ABSTRACT

Developing transparent conductors that can utilize a portion of the UV range of the sunlight requires bandgap engineering by varying the process parameters as well as type and concentration of dopants in the host materials. To this end, ZnO is a desired material because of its wide direct band gap (E_g) of around 3.2 eV, low cost and less toxicity. In this work, Mg^{2+} and/or Al^{3+}-doped ZnO films are prepared by varying a range of process parameters in RF magnetron sputtering. A detailed microstructural and optoelectronic characterization of all these films are then carried out by using a combination of experimental techniques, like, GIXRD, FESEM, EDS, UV-Vis-NIR, PL spectroscopy and Hall Effect measurement system. All these films are found to have high optical transparency and showed blue shift as a result of Mg^{2+} and/or Al^{3+} doping with E_g ranging from 3.24 to 3.90 eV. Moreover, (Mg^{2+}, Al^{3+})-doped ZnO films are found to demonstrates better optoelectronic properties than those of the ZnO films doped only using either Mg^{2+} or Al^{3+}. Whereas Mg^{2+} is found to increase the optical bandgap of these films, Al^{3+} addition is found to increase both the carrier concentration and carrier mobility, with the best values of the electrical properties being obtained when only Al^{3+} is added to ZnO. This study shows a possible method to harness the near UV portion of the sunlight by doing bandgap engineering of ZnO through the addition of Mg^{2+} and/or Al^{3+} without compromising much on their overall electrical properties.