ELECTROPHORETIC DEPOSITION OF PALLADIUM NANOPARTICLES ON InP FOR HYDROGEN SENSORS

Jan Grym[1], Olga Procházková[1], Karel Zdánský[1], Roman Yatskiv[1], and Anton Fojtík[2]
[1]Institute of Photonics and Electronics, ASCR, v.v.i. Czech Republic
[2]Faculty of Nuclear Sciences and Physical Engineering, CTU Prague, Czech Republic
grym@ufe.cz

Semiconducting, insulating, and metallic nanoparticles have attracted considerable interest due to their size-dependent, quantum confinement characteristics, which make them attractive for a wide range of optical, magnetic, and electronic devices. We report on the deposition of Pd nanoparticles prepared with reverse micellae of water/AOT/isooctane solution on the surface of n-type InP substrates and epitaxial layers. High quality metal/InP interfaces are essential for the fabrication of high-speed electronic devices, charge-control devices, optoelectronic and particle detectors. Thanks to catalytic activity of Pd, increasing number of papers has been devoted to hydrogen sensors based on Pd/InP interfaces [1]. Sensors based on Schottky diodes are capable of monitoring hydrogen and hydrogen-containing moieties in subppm and ppm range [2]. The hydrogen molecules are absorbed and dissociated at Pd surface, atomic hydrogen rapidly diffuses to the Pd/InP interface, where the dipole layer develops. Subsequently, the Schottky barrier height decreases and the electric current increases.

Pd nanoparticles with the diameters of 7 and 10 nm were prepared in isooctane colloid solution by the reverse micelle technique [3]. The electrophoretic deposition from the colloid solution took place in a cell with two parallel electrodes. The upper electrode was made from a high-purity graphite, the lower electrode was formed by an InP substrate or an InP substrate with an epitaxial layer, both of n-type conductivity with the background concentration of about 1×10^{16} cm^{-3}. Liquid phase epitaxy from rare-earth treated melts was used to tune the background concentration in the epitaxial layers [4]. DC voltage was applied for a selected period of time to deposit a Pd-based nanolayer of about 100 nm in thickness. Pd nanoparticle shapes and sizes were observed by SEM and TEM, The deposited films were characterized by SEM, TEM, AFM, optical reflection spectroscopy, and SIMS. Several sets of samples were prepared by depositing different materials onto the nanolayer (spots of conductive Ag colloid paint, electrolytically deposited Pd, vacuum evaporated Pd followed by the evaporation of Au) serving as electrodes of a diode. The diodes were characterized by the measurement of I-V characteristics and their sensitivity towards hydrogen was tested.

We discuss the influence of particular combinations of (i) the substrate/epitaxial layer methods of preparation and surface treatment, (ii) conditions of the electrophoretic deposition, and (iii) methods of the electrical contact preparation on the performance of hydrogen detectors.

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