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Cathodoluminescence study of electric-field induced migration of defects in single crystal ZnO

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Point defects in ZnO play importance roles in chemical, optical and electrical properties of the material. Capability of manipulating the defects could lead to material engineering and benefit the field of ZnO based sensor, catalyst and optoelectronics. Here we examined redistribution of charge point defects in hydrothermally grown ZnO single crystal under the influence of external electric field at elevated temperature. Direct current (DC) electric field was applied to the device sandwiched between two parallel plate shaped electrodes with dielectric spacers. Near band edge (NBE) and deep level transitions in ZnO samples were measured using a scanning electron microscope equipped with a cathodoluminescence spectrometer. Green emission band with peak position of about 2.4 eV and yellow emission band with peak position of about 2.0 eV were observed. The most intense green emission was found on the surface of the ZnO sample closed to a negative electrode, whilst that of yellow emission were comparable among all samples. Difference in emission spectrum could contribute to varying density of charge-associated luminescent centres along the direction of electric field. Substitution of lithium, LiZn, has been known to be a neutral acceptor responsible for yellow luminescence in a hydrothermal grown ZnO which could not be influenced by the external field. Suppression of green emission after hydrogen plasma treatment suggests that the responsible luminescence centres could be a donor acceptor pair transition of zinc vacancy, VZn2-, anion and a shallow donor. Analysis of near band edge emission which provide information on types of shallow donor presented in the device will be discussed.

Summary

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