MAR12-2011-006704

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Photoluminescence as a tool for characterizing point defects in semiconductors

MICHAEL RESHCHIKOV, Physis Department, Virginia Commonwealh University

Photoluminescence is one of the most powerful tools used to study optically-active point defects in semiconductors, especially in wide-bandgap materials. Gallium nitride (GaN) and zinc oxide (ZnO) have attracted considerable attention in the last two decades due to their prospects in optoelectronics applications, including blue and ultraviolet light-emitting devices. However, in spite of many years of extensive studies and a great number of publications on photoluminescence from GaN and ZnO, only a few defect-related luminescence bands are reliably identified. Among them are the Zn-related blue band in GaN, Cu-related green band and Li-related orange band in ZnO. Numerous suggestions for the identification of other luminescence bands, such as the yellow band in GaN, or green and yellow bands in ZnO, do not stand up under scrutiny. In these conditions, it is important to classify the defect-related luminescence bands and find their unique characteristics. In this presentation, we will review the origin of the major luminescence bands in GaN and ZnO. Through simulations of the temperature and excitation intensity dependences of photoluminescence and by employing phenomenological models we are able to obtain important characteristics of point defects such as carrier capture cross-sections for defects, concentrations of defects, and their charge states. These models are also used to find the absolute internal quantum efficiency of photoluminescence and obtain information about nonradiative defects. Results from photoluminescence measurements will be compared with results of the first-principle calculations, as well as with the experimental data obtained by other techniques such as positron annihilation spectroscopy, deep-level transient spectroscopy, and secondary ion mass spectrometry.