IOP Publishing Semiconductor Science and Technology
Semicond. Sci. Technol. **29** (2014) 125003 (7pp) doi:10.1088/0268-1242/29/12/125003

Growth of ZnCdS single crystals and prospects of their application as nanoporous structures

G V Colibaba[1], E V Monaico[2,3], E P Goncearenco[1], D D Nedeoglo[1], I M Tiginyanu[3] and K Nielsch[2]

[1] Moldova State University, A. Mateevici str. 60, Chisinau 2009, Republic of Moldova
[2] Institute of Applied Physics, University of Hamburg, Jungiusstr. 11, Hamburg 20355, Germany
[3] National Center for Materials Study and Testing, Technical University of Moldova, Stefan cel Mare av. 168, Chisinau 2004, Republic of Moldova

E-mail: GKolibaba@yandex.ru

Received 27 June 2014, revised 23 September 2014
Accepted for publication 25 September 2014
Published 28 October 2014

Abstract

Substrates of wide band-gap II–VI semiconductor compounds are considered feasible for the fabrication of nanoporous matrices (NM) needed for templated growth of nanowires and nanotubes of solid-state materials promising for applications in various fields. An accessible and cost-effective approach to fabricate NM is based on electrochemical etching (ECE) which, however, depends on the electrical conductivity of the substrates. In this paper, growth of homogeneous $Zn_xCd_{1-x}S$ single crystals, with x varying from 0 to 1, is demonstrated and the influence of chemical composition on optical and electrical properties of the crystals is identified. The feasibility of using $Zn_xCd_{1-x}S$ alloys with $x = 0$–0.6 for the growth of nanopore arrays with pore diameter down to 30 nm is shown. The perspectives and limitations of the use of these semiconductor alloys for the fabrication of NM by means of ECE are discussed.

Keywords: crystal growth, semiconductor substrates, ZnCdS solid solutions, anodic etching, nanotemplates, nanoporous structures

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

1. Introduction

Wide band-gap II–VI semiconductors such as ZnSe, ZnO, CdS, and ZnS are prospective materials for the fabrication of nanoporous matrices (NM) or nanotemplates. The conductive semiconductor nanotemplates possess wide potential for the growth of networks of nanowires, nanotubes, and nanodots based on various materials [1, 2]. These nanostructures are promising for use in high-efficient solar cells with nanostructured p-n junctions, photonic elements, electronic sensors, etc [3, 4].

Electrochemical etching (ECE) is considered the most reliable and cost-effective method for NM manufacturing. The commercially available dielectric NM based on electrochemically prepared Al_2O_3 can be used only for the fabrication of nanowires [5]. ECE technologies, however, can be efficiently used providing that one can manipulate the electrical parameters of the as-grown substrates. This feature, in particular, enables one to control the diameter of pores in electrochemically prepared nanotemplates [1, 6].

The $Zn_xCd_{1-x}S$ compounds have relatively large band-gap energy (E_g) covering the range of 2.53–3.78 eV at room temperature. In this work, we report on the growth of homogeneous $Zn_xCd_{1-x}S$ single crystals with controlled electrical conductivity and demonstrate the possibility to fabricate NM on their basis by means of ECE technologies.

2. Preliminary results, physical–chemical limitations, and problem definition

The development of the technology for manufacturing of ZnSe:Al substrates with controlled electrical conductivity (σ) varying in the range of 0.01–20 $(\Omega \cdot \mathrm{cm})^{-1}$ gave us the

