Correlation between the surface morphology and diffusion lengths of Ga adatom in GaP growth by MBE

豊橋技科大, Toyohashi Tech.
° J. A. Piedra-Lorenzana, K. Yamane, K. Shiota, H. Sekiguchi, H. Okada, A. Wakahara
E-mail: jose-a@int.ee.tut.ac.jp, wakahara@ee.tut.ac.jp

In recent years there has been a lot of effort in researching GaP based III-V-N materials as lattice-matched grown semiconductors on Si for optoelectronic devices. However, III-V /Si heteroepitaxy has difficulties due to the difference in lattice constant, polarity and thermal expansion coefficient between the materials. These differences cause the generation of threading dislocations, stacking faults and antiphase domains.

Diffusion length of adatoms on the grown surface is one of the key factors to understand the growth mechanism. We reported the surface diffusion length on MBE growth of GaP [1]. For deeper understanding, in this work correlation between the surface morphology and diffusion length in GaP growth is investigated.

GaP layers were grown by MBE at the V/III ratio of 4 and growth rate of 300 nm/h. The growth temperature was varied from 500°C to 650°C. Diffusion length of Ga adatoms was estimated by diffusion atoms between different adjacent faces by applying a one-dimensional diffusion growth model as reported in ref. [1].

In Fig. 1 the diffusion length values obtained are plotted in terms of the growth temperature for the <110> and <1$\bar{1}$0> crystal directions. Diffusion length increased with temperature for both directions.

Atomic force microscopy was employed for the study of the surface morphology. For the sample grown at 650°C, step-flow growth was observed and for the rest of the samples, island growth was obtained as shown in Fig. 2. By measuring the mean island size in the <110> and the <1$\bar{1}$0> directions we found that the mean size of the islands increase as the diffusion length increase, this behavior can be seen in Fig. 3. , using this dependence we can estimate the diffusion length by surface morphology analysis.

Acknowledgements
This work was financially supported by the Research Foundation for the Electrotechnology of Chubu.

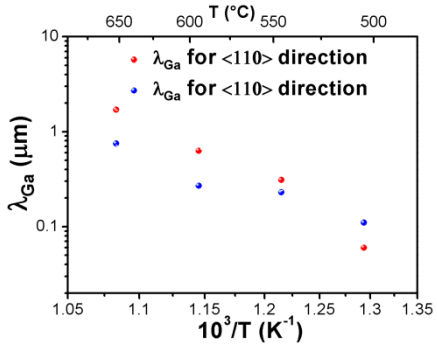

Fig. 1. Arrhenius plots of diffusion length for different crystal directions.

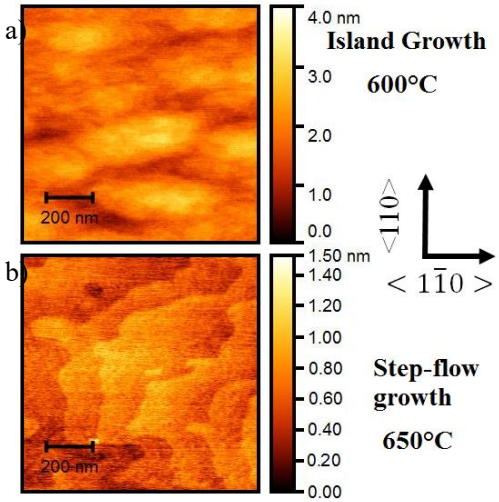

Fig. 2. AFM 1×1 μm^2 images of GaP surface grown at different temperature (a) 600°C and (b) 650°C.

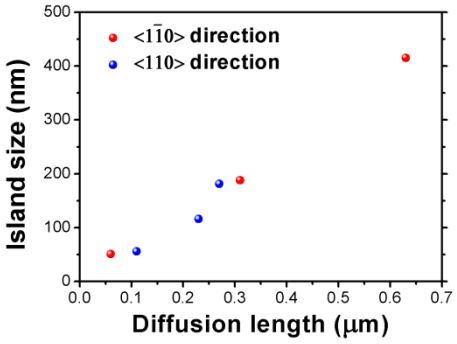

Fig. 3. Island size vs diffusion length for different growth temperatures at <1$\bar{1}$0> and <110> direction.

[1] Shiota et al. 2018 JSAP autumn meeting 18p-234B-3