T1-004

Optical characteristics of p-type ZnO epilayers doped with Sb by metalorganic chemical vapor deposition

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ZnO is a widely investigated material for the blue and ultraviolet solid-state emitters and detectors. It has been promoted due to a wide-band gap semiconductor which has large exciton binding energy of 60 meV, chemical stability and low radiation damage. However, there are many problems to be solved for the growth of p-type ZnO for practical device applications. Many researchers have made an efforts to achieve p-type conductivity using group-V element of N, P, As, and Sb. In this letter, we have studied the optical characteristics of the antimony-doped ZnO (ZnO:Sb) thin films by means of photoluminescence (PL), PL excitation, temperature-dependent PL, and time-resolved PL techniques. We observed donor-to-acceptor-pair transition at about 3.24 eV with its phonon replicas with a periodic spacing of about 72 meV in the PL spectra of antimony-doped ZnO (ZnO:Sb) thin films at 12 K. We also investigate thermal activation energy and carrier recombination lifetime for the samples. Our result reflects that the antimony doping can generate shallow acceptor states, leading to a good p-type conductivity in ZnO.