Giant Second-Harmonic Generation Enhancement in the Presence of Tamm Plasmon-Polariton

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Tamm plasmon polariton (TPP) is an optical analogue of an electronic density localization at the boundary of periodic atomic potential and appears as electromagnetic field localization at the boundary of photonic crystal (PC) and metal [1, 2]. Contrary to the well-known surface electromagnetic waves and surface plasmon-polaritons, TPPs do not require phase-matching conditions for the tangential component of wave vector and can be excited at any angle of incidence. Experimentally, TPPs manifest themselves as narrow resonances in reflectance or transmittance spectra of metal/PC systems. Recently TPPs were proposed to be used in new types of compact lasers and sensors [3, 4, 5].

Enhancement of the second harmonic generation (SHG) due to electromagnetic field localization was explored in details in photonic crystals and in thin metal films in case of surface plasmon excitation. Thus the idea of second-harmonic generation enhancement straightforwardly follows the localization of the electromagnetic field in case of TPP excitation.

The studied samples consist of 6 pairs of ZrO_2/SiO_2 (average thicknesses 110 nm and 145 nm, respectively), covered with a semitransparent 30-nm-thick gold film. Fundamental wavelength was tuned in the range of 720–800 nm. Pump pulse fluence at the sample was about 100 $\mu J \cdot cm^{-2}$.

Figure 1 represent SHG spectra of the Au/PC sample for the *pp* (black squares) and *ps* (blue circles) combinations of fundamental and second-harmonic radiation polarization. Spectrum for *ps* combination is multiplied by the factor of 20. Both spectra demonstrate resonance near 774 nm. For *pp* combination SHG is permitted and enhancement of the local field in the vicinity of the TPP resonance leads to the increase of the SH intensity by a factor of 240 compared to the intensity level far from resonance. Appearance of the peak in forbidden *ps* combination can be interpreted as a result of hyper Rayleigh scattering due to roughness of the gold surface.

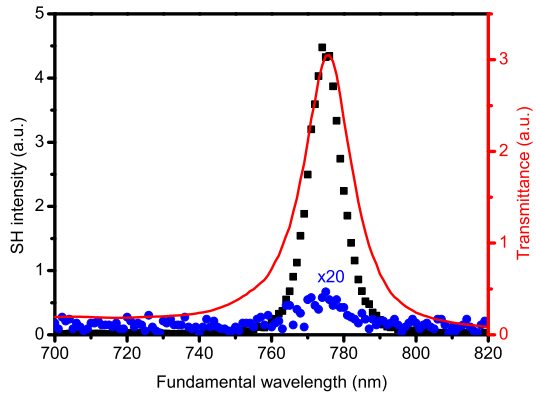

Fig. 1: (Color online) Solid red curve — experimental transmittance spectrum of the Au/PC sample. Black circles — experimental SH spectrum of the Au/PC sample in *pp* geometry. Blue triangles — experimental SH spectrum of the Au/PC sample in *ps* geometry multiplied by 20.

References

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