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Fano resonances in displaced and mirror-symmetric arrays of split ring resonators at sub-terahertz frequency

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Fano resonance provides an effective approach to realize high quality factor with the suppressed radiative loss which underpins concepts of many switching, filtering and sensing devices in photonics [1]. Fano resonance originates when two different resonances, the so-called "bright" and "dark" modes are in superposition. The dark mode is usually obtained by breaking the symmetry in the individual split-ring resonators (SRRs). In this work, we investigate alternative approaches for generating single and multiple Fano resonances in periodic single-gap SRR structures.

We find that the lattice mode in a periodic array of SRRs can play a role of the "dark" mode. In mirror-symmetric SRR array (Fig. 1a), the lattice mode is overlapped with the third-order plasmonic mode of individual SRRs thus giving rise to Fano-type resonance [2]. The quality factor as large as 100 is extracted from the measured results and close to 500 from the simulation.

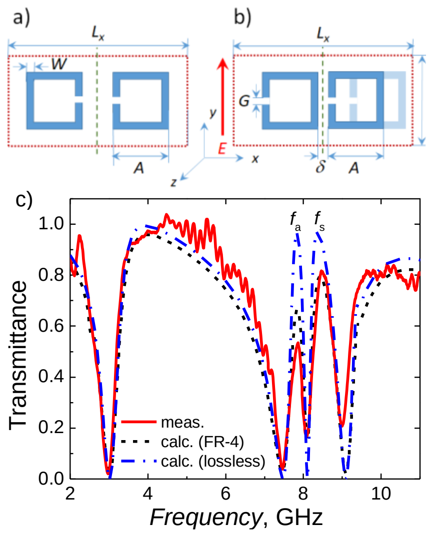

Fig. 1. a) mirror-symmetric array, b) displaced array, c) transmittance of displaced array.

We show that the two Fano resonances, symmetric (f_s) and asymmetric (f_a) appear in the transmittance spectrum (Fig. 1c) as every second column is displaced in a regular array of SRRs (see Fig. 1b, where W = G =1 mm, A = 10 mm, L_x = 2L_y = 16 mm, δ = 0.5 mm). These two resonances are based on the lattice mode, however are of different origin and are differently sensitive to the SRR displacement and the substrate losses [3]. Differences between the two resonances are explained by analysis of the surface current magnitude and phase with respect to the phase of the incident electric field at the plane of SRRs. We observe that at frequency points of almost total reflection and total transmission the phase of the current differs by 90°, which confirms the idea [1] that Fano effect is an interference phenomenon.

Our work aims to provide a deeper understanding of the physics of single and multiple Fano resonances in metasurfaces in the range from several GHz to several hundred of GHz.

REFERENCES

[1] M. F. Limonov, *Adv. Opt. Photonics* **13** (2021) pp. 703–771.

[2] D. Seliuta, G. Šlekas, G. Valušis, and Ž. Kancleris; *Opt. Lett*. **44** (2019) pp. 759–762.

[3] D. Urbonis, P. Ragulis, G. Šlekas, A. Kamarauskas, D. Seliuta, and Ž. Kancleris; *J. Appl. Phys*. **134** (2023) art. no. 133102.