Nanoplasmonics and surface enhanced spectroscopy

Electrolytically deposited Au nanoparticles for solar cell efficiency enhancement

S.V. Mamykin, M.L. Dmitruk, S.V.Sorokin, T.S.Havrylenko

V. Lashkaryov Institute of Semiconductor Physics, Natl. Acad. of Sci. of Ukraine
Nauky Ave., 41, Kyiv-03028, Ukraine
E-mail: mamykin@isp.kiev.ua

Plasmonic nanoparticles of gold and silver is widely used to enhance the interaction of light with matter. Due to the localization of energy and electromagnetic field enhancement in the vicinity of nanoparticles a significant increase in the intensity of absorption, photoluminescence, photocurrent is achieved. The actual problem is increasing of solar cells efficiency and decreasing of the cost of production particularly solved by thin filmed structures. In such cell there is a problem of low light absorption, which can be solved using plasmon active nanoparticles of Au and Ag.

One of the convenient and well-controlled way of metal nanoparticles fabrication is electrolytic deposition. The aim of this work is to optimize the electrolytic deposition of Au nanoparticles on the solar cells of surface barrier type to improve their efficiency. GaAs (100) n- type doped ~ 10^{17} cm^{-3} substrates have been used. Deposition of Au nanoparticles on the surface of substrates also leads to the formation of a potential barrier in the vicinity of which the photogenerated carriers are separated. Ohmic contacts were produced by In deposition on the back side of structure. Part of the substrates were treated to form the microrelief of quasigrating type using anisotropic etching [1]. This microrelief itself reduces light reflection. Deposition of Au nanoparticles on such relief is not only covers the whole surface but also occurred mainly on the top of the lattice grooves forming nanowires, which are not only support local plasmon excitation and surface plasmon-polariton waves [2], but also improve the collection of photogenerated carriers from the surface of solar cell. Light and dark current-voltage characteristics and short circuit photocurrent spectra in the VIS and NIR region have been studied. Significant enhancement of solar cells efficiency have been observed due to using of Au plasmon active nanoparticles and microrelief surface.

1. *Dmitruk N. L. et al.* Metal nanoparticle-enhanced photocurrent in GaAs photovoltaic structures with microtextured interfaces //Nanoscale research letters. – 2015. – **10**, N 1. – P. 72.
2. *Sosnova M. V. et al.* Local plasmon excitations in one-dimensional array of metal nanowires for sensor applications //Applied Physics B: Lasers and Optics. – 2010. – **99, N** 3. – P. 493-497.