INSTITUTE OF PHYSICS PUBLISHING JOURNAL OF PHYSICS: CONDENSED MATTER

J. Phys.: Condens. Matter **13** (2001) 4579–4589 www.iop.org/Journals/cm PII: S0953-8984(01)20203-3

Temperature dependence of Raman scattering in porous gallium phosphide

V V Ursaki[1], I M Tiginyanu[1], P C Ricci[2], A Anedda[2], E V Foca[3] and N N Syrbu[3]

[1] Laboratory of Low-Dimensional Semiconductor Structures, Institute of Applied Physics, Technical University of Moldova, 2004 Chisinau, Moldova
[2] INFM, Dipartimento di Fisica, Universitá di Cagliari, Cittadella Universitaria S P Monserrato-Sestu Km 0,700, 09042 Monserrato (Ca), Italy
[3] Centre of Nanoelectronics, Technical University of Moldova, 2004 Chisinau, Moldova

E-mail: ricci@alfis.dsf.unica.it

Received 18 December 2000, in final form 10 April 2001

Abstract

Porous layers fabricated by electrochemical anodization of (111)A-oriented n-GaP:Te substrates were studied by Raman scattering spectroscopy in the temperature interval from 10 to 300 K. Along with the transverse-optical (TO) and longitudinal-optical (LO) modes, the RS spectra of porous layers show Fröhlich-type vibrations located in the frequency gap between the bulk optical phonons. A longitudinal–transverse splitting of these surface-related vibrations was evidenced at low temperatures. Apart from that, the porous layers prepared on highly doped substrates were found to show LO-phonon–plasmon coupled (LOPC) modes in the whole temperature interval studied. Observation of LOPC modes at low temperatures is explained taking into account that the GaP skeleton consists of both depleted surface layers surrounding the pores and conductive regions. The free electrons in these regions, originating from the impurities actually located in the depletion layers, are shown to be subject to spatial confinement increasing with decreasing temperature.

1. Introduction

After the discovery of visible photoluminescence in porous Si by Canham [1], a great deal of interest has been paid to manufacturing and characterization of different porous materials including Si [2], Ge [3, 4], SiC [5, 6], III–V [7–14] and II–VI [15, 16] compounds. The experience gained shows that porosity represents an effective tool for engineering the band gap, band structure, phonon spectrum, refractive indices, resistivity, thermal conductivity etc of semiconductor materials. Spectacular changes in the material properties may occur at different characteristic dimensions l of the porous skeleton entities. When the dimensions involved are lower than the exciton Bohr radius, the quantum size effect on free carriers gives rise to a band gap increase and sharp modification of the optical and electrical properties. The exciton

0953-8984/01/204579+11$30.00