Preliminary studies of test structures for Si/NRs/AZO photocells

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Recent studies have shown that the structures of Si/NRs/AZO are promising for photovoltaic applications [1]. It has been also widely accepted, that metallic nanoparticles can increase the efficiency of energy transfer in solar cells. The study presented in this paper is an attempt to apply this idea in order to improve the efficiency of the Si/NRs/AZO structures.

The subject of investigations are test structures for photovoltaic applications based on n-type zinc oxide nanorods grown by a low temperature hydrothermal method on p-type silicon substrates (100) The ZnO nanorods were covered using a sputtering method with Ag nanoparticles of two different diameters: 20-30nm and 50-60nm.

The structures have been investigated in terms of their morphology which has been analyzed with the use of SEM and AFM spectroscopy. From the AFM measurements the diameters as well as surface density of nanoparticles have been determined. The latter data are in agreement with the those obtained from the SEM images. Both AFM and SEM images confirm that the deposited nanoparticles have their diameters close to the sizes of applied nanoparticles. The AFM results yield however that the larger nanoparticles coalesce whereas the smaller ones are well separated. The density of the deposited nanoparticles was evaluated from the AFM topography to be ~$2x10^{13}$ m^{-2} for the larger and ~$2.6x10^{13}$ m^{-2} for the smaller ones.

In order to verify the transmittance of the structures with nanoparticles another set of the test samples composed of glass/Ag/AZO and glass/AZO/Ag/AZO were also prepared. For these samples optical spectra (transmission and reflection) were measured in the 300–1800 nm wavelength range using the PVE300 Characterisation System (Bentham). The optical measurements revealed that the samples with smaller nanoparticles exhibit higher transmittance within measured wavelength range, however their spectra show also a minimum around 600nm not observed for the other samples. It seems that the transmittance is slightly higher in the case of the glass/AZO/Ag/AZO samples.

These preliminary results let us conclude that the measured films may be prospective for photovoltaic applications.

[1] R.Pietruszka et al. Photovoltaic properties of ZnO nanorods/p-type Si heterojunction structures, Beilstein Journal of Nanotechnology, No. 5, s. 173–179 (2014). http://dx.doi:10.3762/bjnano.5.17