4-4

DETERMINATION OF THE SOLIDUS AND GALLIUM AND PHOSPHORUS VACANCY CONCENTRATIONS IN GAP

by

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ABSTRACT

The Ga concentration in GaP crystals prepared by a variety of techniques (pulled by the liquid encapsulation Czochralski technique from stoichiometric or nonstoichiometric melts, solution grown, and annealed) has been determined by precision coulometric titration, yielding the experimental solidus boundary which exhibits an excess of Ga along the Ga-rich liquidus. Based on a thermodynamic model, assuming that neutral Ga and P-vacancies are the predominant native defects, the analysis of the solidus data permitted the evaluation of the vacancy concentrations over a wide temperature range. At the melting point of GaP (1465°C) there are 8×10^{18} and 1.3×10^{19} cm^{-3} Ga- and P-vacancies, respectively, in the crystal. The calculated solidus curve well represents the totality of experimental data and shows retrograde temperatures at 1375° and 1400°C on the Ga and P-rich sides, respectively. The energies and enthalpies associated with vacancy formation are given and discussed. It is shown that the data provides strong additional support to the previous identification of Ga-vacancies with killer centers in GaP.

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FIGURE CAPTIONS

Fig. 1 The solidus of GaP. The data represent the growth or annealing temperature of GaP crystals versus the Ga concentration (Eq. (4)) found by coulometric analysis. Note that 1100°C was taken as the average growth temperature of SG crystals.

Fig. 2 The calculated Ga and P-vacancy concentrations for GaP crystals in equilibrium with liquid solutions along the Ga and P-rich branches of the liquidus curve.

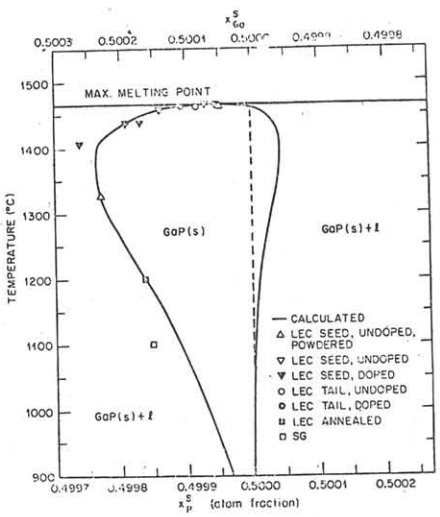

Fig.1

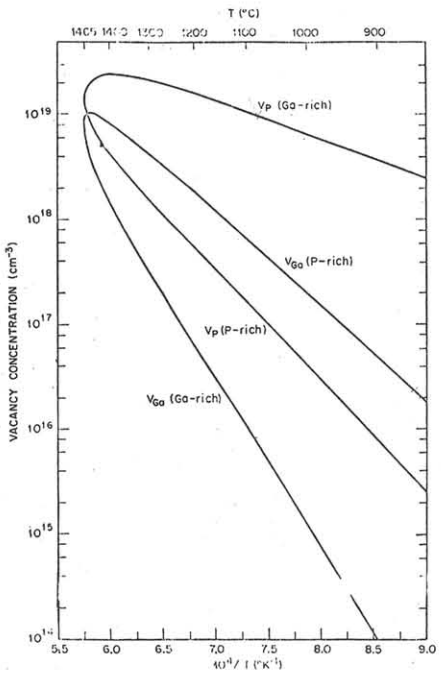

Fig.2