Structure control of InGaP/GaAs hetero-interface by in-situ ellipsometry and numerical analysis of InGaAsP quaternary materials growth in MOVPE

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Metal organic vapor phase epitaxy (MOVPE) technique has potential advantage to deposit epitaxial thin films with superior uniformity in a wide scale. It also provides unique deposition feature, like as selective growth. MOVPE process consists of gas-phase and surface reactions of source precursors, and the mass transport of film growth species by flow and diffusion. Precise control of the film interface structure and composition of grown epi-layers requires basic knowledge of these chemistries and transport phenomena. We are working on analysis and modeling of MOVPE process that will lead to tailor made fine structures for advanced devices.

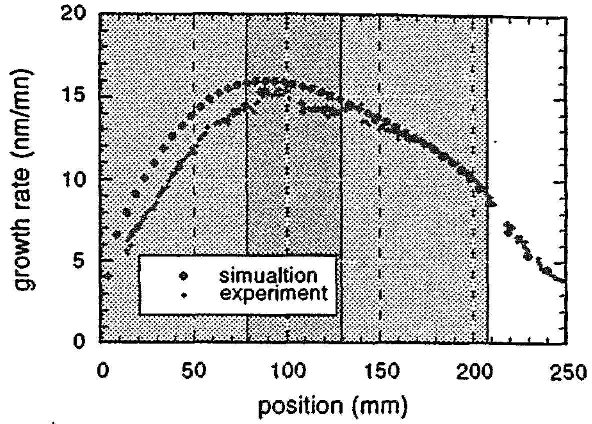

Fig.1 The growth rate profileof InGaP in MOVPE reactor at 610°C.

The study is based on the experimental and numerical analysis of the growth rate and composition distributions in a commercial MOVPE reactor (AIXTRON AIX 200/4). The source precursors are trimethylindium (TMIn), trimethylgallium (TMGa), tert-butylarsine (TBAs) and tert-butylphosphine (TBP) carried by hydrogen. The reactor is equipped with in-situ ellipsometer and FT-IR spectrometer. Growth rate was measured by SEM and composition analyses were performed with XPS. Three dimensional (3D) simulation work is performed using CFD code (Fluent™) and is based on previous kinetic data defined by IR spectroscopy [1]. Figure 1 shows an example of growth rate profile within the reactor. The numerical calculation can well explain the experimental results [2]. Systematic approach to fabricate abrupt hetero interface, like as InGaP/GaAs, is the other major research target of our group. The adsorption/desorption of As and P during the formation of interfaces reduces the abruptness of As/P composition. The gas-switching sequence that determines the amount of surface adsorbates is the key to control interface structure. Thus we made *in situ* analysis using kinetic ellipsometry to observe adsorption/desorption of As and P on InGaP/GaAs surface. Figure 2 shows an example of P desorption from InGaP surface. From the intensity change of the ellipsometry, we could detect the desorption rate constant and it helps to construct optimum gas switching sequences [3].

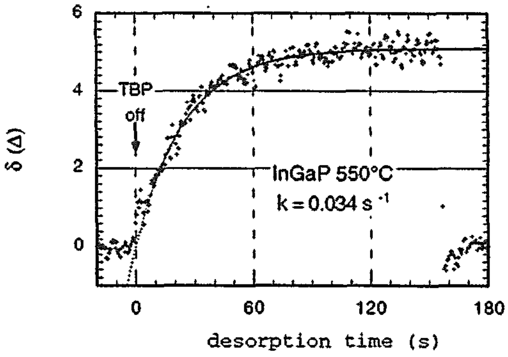

Fig.2 The signal change of ellipsometry due to P desorption from InGaP surface.

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[2] O. Féron , Y. Nakano, and Y. Shimogaki, J. Crystal Growth, in press.

[3] T. Nakano, Y. Nakan, and Y. Shimogaki, J. Crystal Growth, in press.