Nitrogen doped ZnO: from p-type layer to a diode

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Zinc oxide with its E_g=3.37 eV room temperature energy gap and large exciton binding energy is a prospective material for a number of applications such as ultraviolet light emitters or detectors [1]. For such applications successful p-type doping of ZnO is necessary. It is known, however, that it is a difficult task due to the background n-type doping associated with O vacancies (V_o), Zn interstitials (Zn_i), and/or the high hydrogen (H) level compensating p-dopants. Group V elements such as N or As are often used for obtaining *p*-type conductivity in ZnO.

In this work we study the *p*-ZnO/*n*-GaN heterostructures. The high quality p-n structures consist of nitrogen doped ZnO:N films grown by Molecular Beam Epitaxy, and *n*-type GaN templates. The quality of the heterojunction was examined by X-ray diffraction, atomic force and scanning microscopy (AFM, SEM) and photoluminescence measurements. The nitrogen concentration, as measured by secondary ion mass spectroscopy (SIMS), is ~$1x10^{20}$ cm^{-3}. Incorporation of nitrogen atoms in the ZnO lattice was confirmed by the analysis of photoluminescence (PL) spectra which allowed to assign the PL peaks at 3.362 eV and 3.316 eV to N-acceptor.

Room temperature Hall measurements in the van der Pauw configurations revealed p-type conductivity of ZnO:N layers with the hole concentration at about 10^{16} cm^{-3} and Hall mobility 20 cm^2/Vs.

The maximum forward-to-reverse current ratio I_F/I_R in the obtained p-n diodes is of the order of about 10^7 at the bias of ±5 V. This is the very good result for this type of heterojunction. The difference between black and UV light current in the reverse voltage is at about four orders of magnitude. The observed wavelength dependence of the photocurrent confirmed the high selectivity of the photodiodes.

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