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Fröhlich vibrational modes in porous ZnSe studied by Raman scattering and Fourier transform infrared reflectance

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Abstract
Arrays of parallel pores with a diameter of around 60 nm have been introduced by anodic etching in ZnSe single crystals with a free electron concentration of 4×10^{17} cm^{-3}. Porosity-induced Fröhlich vibrational modes were studied by Raman scattering and Fourier transform infrared spectroscopy. The experimental data are compared with the results of theoretical simulation based on the effective medium theory. Traces of Se phase were evidenced at the surface of the porous matrix after anodization, the Raman active modes of this phase being incident in the region of the occurrence of Fröhlich vibrational modes inherent to porous ZnSe. To identify reliably the Fröhlich modes, Raman spectra of porous ZnSe layers were explored under different resonance conditions with several excitation wavelengths and various excitation power densities.

1. Introduction

Nowadays, nanotemplates based on porous alumina are commercially available. However, due to the high resistivity of the nanomatrix of porous alumina they play only a passive role in nanofabrication. At the same time it is well known that the properties of semiconductor materials can be easily changed by external illumination, applied electric fields, etc. It means that semiconductor nanotemplates may play an active role in nanofabrication. In particular, the semiconductor component can be responsible for the high conductivity of polymer–semiconductor nanocomposites fabricated by filling in the pores with polymers [1]. Taking into account the compatibility with available technologies, semiconductor nanotemplates are promising for application as substrates for nanoheteroepitaxy of high-quality materials. These open possibilities for the development of a variety of new optoelectronic devices such as light emitting devices and hybrid solar cells. [2]. In particular, semiconductor nanotemplates can be used for the purpose of developing random lasers [3]. Note that Cr^{2+}-doped ZnSe was shown to be promising material for highly efficient and broadly tunable mid-IR (2–3 μm) lasers [4].

According to the results of a recent study of pore growth in CdSe substrates with different electrical characteristics, the development of CdSe nanotemplates with pore diameters as low as 20 nm is feasible [5, 6]. Besides, the growth of pores with diameters down to 40 nm was demonstrated for ZnSe single crystals [7]. A special approach of co-doping ZnSe by Al and Zn impurities has been developed for the purpose of controlling the material conductivity necessary for the application of electrochemical porosification [8]. It was suggested to use nanostructuring of ZnSe crystals as a tool for phonon engineering through the control of the Fröhlich-type surface-related modes which were also observed in wurtzite ZnSe nanowires [9] and nanorods [10]. However, the segregation of a small amount of Se phase is hardly avoided

