Nanocomposites and nanomaterials

Schottky barriers based on nanoporous InP with gold nanoparticles

T.R. Barlas, N.V. Kotova, S.V. Mamykin, N.L. Dmitruk

V. Lashkaryov Institute of Semiconductor Physics, Natl. Acad. of Sci. of Ukraine.
Prospect Nauki, 41, Kyiv-03650, Ukraine.
E-mail: barlas@isp.kiev.ua

Nanocomposites "porous semiconductors with metal inclusions" and structures based on them seem to be promising for use in optoelectronics, photovoltaics and sencorics etc. due to their optical and electronic properties which are different from the bulk materials, possibility simply tuning their properties and large surface-to-volume ratio. This work is mainly devoted to the study of photoelectric properties of the Au/porous-InP structures in combination with electric ones helping to understand the photocurrent behavior.

Nanoporous InP layers with different thickness have been prepared from n-type (100) single crystals by anodization in 5% HCl electrolyte in the galvanostatic regime. Gold was incorporated in porous layer in electrochemical cell by two different techniques: from the solution of the Au salt and using spherical Au nanoparticles with SiO_2 shell. Au barrier contacts with 30 nm thickness have been deposited by thermal evaporation in vacuum. Surface morphology and pore structure have been analyzed by SEM. Photoelectric and electric properties of structures have been studied with help of short-circuit photocurrent spectra in the 0.4-0.9 μm spectral range and forward/backward I(V) and C(V) characteristics.

As confirmed by the results of the SEM studies porous layers are partially ordered systems of cylindrical cavities or embedded tetrahedrons demonstrating a horizontal-plane correlation between neigbouring pores. Depending on the parameters of anodization process the porous layer properties vary in a very wide range: porosity was from 10% to 70%, diameter of pores was in the range 50 - 200 nm and porous layer thickness was 5 - 90 m. Surface of the sample is "decorated" with metal particles, whereas the cleavage image exhibits that the metal nanoparticles also fill pores.

Deposition of the Au nanoparticles into the pores leads to photosensitivity increase of heterostructures due to increase of light absorption. Interesting effect is that Au nanoparticles in pores lead to decrease of the saturation currents and ideality factor, as we can see from the experimental forward/backward current-voltage characteristics. This can be explained by improvement of the barrier characteristics.