INTENSE LUMINESCENCE FROM POROUS ZnSe LAYERS

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The porous form of III-V semiconductors was extensively studied during the last decade. Porosity enhanced phenomena such as optical second harmonic generation and Terahertz emission have been reported. Porosity induced increase of cathodoluminescence (CL) intensity was observed in GaP. In spite of the huge surface inherent to porous matrix, gallium phosphide in the porous form shows CL intensity one order of magnitude higher than that of bulk crystals under the same excitation conditions. On the other hand, relatively little attention has previously been paid to the study of porosity-induced changes in the properties of II-VI compounds. ZnSe is one of the most important wide-band-gap semiconductors suitable for nanostructuring by means of electrochemical methods. This material is especially interesting in connection with the development of random lasers. Nanocomposite materials prepared on the basis of porous semiconductor templates are most suitable for this purpose, due to the possibility of integration with other optical or electronic functions. Strong light scattering in the porous ZnSe network can ensure the necessary conditions for a resonant feedback. On the other hand, since ZnSe is a direct wide-band-gap semiconductor, it can play the role of a dense exciton system, and assure lasing effects due to exciton-exciton scattering and stimulated emission of electron-hole plasma. The band gap of ZnSe allows emission in the blue spectral region.

We report on the possibility to prepare by means of electrochemical methods ZnSe porous layers with different degrees of porosity including the one ensuring a strong light scattering. The prepared porous structures were characterized by means of scanning electron microscopy (SEM), photoluminescence (PL) and cathodoluminescence (CL). The PL of the as grown material and the porous layers measured at low temperatures (10 K) was found to be dominated by an emission band at 2.796 eV as well as a band at 2.700 eV with several phonon replicas. The analysis of the dependence of these bands upon the excitation power density and temperature suggests that free-to-bound and respectively donor-acceptor electron transitions are responsible for emission bands.

The comparison of SEM and CL images taken from the same porous structures (see for instance figures 1 and 2) demonstrated that cathodoluminescence intensity from layers with small characteristic sizes of the porous entity around 50 nm (region 3) is much weaker than in the bulk material, the luminescence from layers with the diameter of pores around 100 – 200 nm (region 2) is comparable with that of the bulk material, while some regions of layers with the diameter of pores around 500 nm (region 1) exhibit much stronger luminescence. This gain of luminescence is attributed to the formation of ring microcavities for light in the porous network like that recently observed in CdSe porous layers.

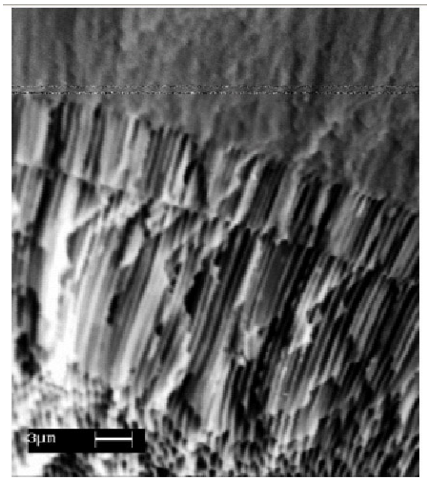

Fig. 1. SEM image taken in cross section from a multilayer porous ZnSe sample.

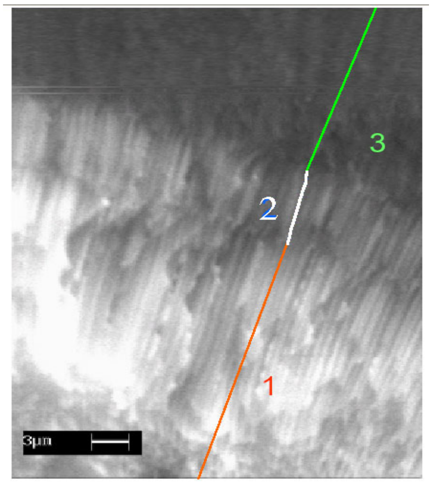

Fig. 2. CL image taken from the same multilayer porous ZnSe sample.