Preface

Extensive research is currently carried out on ZnO as a potential material for the fabrication of optoelectronic devices such as laser diodes (LDs) and light-emitting diodes (LEDs) in the ultraviolet (UV) region because of its wide bandgap (3.437 eV at 2 K) and a large excitonic binding energy of 60 meV at room temperature. However, the bottleneck in ZnO-based devices is the creation of reliable and reproducible p-type films, because ZnO is an intrinsically n-type material due to defects such as oxygen vacancies and zinc interstitials. The low solubility of dopants and self-compensating process on doping further aggravate the problem. This monograph describes the different implantation mechanisms which can be used to achieve strong, reliable and stable p-type ZnO thin films which would result in revelations in the optoelectronics field in the UV region. This monograph will be very useful for new doctorant students who want to work on doping and implantation of ZnO thin films and subsequently fabricating optoelectronic devices. Chapter 1 of the monograph emphasises the importance of ZnO in the field of optoelectronics for ultraviolet (UV) region and also discusses the material, electronic and optical properties of ZnO. Chapter 2 discusses the optimisation of the pulsed laser-deposited (PLD) ZnO thin films in order to make successful p-type films and in order to achieve the high optical output required for higher efficiency devices. It also discusses a hydrogen implantation study on the optimised films to confirm whether the implantation leads to improvement in the optimised results. Chapter 3 gives details about the various implantation studies performed on ZnO thin films in order to achieve successful and reliable p-type ZnO films. Conventional ion implantation (CII) was used to implant lithium and phosphorus ions, while plasma immersion ion implantation (PIII) was used to implant phosphorus and nitrogen ions. Once the p-type ZnO was achieved, the fabrication and characterisation of the different ZnO-based optoelectronic devices were carried out which have been discussed in Chap. 4. The successful fabrication of heterojunction devices such as p-ZnO/n-Si diode and p-ZnO/p-Si detectors is demonstrated. Fabrication of p-ZnO/n-ZnO homojunction LED is also demonstrated. The last chapter summarises the various results of the experiments presented and provides an insight into potential further studies in this field.

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