Defect-related green emission from ZnO microrods – a cathodoluminescence study

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ZnO nanomaterials attract considerable interest due to possible applications in optoelectronic and photonic systems as well as due to interesting light-confinement phenomena which may occur in them. Microresonators based on various self-assembled low-dimensional systems belong to those most intensively studied with particular emphasis on interdependence between their structure, size, crystalline perfectness and optical properties in near band-gap or defect-related luminescence band.

Optical properties of individual ZnO microrods prepared by hydrothermal method were investigated by spatially resolved cathodoluminescence (CL) spectroscopy and imaging at liquid-helium temperature. When a top hexagonal surface was exposed to the electron beam, set of separated fine structures superimposing the broad green band was observed (Fig. 1). We considered this multipeak structure as multiple resonance modes. Monochromatic CL image of the ZnO microrods shows that enhanced luminescence intensity is located near the side walls of the microrods (Fig. 2), which can be attributed to the transverse modes enhanced emission in the resonant cavity. We considered these transverse modes as the Whispering Gallery Modes (WGMs) [1]. However, our analysis showed the discrepancy between observed mode spacing and calculated from the known cavity size.

Further investigations revealed that the cavity size does not impact on the resonance modes. An alternative explanation based on leaky modes theory predicts invariance of the mode spacing with respect to the size of the ZnO microrods [2]. The correspondence between the leaky modes and the observed resonances in our microcavities is analyzed.

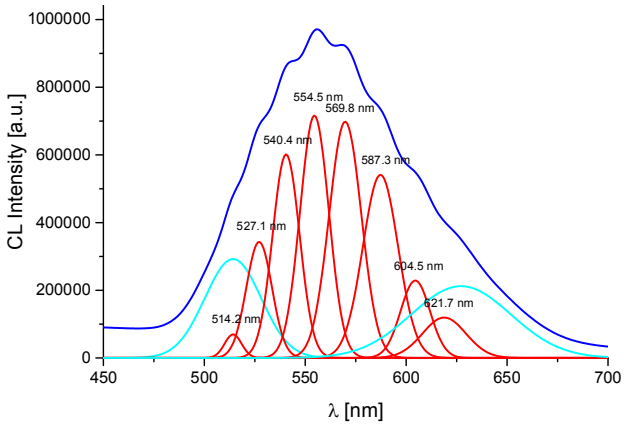

Fig. 1. CL spectrum collected from individual ZnO microrod with diameter of about 1.6 µm. The multipeak structure indicating multiple resonance modes.

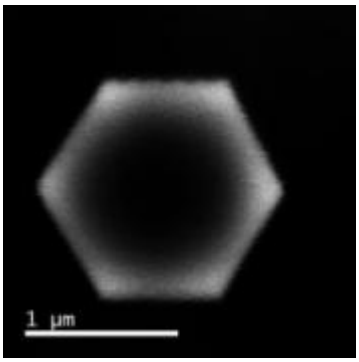

Fig. 2. The monochromatic CL image at 555 nm of the individual ZnO microrods.

[1] S. Choi et al., Applied Physics Letters 103, 171102 (2013),
[2] L. Huang et al., Nano Letter 13, 3559 (2013).

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