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InGaAs MOMBE – system drift and material quality *

E. Woelk, M.E. Sherwin and G.O. Munns

Center for High-Frequency Microelectronics, University of Michigan, 2228 EECS Building, Ann Arbor, Michigan 48109-2122, USA

Lattice matched $In_xGa_{1-x}As$ films were deposited on InP substrate using MOMBE with TMIn, TEGa, and a solid arsenic source. All growth runs reported here were carried out on a quarter 2 inch (100) SI InP wafer. The gas manifold was set to the following parameters, of which bubbler pressure and H_2 flow through the bubblers were varied around the given values for most of the layers. Temperature of the TEGa bubbler was 6.4°C, H_2 flow was 11.2 SCCM, and pressure was 23.2 Torr. The set point for the TMIn line was 19.9°C, about 10 SCCM, and about 18 Torr, respectively. This gives a total alkyl flow of about 2.2 SCCM or 1×10^{-4} mol/min. The vapor pressure values for this calculation were taken from ref. [1] for TMIn and from ref. [2] for TEGa. The temperature of the arsenic effusion cell was adjusted to give a beam flux pressure of about 3.5×10^{-5} Torr. The growth rate under these conditions was found to be about 1 μm/h.

The composition x_s ($=x$) of the $In_xGa_{1-x}As$ layers was extracted from the lattice constant as obtained by the double crystal X-ray diffraction technique. Fig. 1 shows the ratio of TMIn content in the molecular beam, x_g, and the In content in the crystal, x_s, plotted over the run number. The data points show besides the random unreproducibility of the system (±2%), a long term drift indicating that either the TMIn content in the molecular beam increased or the TEGa content decreased. Since the duration of all runs was about the same, the run number is a rough linear time scale for the service time of the MO sources. The possible reasons for this behavior remain speculative: we would suspect a changing bubbler rather than a long-term drift in the electronics or the gas flow components.

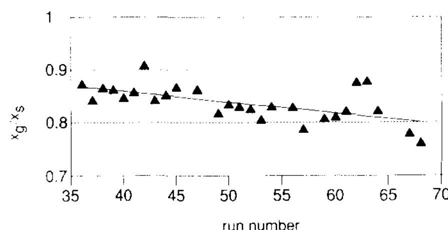

Fig. 1. Long-term drift of molecular beam.

The layers grown had a thickness of about 1.5 μm. Morphology inspection and Hall measurements were carried out. Fig. 2 shows the crystal composition dependence on the gas phase composition and growth temperature as determined by a thermocouple. The data for gas phase composition are corrected for the long-term drift shown in fig. 1. We find a linear dependence around lattice matching. The scatter of the data points is in the range of ±2% and can therefore be attributed to the unreproducibility of the gas handling components. The dependence of crystal composition on

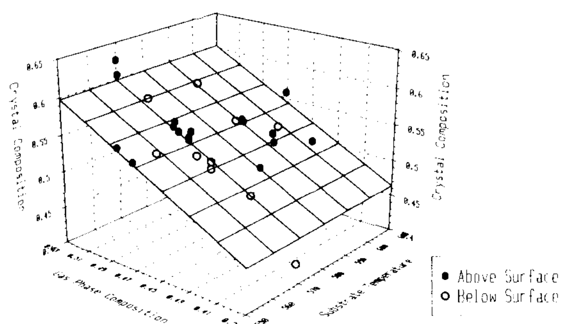

Fig. 2. Crystal composition versus gas phase composition.

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substrate temperature T_s was negligible in the investigated range of 550–610 °C. The temperature determination will be the subject of a forthcoming paper [3].

[1] Alfa Organometallics for Vapor Phase Epitaxy, Morton Thiokol. Inc., Alfa Products, 1986.

[2] C. Plass, H. Heinecke, O. Kaiser, H. Lüth and P. Balk, J. Crystal Growth 88 (1988) 463.

[3] E. Woelk, M.E. Sherwin and G.O. Munns, J. Crystal Growth, in press.