Optical characterization of ZnO nanorods grown by the ultra-fast and low temperature hydrothermal process

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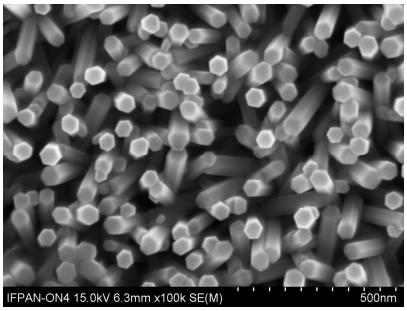
Zinc oxide is a II-VI semiconductor material that focused a growing interest in various fields such as biology, medicine or electronics. It has a direct energy gap of about 3,37eV at room temperature and high transparency in a visible light spectral region. This semiconductor reveals very special physical and chemical properties, which imply many applications including a active layer or transparent electrode in solar cells or LED diodes. ZnO is also tested for applications in new generations of electronic devices as an active part of transparent transistors and cross-bar memories. For sensor and photovoltaic applications developed surface morphology is very important, so the nanorods form is very desirable.



In this work we present advanced optical characterization of ZnO nanorods obtained by the extremely fast and efficient variation of the microwave-assisted hydrothermal method [1]. This environment friendly and fully reproducible method allows growth of nanorods in few minutes time on various substrates, without any catalyst or complexing agent. Growth temperature does not exceed 50ºC and growth can be performed at atmospheric pressure. Moreover the method is also very safe, it requires organic, non-toxic and low-price precursors. The growth can be performed on almost any type of substrate through the homo-nucleation as well as hetero-nucleation. The received nanorods are characterized by a very high quality - they are monocrystalline as confirmed by transmission electron microscopy.

We also present results of photoluminescence (PL) and cathodoluminescence (CL) investigations. An inter-link between samples microstructure and emission properties is investigated. We also present comparison of optical properties between ZnO nanorods and ZnO layers grown by Atomic Layer Deposition. These investigations allow estimation of relaxation process observed along the growth direction. We also study shifts of excitonic emission bands, which are associated by us with the localization effects and stress in the layers. Importantly oxygen vacancies are not found in the PL measurements. In addition, the CL intensity collected from single isolated nanorod is orders of magnitude lower than for one excited nanorod inside nanorods array. Detail information about experiments will be presented.

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[1] B. S. Witkowski, et al., *Ultra-fast growth of the monocrystalline zinc oxide nanorods from the aqueous solution*, Int. J. Nanotechnol., Vol. 11, Nos. 9/10/11, 2014