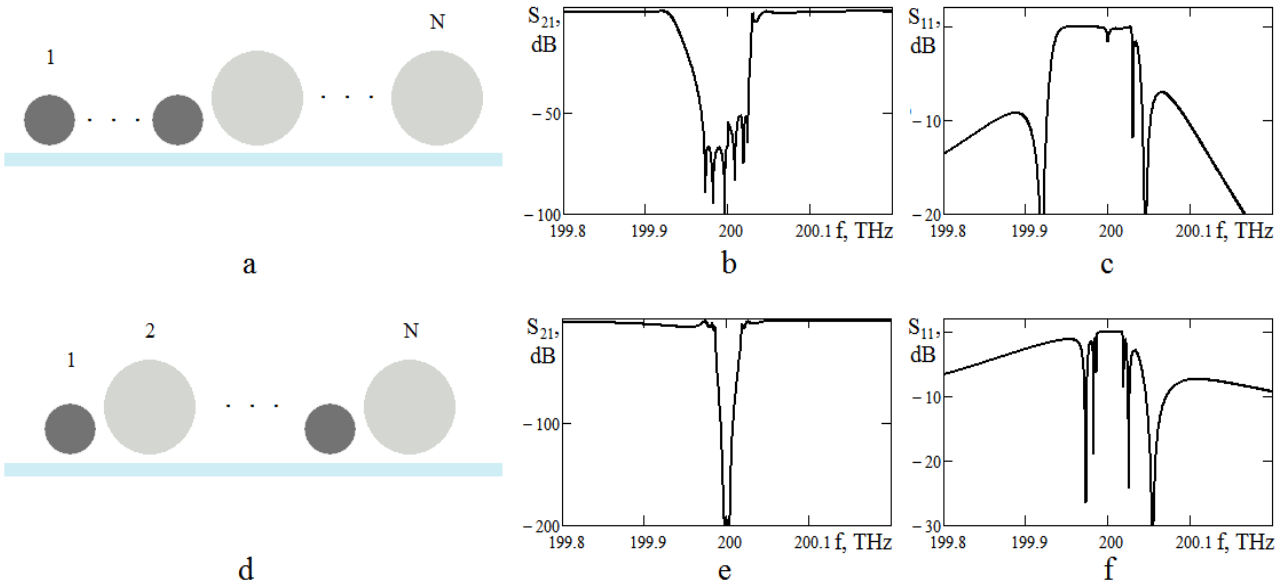

Fig. 1. Bandstop filters on different disk microresonators (a, d).
S-parameter responses of the 9-section filters as functions of the frequency (b - c, e - f). Parameters of the first type resonators: $\varepsilon_{1r} = 16$; $Q_1^D = 10^6$; the parameters of the second type resonators: $\varepsilon_{2r} = 9{,}6$; $Q_2^D = 2 \cdot 10^6$.

Using previously obtained relationships, we present the results of the study process of the scattering of electromagnetic waves on the different structures of disk microresonators. It's assumed that all the microresonators are excited by the magnetic type $HE^{+}_{1,m,1}$ of natural oscillations.

The fig. 1 show bandstop filter scattering parameters, that are buildings up on different disk microresonators. The mutual coupling coefficients was calculated from early obtained relationships. Since all microresonators exchange energy by waves propagating on the transmission line, this leads to an asymmetry of the frequency distribution of the reflection and transmission coefficients (fig. 1, b-c, e-f).

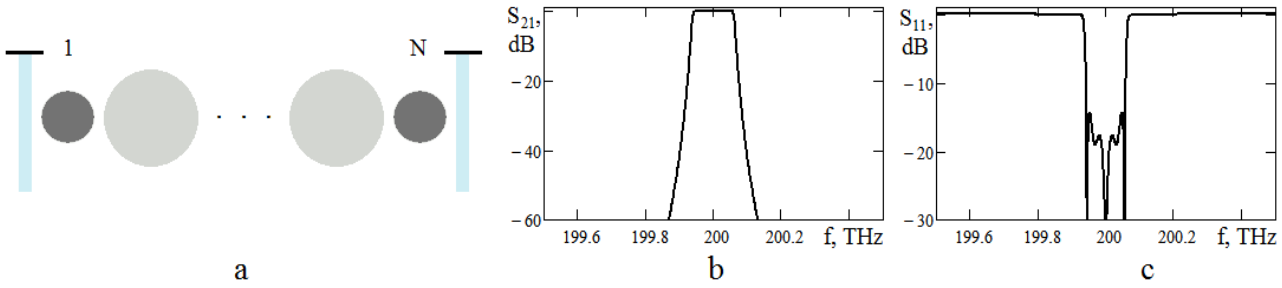

Fig. 2. Bandpass filter on laterally coupled different disk microresonators (a). S-parameter responses of the 7-section bandpass filter on $HE^{+}_{1,m,1}$ mode as functions of the frequency (b - c). The coupling coefficients of the terminal resonators with transmission lines: $k_L = 7 \cdot 10^{-4}$; the 1th and the Nth microresonator parameters: $\varepsilon_{1r} = 16$; $Q_1^D = 10^6$; $m = 20$; another resonator parameters $\varepsilon_{2r} = 9,6$; $Q_2^D = 2 \cdot 10^6$; $m = 24$.

