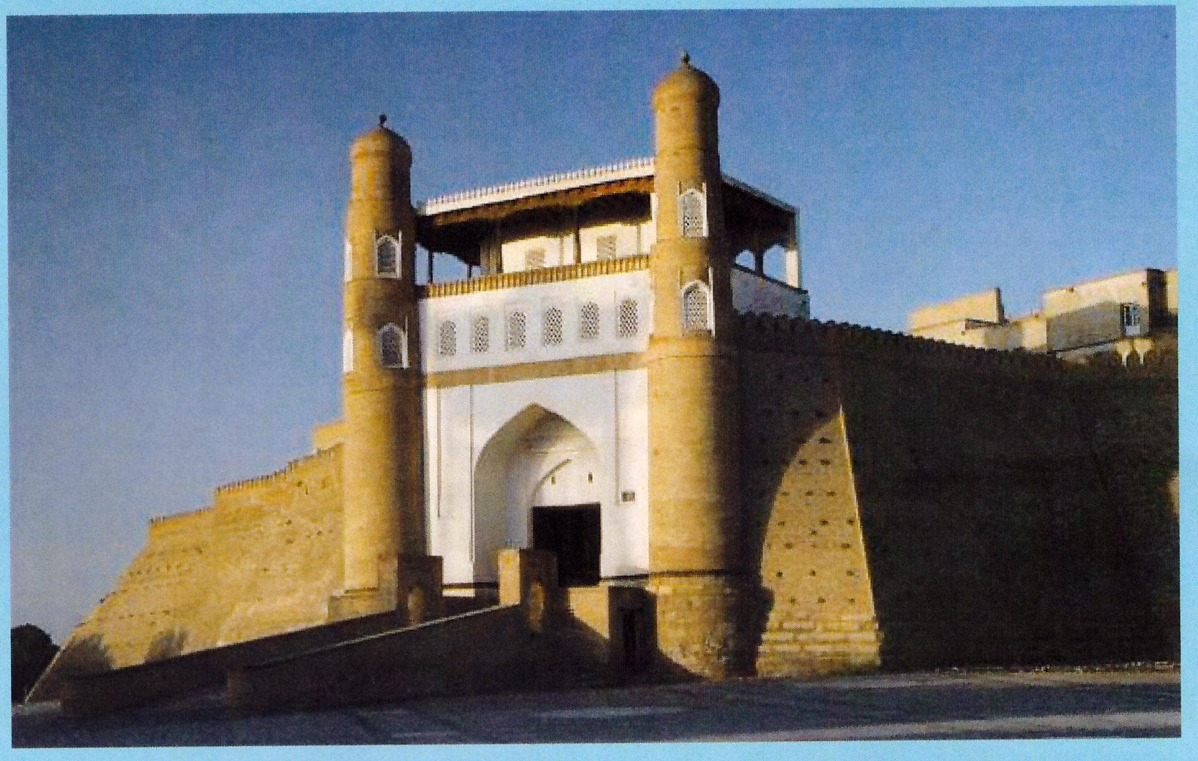
Recent Advances in Photovoltaics:

Novel materials and device concepts for flexible and thin-film solar cells



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Optical absorption properties of organometal perovskites with different iodine and bromine content

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Optical properties of organometal halide perovskites with different halogen content obtained by a two-step deposition from solution were investigated. The optical absorption data indicate an enhancement of the excitonic transition for the bromine-based perovskites in comparison with iodine-based ones. The band gap and exciton binding energy increase for the samples with larger ratio of the bromine content to the iodine one.

Obtained films exhibit a perovskite structure ABX_3 with methylammonium as cation A and lead as cation B. The halogen content was varied from iodine ($CH_3NH_3PbI_3$), mixed halide ($CH_3NH_3PbI_{2.75}Br_{0.25}$) to pure bromine ($CH_3NH_3PbBr_3$). The first stage of the synthesis consisted of deposition of PbI_2 for iodide and mixed perovskites and $PbBr_2$ for bromide-based perovskite dissolved in N,N-Dimethylformamide (DMF) at a concentration of 400 mg/ml. The second deposited substance was CH_3NH_3I and a mixture of CH_3NH_3I and CH_3NH_3Br, $CH_3NH_3Br_3$, for iodide, mixed and bromide perovskites respectively. The solvent in all three cases was isopropanol. The deposition processes was followed by spin-coating and films drying. Finally the films were annealed for 90 min at 100° C. All the processes were conducted in a dry box in nitrogen atmosphere.

Optical transmission spectra of the prepared perovskite films were measured by using a spectrophotometer V-605 Research UV-Vis. The measurements were carried out in air at room temperature. The absorption coefficient was calculated from the experimental transmission spectrum by assuming the optically homogeneous medium with constant reflection. The absorption coefficient spectra are fitted by a model, which considers two interband transitions. The first interband transition with lower band gap energy is a direct-allowed and the second one is a direct-forbidden. An analysis of the band gap values shows that the bromide-based perovskite has larger band gap and the complete replacement of iodine to bromine leads to an increase of the direct band gap from 1.65 eV to 2.4 eV.

The exciton peak in the absorption spectrum was found to be particularly notable for $CH_3NH_3PbBr_3$. An approximation of the exciton peak allows us to estimate the exciton binding energy, E_{ex}, which is of the order of 10 and 20 meV for $CH_3NH_3PbI_3$ and $CH_3NH_3PbBr_3$ respectively. The larger value of E_{ex} for the latter can be explained by an

enhancement of the exciton interaction in the material with a smaller ionic radius. The increase of the perovskite band gap with changing of the iodine and bromine ratio can be used to create tandem solar cells.

Influence of the island films of silver on the spectral-luminescent and photovoltaic properties of poly(3-hexylthiophene)

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An increasing interest for the nanocomposite materials based on organic polymer semiconductor and metal nanoparticles observed in recent years. Interest in these materials is related to the possibility of increasing of the efficiency of photovoltaic and sensory properties of semiconducting conjugated polymers by using surface plasmon resonance effects.

Poly(3-hexylthiophene) (P3HT) is a model semiconducting conjugated polymer. P3HT is used for producing of organic solar cells with bulk heterojunction. This interest is conditioned by the fact that P3HT posess high hole conductivity and high absorption capability in the visible spectrum. Spectral-luminescent and photovoltaic properties of semiconductor polymer films of P3HT on the surface of Ag island films were studied.

Films were deposited onto quartz substrates with thermal evaporation of the silver in vacuum chamber at residual pressure equal to $P=5\cdot10^{-4}$ mm Hg. Further films were annealed in a muffle furnace at temperatures between 60 °C and 240 °C. The growth of the temperature leads to decreasing of size and increasing in number of Ag islands. The size of the islands ranges from 40 nm to 90 nm. An absorption spectra of silver films shows that at thermal treatments short-wavelength shift of maximum plasmon resonance band, significant decreasing of half-bandwidth and increasing of intensity of absorption band occurs with increasing in annealing temperature from 60 °C up to 240 °C.

P3HTpolymer films were prepared by spin-coating. Increasing in the optical density of P3HT takes place in polymer films deposited onto Ag films. Maximum increasing in the optical density of the P3HT film (in ~ 4 times) was observed on silver film that was annealed at 240 °C.

Fluorescence spectrum of the P3HT film is a broad band with maximums at wavelengths at 572, 642 and 708 nm [1]. Change in the spectrum shape and redistribution intensity of fluorescence peaks is observed in the P3HT films on the surface of Ag films. The fluorescence intensity at 572 nm increases and the intensity of other peaks is significantly reduced. Increasing of absorption and fluorescence intensity of the P3HT is