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BANDPASS FILTERS ON DIFFERENT SPHERICAL DIELECTRIC MICRORESONATORS

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СМУГОВІ ФІЛЬТРИ НА РІЗНИХ ДІЕЛЕКТРИЧНИХ МІКРОРЕЗОНАТОРАХ СФЕРИЧНОЇ ФОРМИ

Досліджуються характеристики розсіювання смугових фільтрів, побудованих на відмінних за розмірами та діелектричної проникністю діелектричних мікрорезонаторів сферичної форми. Знайдені структури мікрорезонаторів та типи коливань, які добре реалізують різні смуги пропускання.

Today, microresonators with whispering gallery oscillations are unique elements of a number of devices in the optical wavelength range [1, 2]. Using of different microresonators in some cases significantly improves filter scattering parameters. In this report, we investigate the scattering characteristics of bandpass filters constructed on the basis of different spherical microresonators with whispering gallery oscillations.

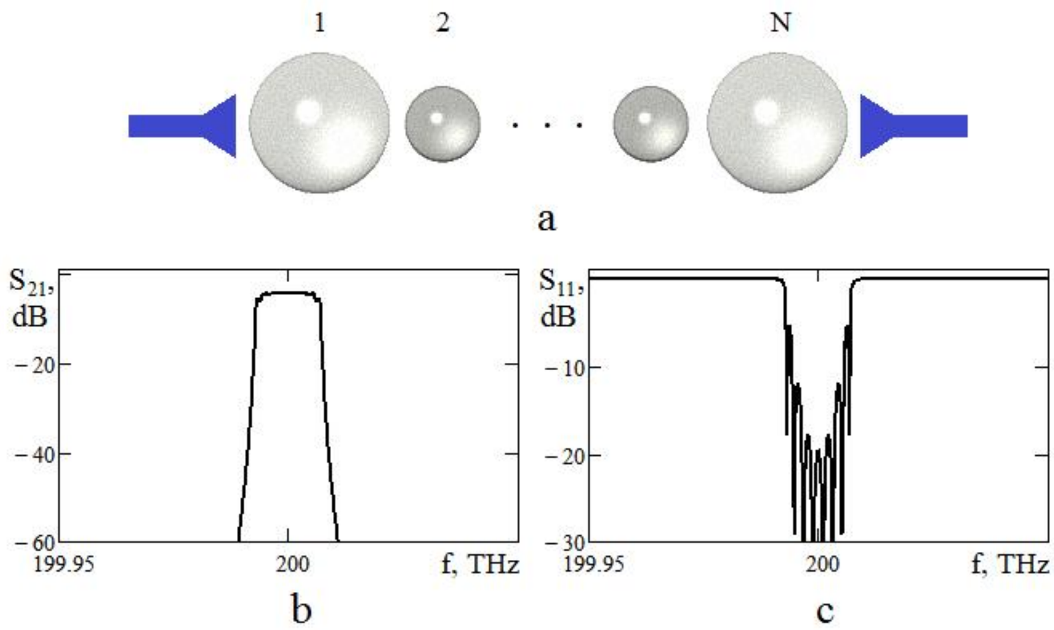

Fig. 1. Bandpass filter on different Spherical microresonators with azimuthally symmetric magnetic modes H_{n01} (a). S-matrix parameters as functions of frequency (b, c) of the filter (a) on 8 ($N=8$) microresonators: ($\varepsilon_{1r}=9$; $\varepsilon_{2r}=16$; $n_1=24$; $n_2=22$; $m_1=m_2=0$; $l_1=l_2=1$).

Using the relations obtained earlier for the coupling coefficients [3], we constructed the electrodynamic models [4] of the filters shown in Fig. 1, 2, 4, a.

