Gold Nanoparticles Arrays in CdS Matrix: Fabrication and Properties

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The CdS/CdTe thin-film solar cells (SC) are among top commercial thin-film cells. The world largest photovoltaic 550 MW power station "Topaz Solar Farm" (USA) includes 9 million of the CdTe thin-film photovoltaic modules. Nevertheless CdS/CdTe SC maximal efficiency 19.6% [1] is still far from the theoretical one 28-30%. The efficiency increase can be achieved due to light scattering and absorption on metal nanoparticles (NP), and electromagnetic field amplification by means of surface plasmon (SP) excitation in active layer.

The possibility of gold NP array formation in the chemically deposited CdS thin film matrix was investigated. The gold NP array were fabricated by thermal annealing (400 ° C, 120 min.) in vacuum (P~1.3 Pa) of the Au thin films with 6-7 nm nominal thickness obtained by magnetron sputtering (Neo Coater MP-19020 NCTR, Jeol, Japan) on CdS thin (100 nm) films. The surface morphology using an atomic probe microscope was investigated. According to APM data this film consists of NP arrays in the form of oblate spheroids with a mean diameter of 61±3 nm and a mean height of 55 nm. The positions of plasmon resonance peaks at 593 nm wavelength were determined using fiber optic spectrophotometer (AvaSpec-ULS 2048-UA-50, Avantes, Netherlands). The CdS films with 100 nm thickness were chemically deposited on the fabricated Au NP arrays. Therefore the Au NP arrays in CdS thin film matrix were fabricated by subsequent CdS film chemical deposition and Au NP formation between semiconductor layers. The plasmon resonance peak shift from 593 to 604 nm in the absorption spectra has been registered.

1. Green M. A., Emery K., Hishikawa Y., Warta W., Dunlop E. Solar cell efficiency tables (version 44) // Prog. Photovolt: Res. Appl.-2014.-**22.**-P. 701–710.