

## **A study of the T2 defect and the emission properties of the E3 deep level in annealed melt grown ZnO single crystals**

### **Abstract**

We report on the space charge spectroscopy studies performed on thermally treated melt-grown single crystal ZnO. The samples were annealed in different ambients at 700 °C and also in oxygen ambient at different temperatures. A shallow donor with a thermal activation enthalpy of 27 meV was observed in the as-received samples by capacitance-temperature, CT scans. After annealing the samples, an increase in the shallow donor concentrations was observed. For the annealed samples, E27 could not be detected and a new shallow donor with a thermal activation enthalpy of 35 meV was detected. For samples annealed above 650 °C, an increase in acceptor concentration was observed which affected the low temperature capacitance. Deep level transient spectroscopy revealed the presence of five deep level defects, E1, E2, E3, E4, and E5 in the as-received samples. Annealing of the samples at 650 °C removes the E4 and E5 deep level defects, while E2 also anneals-out at temperatures above 800 °C. After annealing at 700 °C, the T2 deep level defect was observed in all other ambient conditions except in Ar. The emission properties of the E3 deep level defect are observed to change with increase in annealing temperature beyond 800 °C. For samples annealed beyond 800 °C, a decrease in activation enthalpy with increase in annealing temperature has been observed which suggests an enhanced thermal ionization rate of E3 with annealing.