ISSN 1068-3755, Surface Engineering and Applied Electrochemistry, 2008, Vol. 44, No. 1, pp. 1–5. © Allerton Press, Inc., 2008.
Original Russian Text © A.I. Dikusar, L.I. Bruk, E.V. Monaico, D.A. Sherban, A.V. Simashkevich, I.M. Tiginyanu, 2008, published in Elektronnaya Obrabotka Materialov, 2008, No. 1, pp. 4–9.

ELECTRICAL PRECISION TREATMENT OF MATERIALS

Photoelectric Structures Based on Nanoporous p-InP

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Received September 11, 2007

Abstract—The possibility of nanostructuring of surfaces of indium phosphide with hole conduction is confirmed. The technique of manufacturing and research of SnO_2/InP heterostructures with a nanoporous surface at the interface is developed. It is shown that the investigated structure can form a basis for working out photovoltaic devices with an enlarged active surface.

DOI: 10.3103/S1068375508010018

Indium phosphide is one of the most promising materials for preparation of photoelectric structures, since its bandgap corresponds to the energy of photons of the maximum of the solar irradiation spectral radiation. Therefore, its application makes it possible to obtain the highest efficiency of solar energy transformation into electric energy. Indeed, on the basis of InP, there have already been prepared solar cells with efficiency exceeding 20% [1]. However, due to the high cost of the base material, these cells are not competitive for terrestrial application. It is also known [2] that indium phosphide is a radiation-resistant material; devices on its basis, in particular, solar cells, can operate in conditions of ionization radiation.

The cost of solar cells' may be reduced due to simplification of their fabrication technology, for example, preparation of semiconductor–insulator–semiconductor (SIS) structures by the method of pyrolytic pulverization of a mixture of tin and indium oxides (ITO) on the surface of p-InP crystals [3–6]. The advantage of this method is that its technological preparation does not require the high-temperature processes of diffusion or epitaxy necessary for formation of surface hetero- or *p–n*-junctions in traditional solar cells. In the case of SIS structures, the potential barrier separating the photogenerated charge carriers is formed at the ITO–InP interface, whereupon a tunnel-transparent thin oxide layer of P_2O_5 appears in the process of the ITO layer spraying [7, 8].

The same result may be achieved by enlargement of the active effective area of the photovoltaic cell. The active area enlargement usually occurs due to its texturing by selective chemical etching. As a result, on the surface of the base semiconductor material, there are formed inverse pyramids or truncated cones, their bases having dimensions of about 5×5 μm or a diameter of 10 μm, respectively (see Fig. 1).

The nanostructured surface is a limiting case of texturing. Such a surface has a maximum surface value; therefore, research of the possibility to apply semiconductor materials with a nanostructured active surface in photoelectric devices appears to be relevant. Hence, the aim of the present paper is to study the possibility to obtain heterostructures based on conducting solar-radiation-transparent oxides ITO, SnO_2, and p-InP with a nanoporous surface as well as the corresponding photovoltaic cells; the authors have accumulated sufficient experience in their preparation with application of indium phosphide with a smooth surface [2–6].

The parameters of the photocells prepared on the basis of ITO/p-InP structures with a smooth surface are given in the table.

As one can see from the table, the efficiency of the ITO/p-InP structures prepared by a simple method of pulverization of a solution of indium and tin chlorides in ethanol on indium phosphide plates at a temperature of 450°C is comparable with the efficiency of other

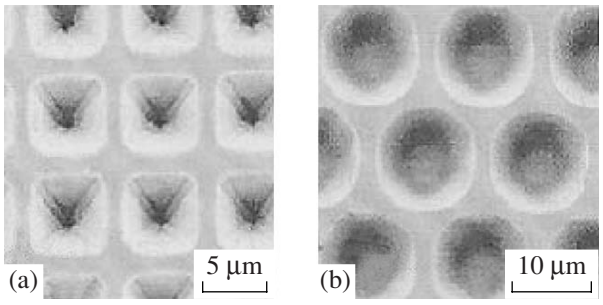

Fig. 1. Textured active surfaces of the photocells in the form of inverse pyramids (a) and truncated cones (b).