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In-situ Optical Monitoring on III-V surface using Surface Photo-Absorption

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Monitoring of monolayer (ML) changes in III-V surfaces in metalorganic chemical vapor deposition (MOCVD) was performed by using surface photoabsorption (SPA). For the growth monitoring, we could observe the monolayer change during the growth of GaAs at 650 C to obtain the appropriate ML growth condition AlGaAs quantum well (QW) structures were also grown by monitoring SPA signal oscillations. Photoluminescence measurements of these QWs show excellent agreement between the observed spectra and model calculations in both peak energies and line width, confirming that the growth rate was 1 ML per cycle and that the roughness at the interface was < 1 ML.

For the monitoring of desorption process, investigation on As- and P-desorption processes from (001) InP surface was performed at various temperatures. When we performed As-adsorption and desorption on the (001) InP surface at 470℃, the SPA signal change at 470nm along [1 0] direction shows the same behavior observed in previous reports in that the SPA signal shows a final stable value (M-surface) after AsH3 is turned off. This final surface was interpreted as In-stabilized surface in previous reports.[1] The reason why the SPA signal of the same In-stabilized surface (In-surface) before and after AsH3 supply (M-surface) is different was also explained by the formation of 1-2 monolayer thick InAsP layers under the surface caused by As/P exchange reaction. However, the SPA subtraction spectra of current work at various temperatures show that the spectrum of M-surface is not similar to that of In-surface but closer to that of the A-surface of the As-stabilized surface, indicating that the M-surface which was a stable state at 470℃ is only a transient state at 570℃, quickly evolving to a new stable state (S-surface), resulting that the S-surface may be the real In-surface. The SPA subtraction spectra for each of the state also confirmed our analysis. If our interpretation is correct, the conventional measurement of the amount of As/P exchange effect should be changed. We also conclude that in contrast to P-desorption of a one step process, the As-desorption from the (001) InP occurs as a two-step process, consisting of first the desorption of the weakly-bonded isotropic excess As followed by the desorption of chemically-bonded anisotropic As-dimers.

Finally, we will present our work with our newly developed (modified) SPA subtraction formular with which we could obtain the SPA response of group III and V surfaces separately, as can be done in Reflectance Difference Spectroscopy, so we could observe a new feature on InP (001) surface.

[1] N. Kobayashi and Y. Kobayashi, J. Cryst. Growth. 124, 525 (1992).