Fabrication and photoluminescence properties of porous CdSe

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We report the results of a study of the growth of pores in *n*-CdSe single crystals using anodic etching techniques. Upon anodization in dark, a nonuniform distribution of pores was produced. However, anodic dissolution of the material under *in situ* UV illumination proves to result in uniform distribution of pores stretching perpendicularly to the initial surface of the specimen. The porous structures exhibit less luminescence than the bulk samples. These results pave the way for cost-effective manufacturing of CdSe-based semiconductor nanotemplates for nanofabrication. © *2005 American Institute of Physics*. [DOI: 10.1063/1.1864240]

Over the past several years, artificially introduced porosity has been shown to result in spectacular modification of the optoelectronic properties of III-V semiconductor compounds. In particular, dramatic surface effects, efficient optical phonon engineering, induced birefringence, and strongly enhanced nonlinear optical phenomena such as optical second-harmonic generation and terahertz emission have been demonstrated.[1–5] Recently, nonlithographic growth of two-dimensional single crystals of pores with diameters of 100 nm was realized on *n*-InP.[6] On the other hand, little attention has been paid to the study of porosity-induced changes in the properties of II-VI compounds. In particular, Zenia *et al.* subjected *p*-ZnTe crystals to electrochemical etching and observed the formation of needle-like structures exhibiting a blueshift of the excitonic transition energies.[7] The effect of photoetching on photoluminescence (PL) of *n*-CdSe was studied many years ago by Garuthara *et al.*, who claimed the formation of etch pits.[8] No data on electrochemical growth of pores in *n*-type II-VI compounds have yet been reported. In this work, we present the results of our study of pore growth in *n*-CdSe single crystals subjected to anodic etching. The production of uniformly distributed, parallel pores is demonstrated. Porous CdSe structures are found to exhibit less luminescence intensity than the bulk material.

Wurtzite-phase *n*-CdSe single crystals were grown by chemical transport techniques using iodine as the transport agent. The concentration of free electrons in bulk material was 3×10^{17} cm^{-3} at 300 K, while the density of dislocations did not exceed 5×10^5 cm^{-2}. Samples with dimensions $5 \times 5 \times 2$ mm^3 were used. Electrochemical etching was carried out in 5% HCl aqueous solution at room temperature under potentiostatic conditions as described elsewhere.[6] To reach uniform nucleation of pores, the samples were *in situ* illuminated by focusing the UV radiation of a 200 W Xe lamp onto the CdSe surface (0.15 cm^2) exposed to electrolyte. The morphology and the chemical composition microanalysis of etched samples were studied using a TESCAN scanning electron microscope (SEM) equipped with an Oxford Instruments INCA energy dispersive x-ray (EDX) system. PL was excited by the 514 nm line of an Ar$^+$ SpectraPhysics laser and analyzed through a double spectrometer. The resolution was better than 0.5 meV. The samples were mounted on the cold station of a LTS-22-C-330 cryogenic system.

For anodization in dark, the etching process starts at surface imperfections. After this initial pitting of the surface, further etching proceeds in all directions radially away from the initial surface imperfection [Fig. 1(a)]. As a result, a po-

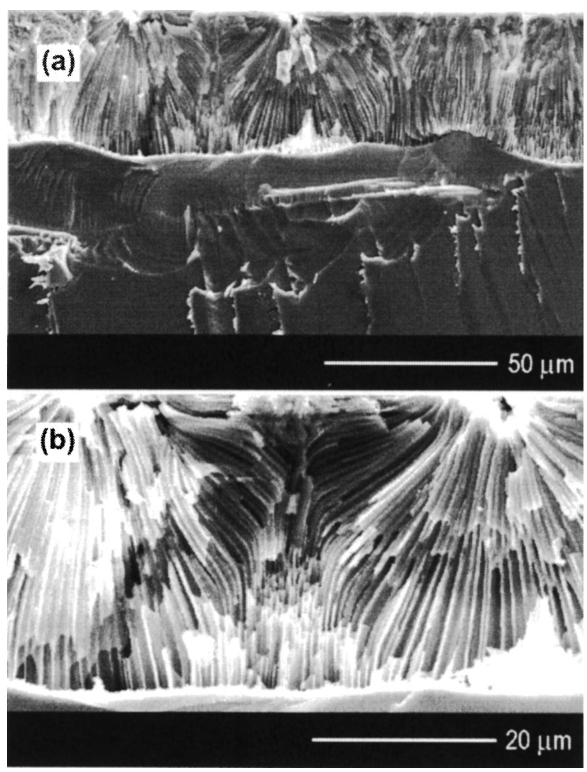

FIG. 1. SEM images taken in cross section from a CdSe sample anodized in dark: (a) general view and (b) development of the porous structure after neighboring domains meet.

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