AM-MEE growth of InAlN on Si(111) using RF-MBE

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1. Introduction

RF-MBE (Radio frequency plasma assisted molecular beam epitaxy) is the most simple growth method for group III-nitrides using group III metal atoms and N atoms. It uses chemicaly safe materials only and a material saving growth method. AM-MEE (the activity modulation migration enhanced epitaxy) of RF-MBE method is a candidate to grow high quality group III-nitrides on a large size Si wafer. The AM of an rf discharge means the activity selection of chemically active nitrogen atoms (N+N*), where N and N* are ground and excited atoms, respectively, produced by a high brightness (HB) discharge mode and physically active excited nitrogen molecules N_2* produced by a low brightness (LB) discharge mode [1].

In this report in order to improve lattice miss matching of AlGaN/GaN HEMT, $In_{0.17}Al_{0.83}N$ mixed nitride film, which is a lattice matching material for GaN film as shown in Fig.1, is grown by AM-MEE and the charaltalization of these films is presented.

2. Experimental

An IRFS-501 rf nitrogen radical source made by Arios Inc and a periodical power controler were in a VG-80H MBE chamber. After preparing a DBL of AlN/β-Si_3N_4/Si, which is formed by reactive epitaxy with Al and an intermediate layer of β-Si_3N_4 [2-3] on Si, the AM-MEE growth of $In_xAl_{(1-x)}N$ was performed. The detailed procedure of AM-MEE is shown in elsewhere[3-5]. The time sequence of AM-MEE is shown in Fig. 2 and 3 schematically. To prove the lattice matching HEMT strauture of InAlN/GaN/AlN/DBL/Si(111) was prepared. Mixing effect of In and Al atoms by exposure of N_2* is characterized by XRD 2θ-ω measurement.

3. Results and discussion

Fig. 4 shows a wide range $\omega/2\theta$ measurement from 25 to 160 deg for $In_{0.17}Al_{0.83}N$/GaN/AlN/GBL/Si HEMT structure. Lattce matching was not perfect because of higher angle peak separation of GaN(0006) and $In_{0.17}Al_{0.83}N$ (0006). The higher angle measurment of XRD is a good tool for lattice maching interface proof.

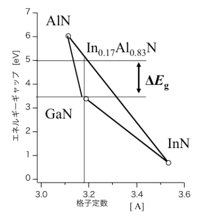

Fig. 1 Lattice constant and energy gap.

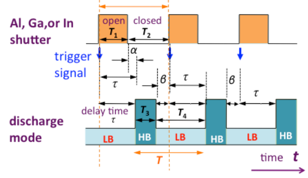

Fig. 2 Pulse exposure of group III atoms and N radicals mode change between LB and HB.

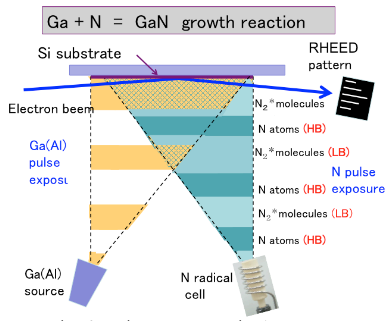

Fig. 3 Pulse exposure in AM-MEE.

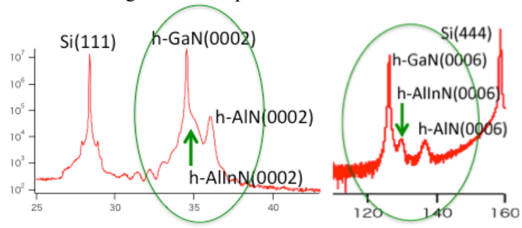

Fig 4 XRD pattern of $In_{0.17}Al_{0.83}N$/GaN/Si(111).

References

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