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Invited Article

Optical reflectance studies of highly specular anisotropic nanoporous (111) InP membrane

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Abstract

High-precision optical angular reflectance measurements are reported for a specular anisotropic nanoporous (111) InP membrane prepared by doping-assisted wet-electrochemical etching. The membrane surface morphology was investigated using scanning electron microscope imaging and revealed a quasi-uniform and self-organized nanoporous network consisting of semiconductor 'islands' in the sub-wavelength regime. The optical response of the nanoporous InP surface was studied at 405 nm (740 THz; UV), 633 nm (474 THz; VIS) and 1064 nm (282 THz; NIR), and exhibited a retention of basic macro-dielectric properties. Refractive index determinations demonstrate an optical anisotropy for the membrane which is strongly dependent on the wavelength of incident light, and exhibits an interesting inversion (positive anisotropy to negative) between 405 and 633 nm. The inversion of optical anisotropy is attributed to a strongly reduced 'metallic' behaviour in the membrane when subject to above-bandgap illumination. For the simplest case of sub-bandgap incident irradiation, the optical properties of the nanoporous InP sample are analysed in terms of an effective refractive index n_{eff} and compared to effective media approximations.

Keywords: nanoporous, InP, anisotropic, angular reflectance

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

1. Introduction

Wet electrochemical etching methods deliver extensive possibilities for altering the surface morphology of semiconductors and light propagation in a complex nanostructured media is now a well-established field, appealing to electro-optic and photovoltaic applications [1]. Porous Si has been extensively investigated [2, 3] and, for all the useful advantages, still has unstable chemical and physical properties at the nanometre scale [4, 5]. Thus, focus has shifted to attractive alternatives such as porous III-V semiconductor compounds like GaP, GaAs and InP [6].

A good understanding of optical interactions on the surface of porous InP (por-InP), and other porous III-V semiconductors, is important for both fundamental material science and device application. Nanoporous InP, with pore

