

Spectroscopic analyses of surface and defects states of zinc oxide and controlling of its emission properties

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Zinc oxide is an oxide semiconductor having direct band gap of 3.3 eV. It has been applied to white paint or additive for rubber forming. Recently, some new applications of ZnO have been developed because of its wide bandgap and capability of electron doping. For example, transparent electrodes for displays and solar cells, UV cut filters and coatings (sunscreen foundation), and light emitting diode including UV laser. For all electrical and/or optical applications, controlling of electronic states of defects and impurities is the most important technology to realize useful and efficient devices or components. Thus, in this study, growth of high quality ZnO single crystals, doping defects into them, and characterization of their electro-optical properties were carried out in order to investigate the electro-optical properties of ZnO.

The single crystals grown by CVT method exhibited high efficiency for UV emission, while the flux grown crystal showed relatively lower UV emission efficiency and/or relatively strong visible light emission originated by defects and impurities.

The origin of the visible light emission has been investigated by doping experiments and the following conclusions were given,

- (1) the green emission due to deep donor is diminished by heat treatment, while that due to Cu impurity appear after the treatment.
- (2) the yellow emission appears in the ZnO doped with donor (Al) and acceptor (Li, Na), simultaneously. Further, the reduction, which increase donor concentration, makes yellow emission intensity higher.
- (3) red light emission was found by heavy doping of acceptors (Na, Li).

It is plausibly said that the understanding and controlling of light emission properties of ZnO will provides highly functional sunscreen cosmetics.