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Electrochemical nanostructuring of (111) oriented GaAs crystals: from porous structures to nanowires

Elena I. Monaico[1], Eduard V. Monaico[*1], Veaceslav V. Ursaki[1,2], Shashank Honnali[3], Vitalie Postolache[1], Karin Leistner[3], Kornelius Nielsch[3] and Ion M. Tiginyanu[1,2]

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Address:
[1]National Center for Materials Study and Testing, Technical University of Moldova, Chisinau MD-2004, Republic of Moldova, [2]Academy of Sciences of Moldova, Chisinau MD-2001, Republic of Moldova and [3]Leibniz IFW Dresden, Helmholtzstr. 20, 01069 Dresden, Germany

Email:
Eduard V. Monaico[*] - eduard.monaico@cnstm.utm.md

* Corresponding author

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Abstract

A comparative study of the anodization processes occurring at the GaAs(111)A and GaAs(111)B surfaces exposed to electrochemical etching in neutral NaCl and acidic HNO_3 aqueous electrolytes is performed in galvanostatic and potentiostatic anodization modes. Anodization in NaCl electrolytes was found to result in the formation of porous structures with porosity controlled either by current under the galvanostatic anodization, or by the potential under the potentiostatic anodization. Possibilities to produce multilayer porous structures are demonstrated. At the same time, one-step anodization in a HNO_3 electrolyte is shown to lead to the formation of GaAs triangular shape nanowires with high aspect ratio (400 nm in diameter and 100 μm in length). The new data are compared to those previously obtained through anodizing GaAs(100) wafers in alkaline KOH electrolyte. An IR photodetector based on the GaAs nanowires is demonstrated.

Introduction

Electrochemical technology became an established and cost-effective approach for the preparation of porous semiconductor matrices and arrays of nanowires with tailored architecture at the submicrometer scale [1-3]. Semiconductor nanotemplates provide many possibilities for nanofabrication through electrochemically filling the pores with metallic nanostructures such as nanowires or nanotubes, resulting in the production of 2D metallo-semiconductor interpenetrating networks, which are promising for various nanoelectronic, optoelectronic, plasmonic, and nanophotonic applications [4-6]. While the growth of crystallographically oriented and current line oriented pores has been demonstrated in a variety of semiconductors [1-3], to date, only crystallographically oriented pores were observed in GaAs crystalline wafers. This observation is a factor limiting