ECS Transactions, 58 (8) 17-22 (2013)
10.1149/05808.0017ecst ©The Electrochemical Society

Electrochemical and Hydrothermal Synthesis of Epitaxial Arrays of Doped ZnO Nanowire Emitters for Light Emitting Diodes With Tunable Emission From Near-UV to Blue

Thierry Pauporté*[a], Oleg Lupan[a,b], Bruno Viana[b]

[a] Laboratoire d'Électrochimie, Chimie des Interfaces et Modélisation pour l'Énergie, (LECIME) UMR-CNRS7575, ENSCP-Chimie-Paristech 11 Rue P. et M. Curie 75231 Paris cedex 05 France.
*E-mail : thierry-pauporte@chimie-paristech.fr
[b] LCMCP UMR7574 ENSCP-Chimie-Paristech 11 Rue P. et M. Curie 75231 Paris cedex 05 France

ABSTRACT

The bandgap control of doped-ZnO nanowires is important for tunable light emitting diodes (LEDs). Ultraviolet (UV), violet, blue and near-white LED structures based on Cu- or Ag-doped ZnO /*p*-GaN and Cd-alloyed ZnO ($Zn_{1-x}Cd_xO$) nanorods or nanowires (NWs)/*p*-GaN heterojunction have been fabricated by epitaxial electrodeposition and hydrothermal growth at low temperatures. A single UV electroluminescence (EL) peak centered at around 397 nm was observed at room temperature for pure ZnO nanowires/*p*-GaN. The emission was shifted to 405-450 nm by using heterojunction between Cu or Ag-doped ZnO and $Zn_{1-x}Cd_xO$-nanorods grown on *p*-GaN substrate. Moreover, the shift could be tuned by changing the dopant concentration. The electroluminescence emission threshold voltage was low at about 5.0 V and EL intensity increased with the applied forward voltage bias. In the case of Cu-doped ZnO prepared by hydrothermal growth, a near-white electroluminescence was achieved. The presented experimental results demonstrate the tunable emission from transition metal-doping in ZnO-based nanoLEDs.

Keywords: UV, blue LED, ZnO, GaN, Electrodeposition, Hydrothermal growth, Cu, Ag and Cd doping

1. Introduction

The field of nanoelectronics is emerging and has attracted great attention of researchers with promising new optoelectronic devices with multi-functionality capabilities, such as nano-LED, nanowire-based solar cells, nanophotodetectors, nanosensors, etc. [1-3] Zinc oxide is a direct wide bandgap (3.37 eV at room temperature) material with a cohesive energy of 1.89 eV.[3-4] By doping zinc oxide with new elements, it is possible to achieve desirable optical, electrical, magnetic or sensing properties which are quite important for multifunctional device applications.[3-7] ZnO nanowires (NWs) and nanorods (NRs) have a strong exciton binding energy[3,6] which should favor the development of ZnO-LEDs much brighter than corresponding GaN-light emitters.[2,8-9] For such devices, a heterojunction is required and it can be developed by using another *p*-type material with lattice constants well-matched to ZnO, e.g. GaN. This is of great importance because large lattice mismatch could introduce defects resulting in interface states between the two materials and reduced efficiency of the nano-LEDs.