8-3 Green-Light-Emitting Diodes of GaP Doped with Oxygen and Indium

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We report that high intensity green light emission from GaP diodes was observed. The diodes were fabricated by diffusing zinc into n-type GaP doped with oxygen, indium, and tellurium.

N-type GaP crystals were grown from indium-gallium solutions by a modified vapor-liquid-solid method[1] and by the liquid phase epitaxial growth technique.[2] The solution contain a small amount of tellurium for n-type dopant and gallium oxide. Grown GaP crystals contain about 2 mol % of InP, and the carrier density is about $5 \times 10^{17}/cm^3$. The pn-junction is formed by the diffusion of zinc at 800°C for two hours.

The pn-junction diodes thus prepared emitted high intensity green light. The emission spectra at room temperature comprised strong sharp green band (555 nm) and weak broad red band (620 - 730 nm), as shown by the curve I in Fig. 1. Cureves I, II, III, represent emission spectra of the GaP diodes of three different combinations of dopants : for curve I, dopants are O, In, Te ; for curve II, O and Te ; for curve III, In and Te. The current densities are 2 A/cm^2 for curve I, 20 A/cm^2 for curve II, and 10 A/cm^2 for curve III. For the diode of curve I, the intensity of green band emission is high and that of red band emission is low although the diode is doped with oxygen. As the current density increases for the diode of curve I, the green emission intensity increases remarkably, while the red emission intensity saturates. The

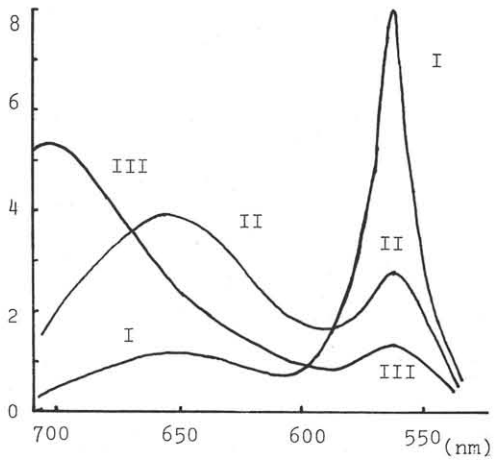

Fig. 1

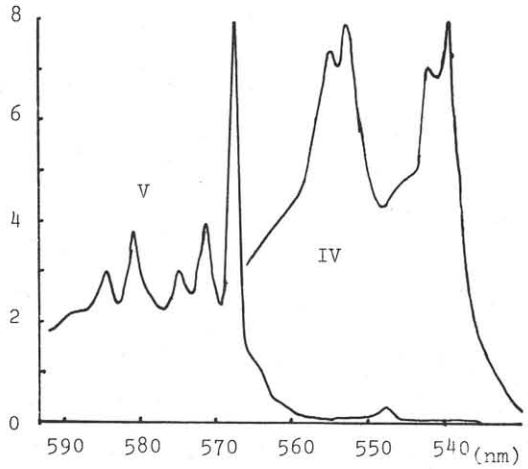

Fig. 2

curves in Fig. 1 strongly suggest that the observed green-light emission is due to the presence of oxygen and indium in GaP.

In view of the previous reports that showed the existence of nitrogen in GaP[3] was responsible for green-light emission[4], we studied emission spectra at 77°K from two differently prepared diodes and the results are shown in Fig. 2. The curve IV in Fig. 2 is for a GaP diode doped with O and In, and the curve V for a diode doped with N. As is evident from Fig. 2, the emission spectrum of the O- and In-doped GaP diode is clearly different from that of the N-doped GaP diode. The O- and In-doped GaP diode has its emission spectrum in the shorter wavelength range than that of N doped one. Furthermore, similar green light emission is obtained from the diodes prepared with GaP crystals grown after preheating the indium-gallium solution at 800°C in a vacuum before introducing Ga_2O_3, Te and P without exposing to air in order to avoide nitrogen contamination. These results support that the green light emission of the diode of curve I in Fig. 1 is not due to nitrogen.

Indium and oxygen are needed for this high intensity green light emission although oxygen is generally known to be an origin of red light emission. Thus, the oxygen and indium doped GaP green-emitting diodes relax the no-oxygen-contamination requirement for green-emitting diodes which are difficult to meet.

References

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