Study of surface plasmon polarization conversion with Au surface-relief gratings

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The effect of polarization conversion (PC) caused by excitation of surface plasmons on metal gratings was studied in many theoretical and experimental works. However, these studies mainly concerned the samples with spatial period (d) greater than the excitation wavelength (λ). Here we report the results of experimental studies of plasmon-stimulated PC for Au gratings with different d/λ ratios and different relief depth (h).

The samples were prepared by interference lithography based on chalcogenide glass photoresist ($As_{40}S_{40}Se_{20}$). After exposure of $As_{40}S_{40}Se_{20}$ layer by interference pattern formed with a He-Cd laser, the samples were chemically treated to form gratings with desired characteristics. The gratings were coated by vacuum thermal evaporation with thin MgF_2 layer, then with opaque (80 – 100 nm) Au layer. Prepared samples were characterized morphologically using a Dimension 3000 Scanning Probe Microscope.

The PC efficiency was characterized by the ratio (R_{ps}) of the intensity of the S-polarized component in the specularly reflected light to the intensity of the incident P-polarized radiation of the He-Ne laser (λ = 632.8 nm). Investigation of R_{ps} as a function of the incidence angle (θ) and/or the azimuth angle (φ) was carried out on an optical stand mounted on the basis of the G5M goniometer.

It has been established that for low frequency gratings with $\lambda/d < \sqrt{2}$ the maximum of R_{ps} is reached at $\varphi \approx 45°$ and is determined by the grating modulation depth (h/d). When increasing the ratio h/d of such grating to 0.14, the value of R_{ps} increases monotonously. However, for high-frequency gratings (for which λ/d is close to 2), the R_{ps} value is an order of magnitude smaller than the corresponding values for low-frequency gratings with the same h/d. This may be due to the fact that for high-frequency grating surface plasmon and, respectively, R_{ps} are excited at large incidence angles ($\theta > 60°$).

Efficient and stable hybrid solar cells of nanostructures and bulk heterojunction Organic semiconductors

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The research and development in the field of organic photovoltaic have gained huge research interests recently. The organic solar cells have exhibited a power conversion efficiency (PCE) up to 12 % . Organic solar cells (OSCs) are very economical to produce by very cost effective and low temperature based chemical processes. In addition, OSCs can be fabricated as thin flexible films and hence require less amount of raw materials. However, OSCs have to overcome the two very important challenges before they can be commercialized: 1) power conversion efficiency (PCE) is still relatively lower than their inorganic counter parts, e.g., silicon solar cells and 2) poor stability or the problem of degradation with prolong exposure to sunlight. The problem 1 is being tackled with the structure of bulk heterojunction (BHJ) and gradually PCE of OSCs is increasing close to 12% . However, the problem of stability is less rigorously studied. As most organic materials degrade with long exposure to solar radiation, only possible solution appears to be the use of hybrid structure with inorganic materials.

This paper presents simulation of a hybrid structure of BHJ OSC with structure Glass/ITO/ PEDOT:PSS/PBDT-TS1:PCBM/Al and CZTS quantum dots (QDs) producing the hybrid cell with structure: Glass/ITO/ PEDOT:PSS/CZTS-QDs:PBDT-TS1:PCBM/Al. This structure with the incorporation of varying size of 11 CZTS QDs enhances the absorption and hence PCE to 16%. An improvement in stability is obtained by incorporating super-hydrophobic ZnO nanowires (NW) which also absorb the UV radiation before solar radiation reaches the active layer and hence increase the stability. The simulated proposed structure thus becomes ZnO-NW/Glass/ITO/ PEDOT:PSS/CZTS-QDs:PBDT-TS1:PCBM/Al and it also enhances PCE further to 16.9%. A detailed discussion on the proposed structure and resulting advantages will be presented in this talk.

Surface plasmon resonance in As_2Se_3 planar waveguides for the IR spectral region

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The solid amorphous materials have some specific optical properties who cannot be finded in the crystalline state. One of the main phenomenon is photo-induced modification of optical constants (n, k), which can be used in various optoelectronic devices. Unfortunately, the changes, though largely dependent on the material, are not very large. This fact limits in many cases possible applications. An efficient solution to the problem consists in achieving a resonance structure, when small changes in optical constants lead to a considerable change in transmission or optical reflection. Such a structure would be the surface plasmon resonance, usually realized in Kretschmann configuration. So, the illumination of the As2S3 films in conditions of surface