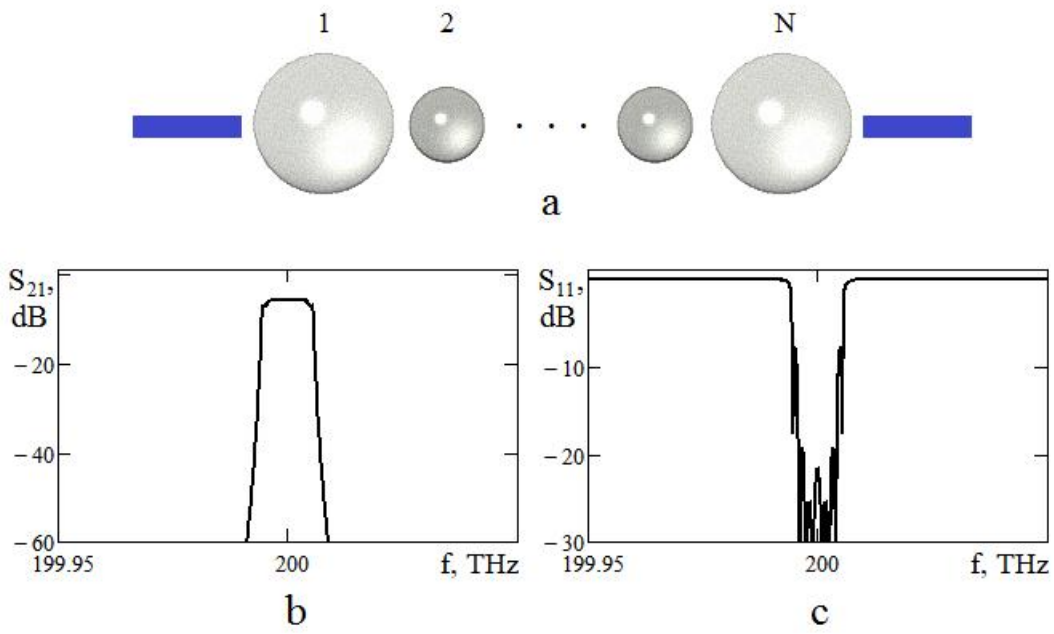

Fig. 2. Bandpass filter on different Spherical microresonators with magnetic modes H_{n11} (a). S-matrix parameters as functions of frequency (b, c) of the filter (a) on 8 ($N=8$) microresonators: ($\varepsilon_{1r}=9$; $\varepsilon_{2r}=16$; $n_1=24$; $n_2=22$; $m_1=m_2=1$; $l_1=l_2=1$).

The placement of the input and output transmission lines (for example the optical waveguides or tapered fibers) corresponds to the maximum coupling between it and the microcavity for a given type of oscillation. It was assumed that each of these filters contains elements of coupling with the transmission lines that allow exciting non-degenerate types of oscillations in each of the resonators with a given value of the azimuthal number m. It was also assumed that the coupling coefficients k_L of the first and last microresonators with transmission lines are known. The losses

