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Control of persistent photoconductivity in nanostructured InP through morphology design

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Abstract
In this paper, we show that long-duration-photoconductivity decay (LDPCD) and persistent photoconductivity (PPC) in porous InP structures fabricated by anodic etching of bulk substrates can be controlled through the modification of the sample morphology. Particularly, the PPC inherent at low temperatures to porous InP layers with the thickness of skeleton walls comparable with pore diameters is quenched in structures consisting of ultrathin walls produced at high anodization voltages. The relaxation of photoconductivity in bulk InP substrates, porous layers, and utrathin membranes is investigated as a function of temperature and excitation power density. The obtained results suggest that PPC in porous InP layers is due to porosity induced potential barriers which hinder the recombination of photoexcited carriers, while the photoconductivity relaxation processes in ultrathin membranes are governed by surface states.

Keywords: porous InP, anodic etching, ultrathin membranes, photoconductivity decay, persistent photoconductivity

(Some figures may appear in colour only in the online journal)

1. Introduction

Porous materials enlarge continuously the area of their applications due to simple, accessible, and cost effective methods of fabrication such as electrochemical and photoelectrochemical etching. Over the last decade, a variety of porous semiconductor architectures have been demonstrated by electrochemistry. Because of the nanoscale nature of light absorption and photocurrent generation in solar energy conversion, the advent of methods for controlling inorganic materials on the nanometer scale opens wide opportunities for improving the performance of solar cells [1–5]. InP and GaAs are among the most suitable materials for these purposes, especially when high radiation hardness is required, e.g. in space applications. The applicability of a porous GaAs electrode in a photoelectrochemical solar cell was demonstrated [6]. It was shown that the introduction of porosity in the photoelectrode leads to a considerable photosensitivity increase in the longwavelength region near the bandgap which results in an increase of the output power by a factor of four in comparison with the cell based on bulk electrodes. Nanostructured semiconductors also show enormous potential for their use as active components in photodetectors [7], light-

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