A Numerical Study on the Growth and Composition of InGaAsP in a Horizontal MOCVD Reactor

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Metalorganic chemical vapor deposition, also known as metalorganic vapor phase epitaxy has become one of the main techniques for growing thin, high purity films for compound semiconductors such as GaAs, InP, and InGaAsP. In the MOCVD system, the film growth of such materials requires high growth rate, uniformity of film thickness and homogeneous composition. Required precision for thickness control is less than a nanometer, and the composition must be controlled by less than a percent. Féron et al. [1] tried to simulate the film growth of tertiary and quaternary materials using the linear combination model.

In this study, the growth rate and composition variations of InGaAsP film were studied using computational methods. The influences of process parameters such as pressure and temperature on the growth rate and composition distributions are analyzed. Governing equations for the transport phenomena in the reactor are the continuity, momentum, energy and species mass fraction conservation equations. Trimethyl-indium, trimethyl-gallium, tertiary-butyl-arsine and tertiary-butyl-phosphine were used as precursors and hydrogen as a diluting gas. The reaction model includes 4 gas-phase reactions and 8 surface reactions. The ideal gas law and kinetic theory were used to estimate the gas properties.

The predicted value of the growth rate and composition were compared to the experimental results to validate the numerical model. In the simulation, the Ga composition was determined by the ratio of the flux between the In- and Ga- intermediates, and the composition of As was assumed to be proportional to the surface coverage of As. The influences of heater temperature and operating pressure were analyzed thereafter.

References