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Topical Review

Porous semiconductor compounds

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Abstract
In this review paper, we present a comparative analysis of the electrochemical dissolution of III–V (InP, GaAs, GaN), II–VI (ZnSe, CdSe) and SiC semiconductor compounds. The resulting morphologies are discussed, including those of porous layers and networks of low-dimensional structures such as nanowires, nanobelts, and nanomembranes. Self-organized phenomena in anodic etching are disclosed, leading to the formation of controlled porous patterns and quasi-ordered distribution of pores. Results of templated electrochemical deposition of metal nanowires, nanotubes and nanodots are summarized. Porosification of some compounds is shown to improve luminescence characteristics as well as to enhance photoconductivity, second harmonic generation and Terahertz emission. Possible applications of porous semiconductor compounds in various areas are discussed.

Keywords: porous semiconductor compounds, electrochemical and photochemical etching, dissolution mechanisms, self-organized phenomena, templated electrodeposition of metals, optical phonon engineering, nonlinear optical properties

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

1. Introduction

The wide class of porous materials includes both organic and inorganic materials such as porous metals, porous semiconductor and dielectrics, porous ceramics, polymer foams, and metal-organic frameworks [1–3]. Porous solids often serve as structural bodies in nature, including in wood, bones and other biological objects. Depending on their nature, porous materials are prepared by specific technologies involving a lot of fundamental concepts, and specific fields of applications are determined by their properties.

Among semiconductor materials, considerable interest has been triggered by the discovery of luminescent porous Si three decades ago [4]. The efficiency of porous silicon LED's has risen by 5 orders of magnitude over the years and is currently approaching commercial viability for some integrated display applications [5]. During this time, it was shown at the laboratory research level that porous Si is suitable for many applications, including optic and optoelectronic applications (light emitting devices, optical waveguides, photonic crystals, optical resonators, distributed Bragg reflectors and diffraction gratings), electronic applications (gas sensing, gettering, lithium-ion batteries, and solar cells antireflection coatings), microfluidics, medical applications, etc [6–10].

Recently, it was proposed to produce size-controlled nanocrystalline (nc-Si) dot colloids by exposing porous silicon (PSi) in solvents to pulse laser, which results in fragmentation of the PSi layer with a considerably higher yield than the conventional techniques [11]. This was shown to pave the way for emerging functions of nanostructured PSi related to strong visible photoluminescence of about 40% in quantum efficiency in the red band, efficient quasi-ballistic hot electron emission from an nc-Si diode due to multiple-tunneling transport mode through nc-Si dot chain, and enhanced to a practical level thermo-acoustic conversion due to an extremely

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