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Use of porous GaAs electrodes in photoelectrochemical cells

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The photoelectrochemical properties of semiconductor-electrolyte solar cells with carbon auxiliary electrode and colloidal aqueous solution of Na_2SiO_3 have been investigated. Bulk n-type single crystalline and nanoporous GaAs material were used as semiconductor electrodes. Current–voltage characteristics under different illumination intensities and spectral distribution of the photosensitivity were studied. The photopotential was found to reach values as high as 0.46 V for bulk n-GaAs. The introduction of porosity in GaAs shifts the maximum of the spectral distribution of photosensitivity towards the longwavelength region and increases the short circuit current by a factor of two.

1 Introduction

The photovoltaic cells are usually based on absorption of solar energy and separation of the photoexcited carriers by potential barriers in different solid state structures such as p–n junctions, Schottky diodes, heterojunctions, MDS and SDS structures. The same processes prove to occur at semiconductor-electrolyte interfaces [1, 2]. The absence of expensive electrovacuum technologies and high-temperature processes in the fabrication of photoelectrochemical cells (PEC) is an important advantage. Different semiconductor materials and electrolyte based redox couples were used for the fabrication of PEC [3]. Solar energy conversion efficiencies more than 10% have been reached.

One of the major problems of PEC is the degradation of the photoelectrochemical parameters due to the corrosion of the photoelectrode at the semiconductor-electrolyte interface. The efficiency and the lifetime of these devices are limited by the photoelectrode corrosion.

The goal of this work is to investigate PECs with a new type of electrolyte avoiding photoelectrode corrosion. For this purpose we used a colloidal aqueous solution of Na_2SiO_3. Single crystalline gallium arsenide was used as semiconductor electrode since its band gap fits very well the maximum of the solar energy distribution. Another specific goal of the work was to make use of the huge surface of nanostructured materials for the purpose of improving PEC characteristics.

2 Experimental

The investigation of the electrical and photoelectrical properties of the semiconductor-electrolyte interface was carried out either in an organic glass cell described in [4, 5], or in a PEC illustrated in Fig. 1. A colloidal aqueous solution of Na_2SiO_3 with different concentrations was used as electrolyte. Either bulk

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