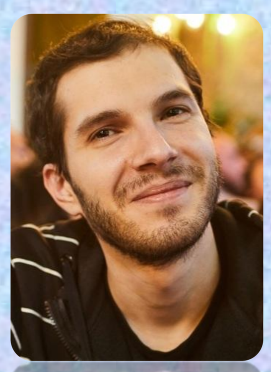
20th Asia-Pacific Conference on Fundamental Problems of Opto- and Microelectronics (APCOM-2022),
Vladivostok, Russia, October 2-6, 2022

DISPERSION RELATIONS AS A METHOD FOR STUDYING THE OPTICAL PROPERTIES OF METASURFACES

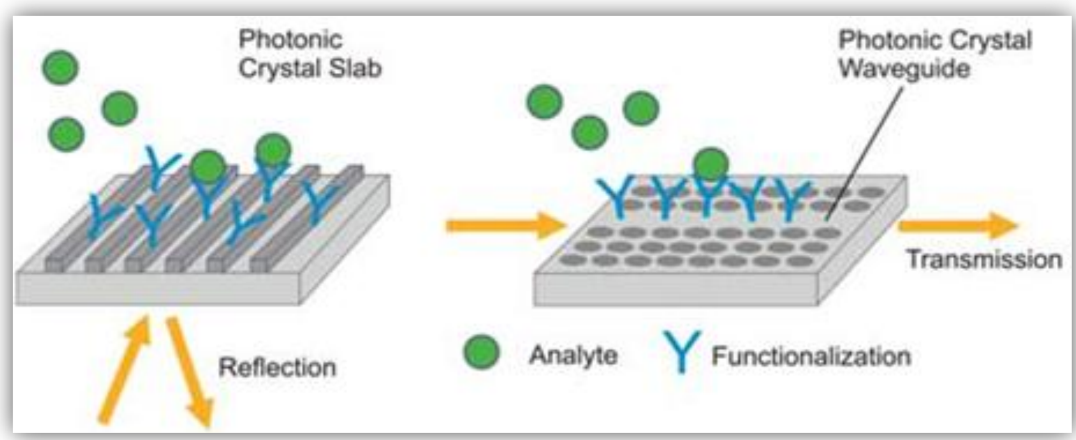




A.F. Valitova, A.R. Gazizov, M.Kh. Salakhov

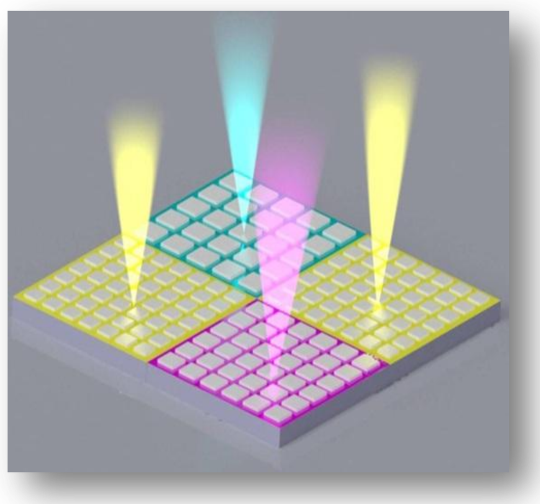
Kazan Federal University, Kazan, 420008, Russia
Tatarstan Academy of Sciences, Kazan, 420111, Russia
e-mail: valaigul94@gmail.com

This paper investigates the possibility of controlling the optical properties of plasmons on the metasurface. Extensive possibilities for controlling the properties of light waves at the nanoscale by tuning the parameters of the metasurface can form the basis for creating photonic devices with improved spectral characteristics. The considered structure consists of the continuous corrugated Au metasurface supported by the opal-like photonic crystal. The interaction of optical Tamm states of an opal-like crystal with surface plasmons results in optical modes* that exhibit polarization sensitivity. We also study these mode from the perspective of dispersion. The specific behavior of dispersion curves obtained in the numerical simulation open the way to control the dispersion of these modes as well. The result of our study is the obtained dispersion relations for the corrugated Au metasurface.

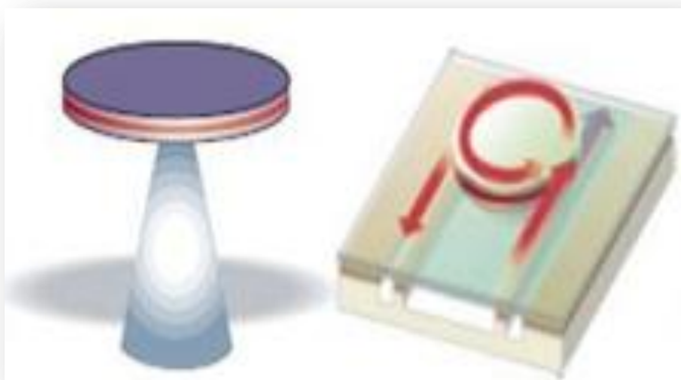
Relevance:



Biosensors **[1]**



Transmissive color filters **[2]**



Photonic integral schemes **[3]**

Strong interaction of light with matter **[4]**

In this paper, dispersion relations are demonstrated for varying structural and geometric parameters for a corrugated Au metasurface as one of the most effective methods for studying the surface properties of structures. Results are presented on the detection of hybrid modes in the band gap of a PC that are sensitive to changes in the polarization of light. The polarization sensitivity of the corrugated structure arises from the excitation of a localized surface plasmon mode. These results contribute to the development of sensitive sensors based on surface plasmon resonance in the structures under consideration.