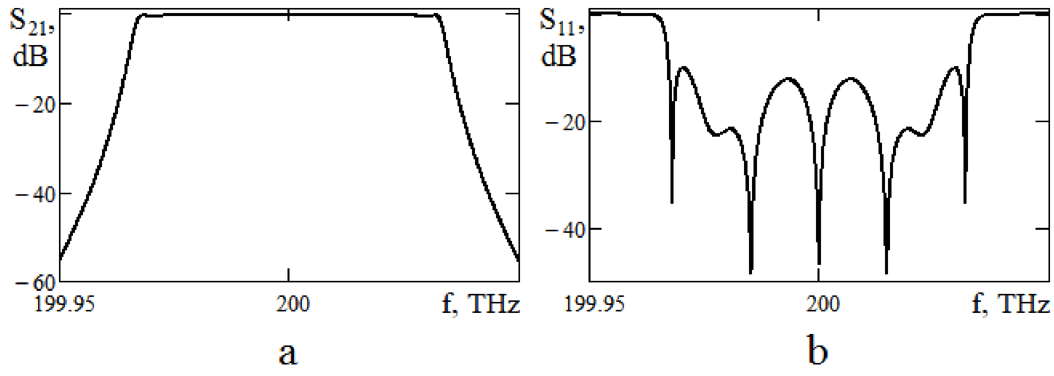

Fig. 3. Frequency responses of S-matrix parameters (a, b) of the bandpass filter on 9 microresonators with electrical E_{n11} modes: ($\varepsilon_{1r}=9$; $\varepsilon_{2r}=16$; $n_1=24$; $n_2=22$; $m_1=m_2=1$; $l_1=l_2=1$).

in the dielectric of each of the resonators were characterized by numbers: $Q_1^D = 1/\mathrm{tg}\delta_1 = 10^6$; $Q_2^D = 1/\mathrm{tg}\delta_2 = 2\cdot 10^6$. It was assumed too, all the resonators were not shielded and their radiation was taken into account in the open space.

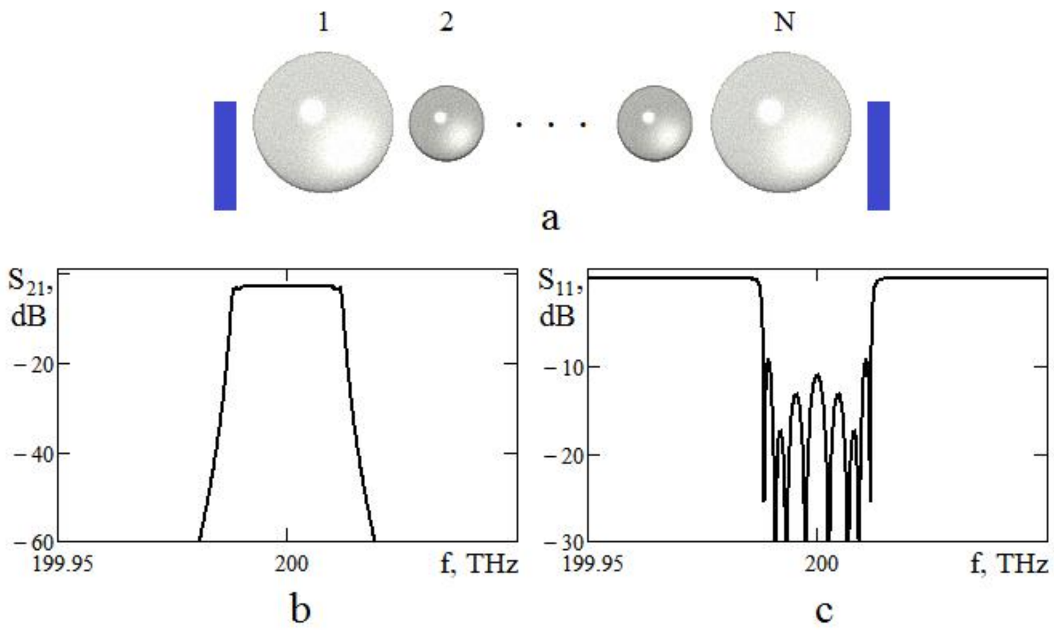

Fig. 4. Bandpass filter on different Spherical microresonators with magnetic H_{mm1} modes (a). S-matrix parameters as functions of frequency (b, c) of the filter (a) on 8 microresonators: ($\varepsilon_{1r} = 9$; $\varepsilon_{2r} = 16$; $m_1 = m_2 = 24$; $l_1 = l_2 = 1$).

The frequency responses of the scattering coefficients of the tuned filters for different types of whispering gallery oscillations are shown in fig. 1-4, b, c.

As can be seen, the use of different types of microcavities in the filters makes it possible to obtain acceptable transmission bands. As noted, such filters have a significant number of advantages over the known ones, for example, they have sparse bands of parasitic oscillations and also provide more opportunities for adjusting the coupling between microcavities and transmission lines.

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