Semicond. Sci. Technol. **24** (2009) 085017 (5pp) doi:10.1088/0268-1242/24/8/085017

Random lasing in nanostructured ZnO produced from bulk ZnSe

V V Ursaki[1], V V Zalamai[1,2], A Burlacu[1], C Klingshirn[2], E Monaico[3] and I M Tiginyanu[3,4]

[1] Institute of Applied Physics, Academy of Sciences of Moldova, MD-2028 Chisinau, Moldova
[2] Institut für Angewandte Physik, Universität Karlsruhe (TH), Wolfgang-Gaede-Str. 1, 76131 Karlsruhe, Germany
[3] National Center for Materials Study and Testing, Technical University of Moldova, Stefan cel Mare av. 168, MD-2004 Chisinau, Moldova
[4] Laboratory of Nanotechnology, Institute of Electronic Engineering and Industrial Technologies, Academy of Sciences of Moldova, MD-2028 Chisinau, Moldova

Received 26 January 2009, in final form 19 June 2009
Published 17 July 2009
Online at stacks.iop.org/SST/24/085017

Abstract
We propose to produce three-dimensional ZnO random laser media on the basis of bulk ZnSe. Bulk ZnSe wafers are transformed into granular ZnO media by thermal treatment in oxygen ambient at temperatures in the range of 700–800 °C. This technology ensures a high optical quality of the ZnO nanostructured material produced to act as a gain medium for stimulated emission in the ultraviolet spectral region in combination with high-quality factor random laser resonators indicated by narrow lasing peaks. The quality factor for the observed emission modes is estimated to be around 1500. The structures produced are expected to find applications in microlaser technologies for optoelectronics and photonics.

1. Introduction

Since the pioneering work of Letokhov and co-workers [1], lasing in disordered media (random lasers) has been the subject of intense theoretical and experimental studies. A main difference between the conventional and random lasers is the feedback mechanism, it being supplied by optical scattering in a random laser. The interest in the development of random lasers was renewed with the experimental demonstration of a coherent random laser [2]. The stimulated emission in a random laser may come either from near-bandgap electronic effects (exciton–exciton scattering or electron–hole plasma) as in the case of lasers based on ZnO [3, 4], from intra-central lasing transitions in rare earth elements doped into strongly scattering dielectric media [5, 6] or from high-gain organic media [7, 8]. With a wide bandgap of 3.36 eV at room temperature and large exciton binding energy of 60 meV (excitons being stable up to room temperature), ZnO holds a promise for blue and ultraviolet optical devices [3, 9], including ultraviolet microlasers [10, 11] and random lasers [12–21]. Random lasing has been demonstrated in ZnO powders [12–15], nanocrystalline films [16–18], ZnO nanorod arrays embedded in ZnO films [19, 20] and random-growth-oriented ZnO nanowires [21].

In this paper, we propose a simple method to produce ZnO random laser media through thermal treatment of bulk ZnSe wafers.

2. Experimental details

Bulk ZnSe single crystals have been used to prepare nanostructured ZnO material. ZnSe wafers were transformed into ZnO by thermal treatment in oxygen ambient at different temperatures in the range of 600–800 °C for 1 h.

The morphology and chemical composition microanalysis of samples were studied using a VEGA TESCAN TS 5130 MM scanning electron microscope (SEM) equipped with an Oxford Instruments INCA energy dispersive x-ray (EDX) system.

The continuous wave (cw) PL was excited by the 351.1 nm line of an Ar^+ SpectraPhysics laser and analyzed with a double spectrometer ensuring a spectral resolution better than 0.5 meV. The samples were mounted on the cold station of a LTS-22-C-330 optical cryogenic system.

The lasing characteristics of the ZnO structures produced were measured at room temperature under the pumping by the third harmonic of a Q-switched Nd:YAG laser (355 nm,

