Book of abstracts

PHOTONICA2019

The Seventh International School and Conference on Photonics, 26 August – 30 August 2019, Belgrade, Serbia

& Machine Learning with Photonics Symposium (ML-Photonica 2019)

& ESUO Regional Workshop

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Editors: Milica Matijević, Marko Krstić and Petra Beličev

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Broadband enhancement of light harvesting and photocatalytic devices

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Stochastically roughened surfaces of plasmonic materials can provide field enhancement under irradiation by visible light due to the appearance of surface plasmon polaritons (SPP) [1, 2]. The stochastic surface profile acts as a superposition of diffraction gratings with different grating constants, which ensures a broadband coupling between propagating and surface modes [3]. There are various materials that can be used for the mentioned purpose, including noble metals such as gold or silver and, alternatively, doped transparent conductive oxides (TCO).

We considered the structure with a roughened metallic film on the bottom and a roughened TCO glass layer on the top, separated by a thin dielectric layer. We fabricated experimental structures and simulated them by the finite element method. Thus, we verified that the combined influence of two rough films significantly improves light trapping within the dielectric layer between them while plasmonic effects lead to concentration of electromagnetic field into volumes much smaller than a single wavelength. Consequently, the radiation intensities are proportionally increased, even for several orders of magnitude, compared to the incident beam. Another interesting property observed is that the structure continues to act as a diffractive light trap well into the UV region and simultaneously as a plasmonic superabsorber for IR light, turning the increase of TCO opaqueness with wavelength into a benefit since it significantly expands the useful spectral range. Tuning of dopant levels in TCO or using different metals or alloys together with varying coarseness of the films can further be used to tailor the electromagnetic response.

The proposed structure can be utilized for a vast majority of photocatalytic systems, for the enhancement of light harvesting devices regardless of their type as well as for ultrasensitive chemical sensing [4-6]. The small distance between the two metal films ensures that practically the whole region between metal and TCO is the area of enhanced evanescent field allowing for ultrathin devices. This is particularly beneficial for light harvesting devices as it increases their sensitivity while reducing the materials consumption and thus the device cost while at the same time it utilizes one transparent (TCO) and one opaque (metal) electrode of the kind already present in a majority of solar cells. Similar conclusions on materials consumption can be drawn for photocatalytic devices, only instead of the active region there is a microreactor channel.

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