The fig. 2-4 show results of the calculation of S-parameters of the bandpass filters. Proposed, that the coupling coefficients of terminal microresonators k_L with transmission lines are known.

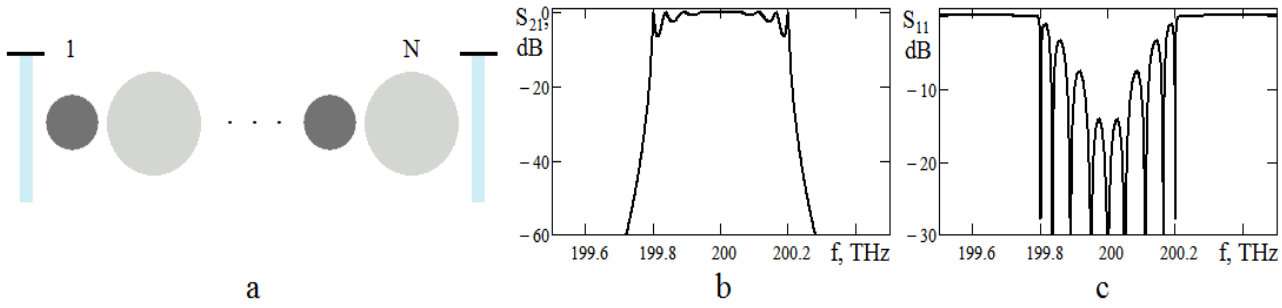

Fig. 3. Bandpass filter on repeating different disk microresonators (a). S-parameter responses of the 9-section bandpass filter with $HE^{+}_{1,m,1}$ mode as functions of the frequency (b - c). The coupling coefficients of the terminal resonators with transmission lines: $k_L = 9,0 \cdot 10^{-4}$; the odd microresonator parameters: $\varepsilon_{1r} = 16$; $Q_1^D = 10^6$; the even microresonator parameters: $\varepsilon_{2r} = 9,6$; $Q_2^D = 2 \cdot 10^6$.

It's seen, that in consequence of rapidly coupling coefficients decreasing, all bandpass filter S-matrix parameters are symmetrical functions on the frequency (fig. 2-4, b-c).

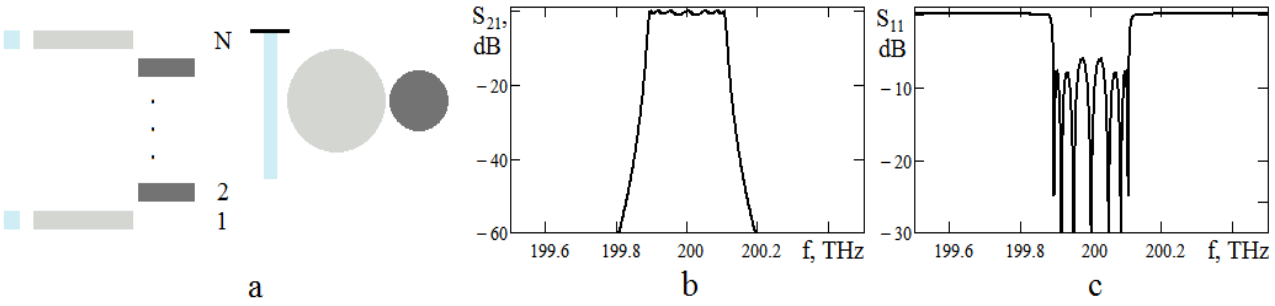

Fig. 4. Bandpass filter on vertically coupled disk microresonators (a). S-parameter responses of the 7-section bandpass filter with $HE^{+}_{1,m,1}$ mode as functions of the frequency (b - c). The coupling coefficients of the terminal microresonators with transmission lines: $k_L = 5 \cdot 10^{-4}$.

Thus, the use of different microresonators can greatly enhances design filters. As shown by preliminary calculations, the developed electrodynamic model correctly describes the scattering processes in the systems of different microresonators with WGM.

Despite the absence of the screen, the bandpass filters on WGM microresonators has acceptable frequency responses and maybe recommended for utilization on multiplexing of various communication systems of the optical and infrared wavelength ranges.

References

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