Activity modulation MEE growth of 2H-AlN on Si(111) using double buffer layer grown by PA-MBE

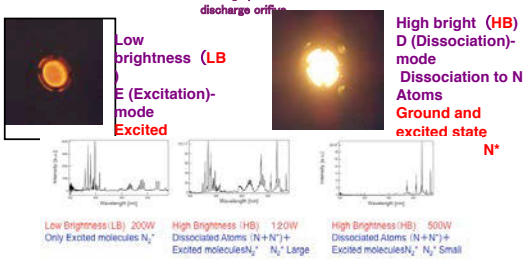
Tadashi Ohachi[a,b], Yuka Yamamoto[a], Osamu Ariyada [c],Yuuki Sato[a], Shinzo Yoshikado[a] , and Motoi Wada[a]
Department of Electrical Engineering, Doshisha University [a] , IRE Laboratry Doshisha University[b], and Arios Inc.[c]
tohachi@irel.jp http:// www.ire;.jp URL : www.irel.jp

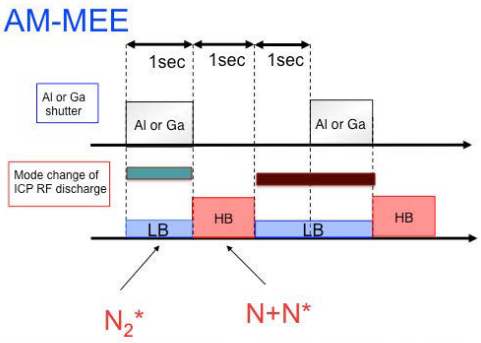
Objective

- Group III nitride devices on a large diameter Si substrate
  Continuous process system from a Si wafer to AlN, GaN, InN and their alloy using PA-MBE
- Interface reaction epitaxy (IRE) of β-Si_3N_4 and IRE-AlN
- Activity modulation migration enhanced epitaxy using HB and LB SS-jet flux

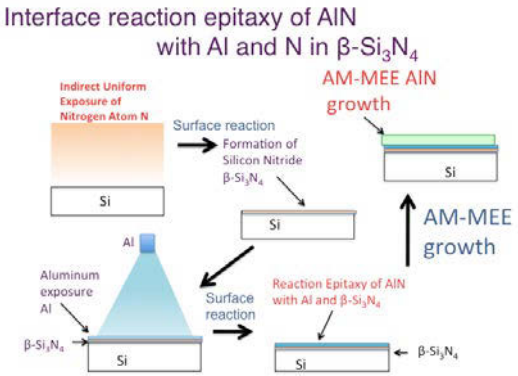
Method

- rf ICP two discharge modes:
  LB mode and HB mode

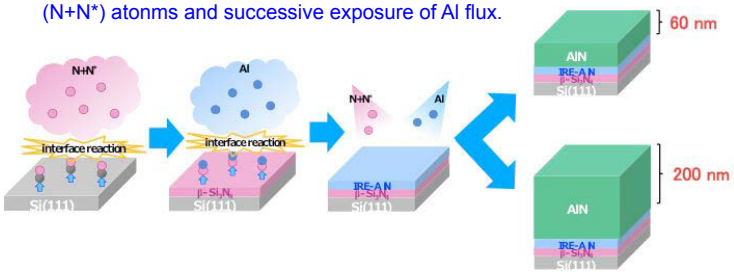




MEE is available using N shutter



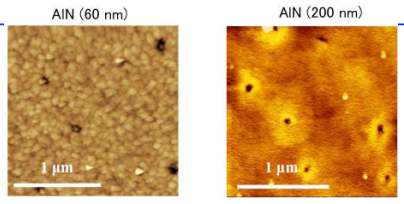
Processes of DBL formation in a MBE chamber with indirect exposure of (N+N*) atonms and successive exposure of Al flux.



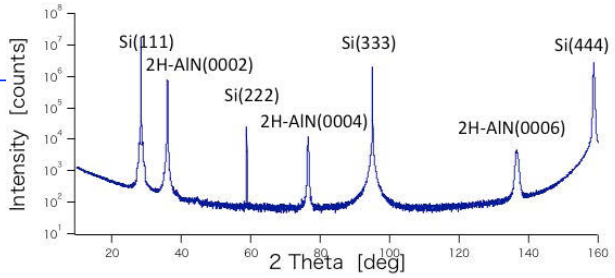
(a) Growth of β-Si_3N_4 on Si(111) by IRE.
(b) Growth of IRE-ALN by IRE.
(c) Growth of different AlN templates the DBL by AM-MEE.

Preparation process of AlN templates of 30 and 200 nm thickness on Si(111) after growth of DBL, IRE-AlN/β-Si_3N_4/Si(111).

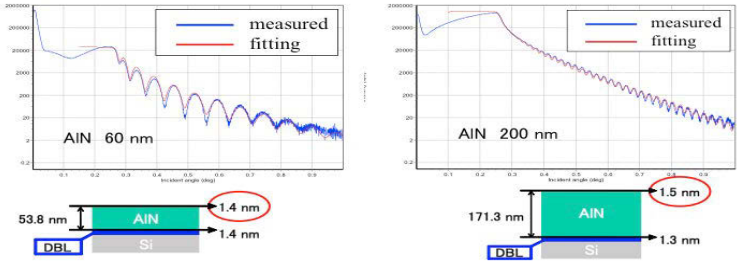
Results and Discussion



AFM images for 60 and 200 nm AlN films.



2 Theta Omega XRD data 2H-AlN on Si(111) film. FWHM of Omega rocking curve for AlN(0002), AlN(0004) and AlN(0006) are 0.76, 0.77, and 0.83 deg respectively.



GIXR patterns for 60 nm (53.8 nm by fitteing) and 200 nm (171.3 nm by fitting) AlN templates and results of simulation by a PANAlytical software of Reflectivity.

Conclusion Changing nitridation temperature of Si(111) in a MBE chamber, the thickness of b-Si_3N_4 increased from 0.18 nm to 0.35 nm at from 830 °C to 680 °C, due to the relation between the surface density of (N+N*) atoms and the substrate temperature. By increasing the thickness of the AlN from 60 nm to 200 nm the crystallinity was improved from 53.9 arcmin to 51.7 arcmin, obtained by the measurement of rocking curve of w full width at half maximum (FWHM) for AlN (0002) peak of X-ray diffraction. On the other hand, the surface roughness of AlN did not depend on the thickness of the AlN films obtained by fitting results of GIXR curves.