We have established that additional extraordinary optical modes appear in the metasurface, the dispersion of which can be controlled. The presence of periodicity leads to the appearance of additional modes in the high-frequency region, similar to the existing low-frequency modes.

Model Description:

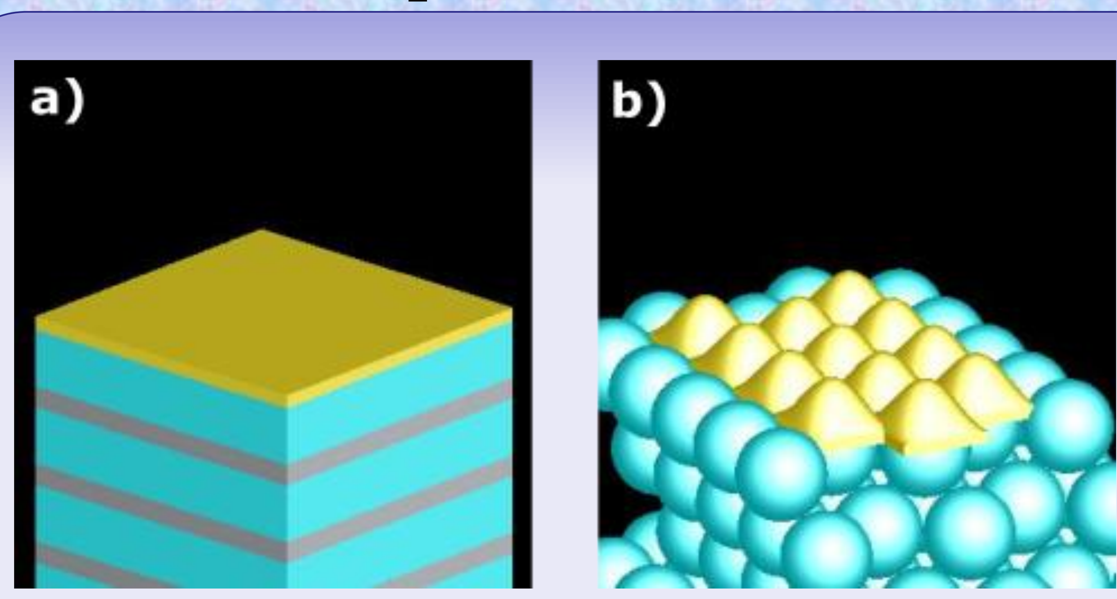


Fig. 1. Schematic representation of HPPC with a 40 nm Au layer: a) 1D PC with a flat Au layer; b) 3D HPPC with a corrugated Au layer

***The existence of a new hybrid plasmon-like mode, consisting of the Tamm and surface modes in three-dimensional structures, we showed in earlier works **[5]**, **[6]**.

Simulation results:

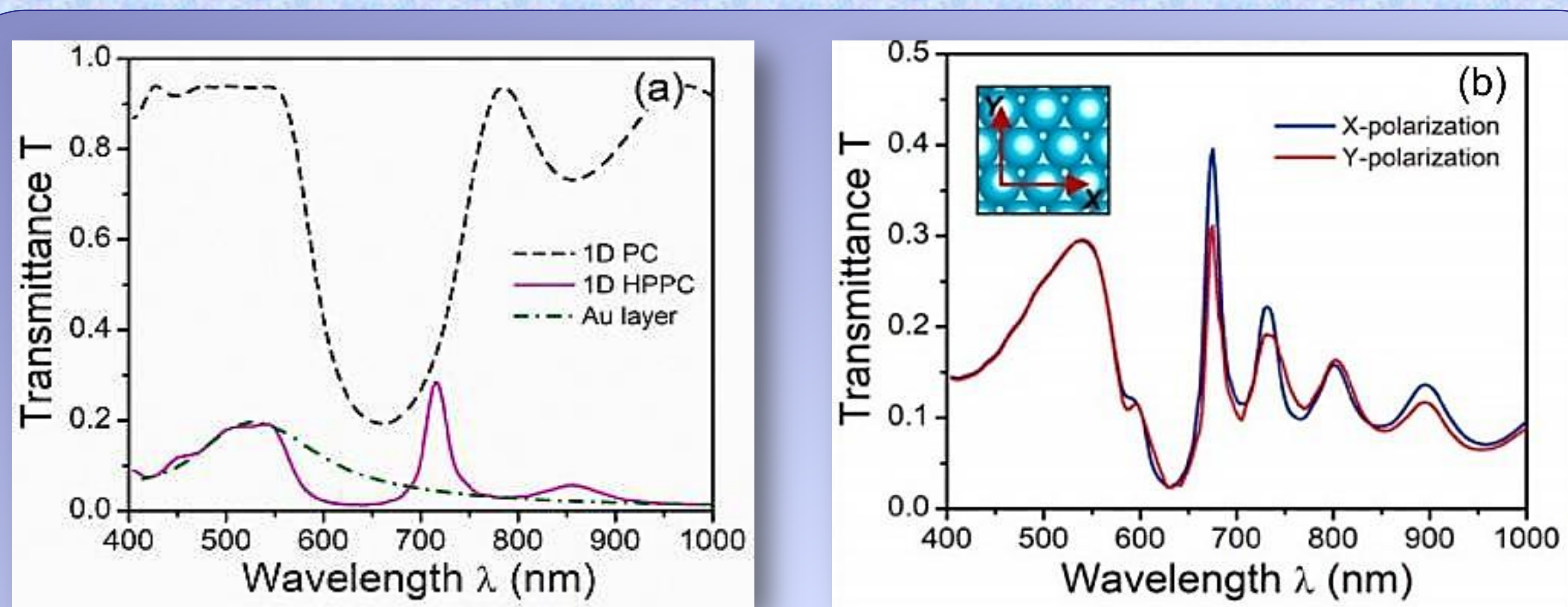


Fig. 2. (a)Transmission spectrum of the 1D HPPC compared with the spectra of the 1D PC and the standalone flat Au layer of the same thickness (d = 40 nm); (b) Transmission spectra of 3D HPPC structure for X- and Y-polarization at normal light incidence with the 40 nm corrugated Au layer **[7]**

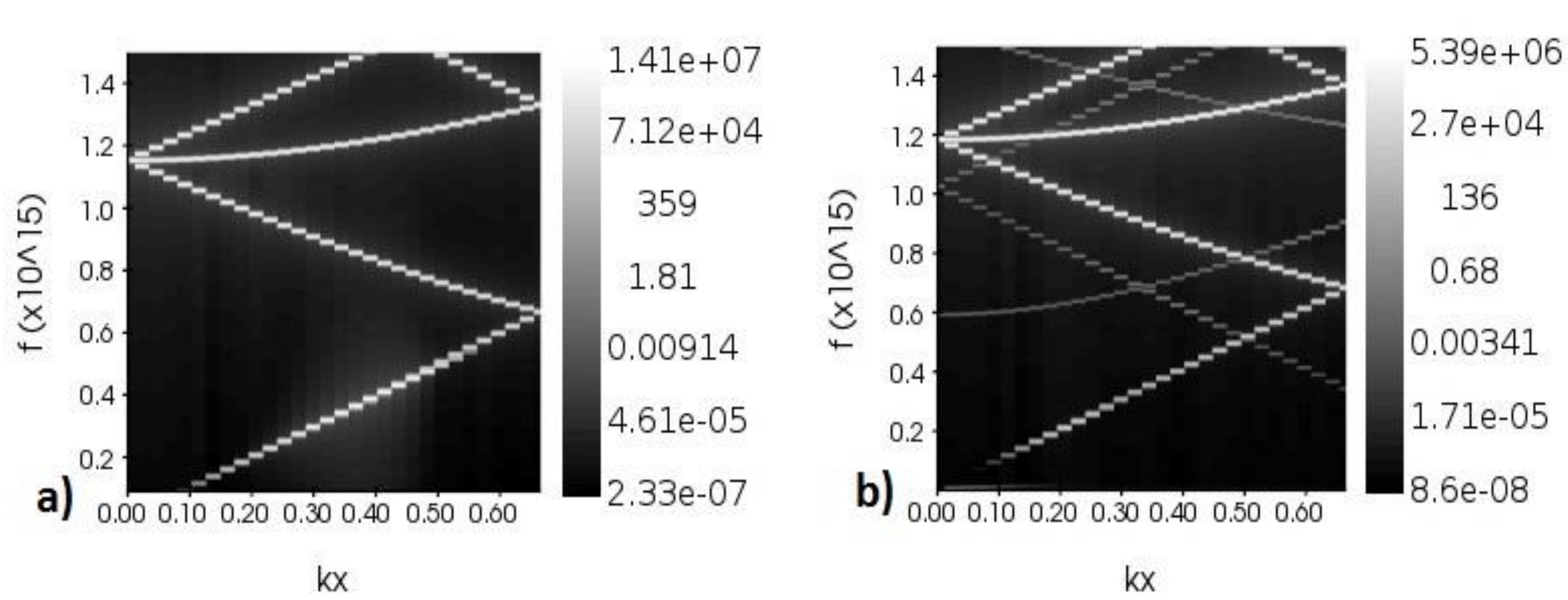


Fig. 3. Dispersion relations (a) for a flat Au metasurface and (b) for a corrugated Au metasurface with a layer thickness of 40 nm

The practical significance of this work is to demonstrate the expansion of the functional capabilities of optical materials based on colloidal PCs with different shapes of the surface layer.

References:
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