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# Photoluminescence and vibrational properties of nanostructured ZnSe templates

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**Abstract**
Electrochemical etching of pores in as-grown and doped n-type ZnSe substrates is reported. To dope the samples the as-grown semi-insulating substrates were annealed in a Zn melt containing Al impurity at concentrations ranging from 0.1 to 40 at.%. We demonstrate the growth of arrays of parallel pores with diameters ranging from several hundreds of nanometers down to 40 nm. According to the dependence of the anodic current on the applied potential, the pore growth is found to be mediated by oxide formation. LO–phonon–plasmon coupling and the emergence of the Fröhlich-type surface phonon mode are studied by Raman spectroscopy of annealed and electrochemically treated samples. The position of the Fröhlich mode is found to be identical in porous samples with different diameters of pores and skeleton wall thicknesses, in accordance with the effective medium theory when applied to porous materials with identical semiconductor skeleton relative volume concentration. The photoluminescence analysis of the prepared porous structures is indicative of effective passivation of the porous skeleton surface during anodization while Raman scattering evidences a decrease in the free carrier concentration and neutralization of impurity centers in the porous skeleton walls.

## 1. Introduction

Over the last decade, artificial nanostructuring of semiconductor materials has emerged as an effective tool for controlling their optoelectronic properties. Particularly, efficient optical phonon engineering, induced birefringence, strongly enhanced second harmonic generation and terahertz emission have been demonstrated [1–5]. Nanotemplates containing periodic arrays of pores are particularly promising for use as photonic crystals, with inherited photonic bandgap depending upon the transverse dimensions of pores and the structure of the skeleton [5].

The electrochemistry offers an easily accessible and cost-effective approach for tailoring the morphology of semiconductors by introducing porosity on a variable length scale. This approach has been demonstrated [5] in Si and III–V compounds using wet chemical etching. A variety of porous semiconductor architectures have been produced by anodic chemical etching, including periodic pore arrays [6]. While the electrochemical etching is a versatile tool for use in nanostructuring of narrow and medium bandgap materials such as Si, InP, GaAs, GaP, use of this method for wide bandgap II–VI semiconductors is still a challenge. The related difficulties are linked with controlling the conductivity of the source material, as high carrier concentration is needed to apply anodic etching for nanostructuring. It is difficult to obtain wide bandgap semiconductors with high conductivity due to self-compensation phenomena inherent to these materials [7].