Activity modulation MEE growth of group III nitrides on Si(111) using PA-MBE

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Objective

Growing high quality group III nitrides on a large size Si wafer using RF-MBE!
- Improve activity modulation (AM) migration enhanced epitaxy (MEE)
- Seek continuous process system from a Si wafer to AlN, GaN, InN and their alloy using PA-MBE
- Interface reaction epitaxy (IRE) of $\beta$-Si$_3$N$_4$ and IRE-AIN
- Apply AM-MEE growing alloy group III nitrides (InGaN and InAlN) using HB and LB SS-jet flux

Method and Principle

- rf ICP two discharge modes: LB mode and HB mode
  - Low brightness (LB) E (Excitation)-mode
  - Excited molecules N$_2^*$
  - High brightness (HB) D (Dissociation)-mode
  - Dissociation to N Atoms
  - Ground and excited state
  - Atoms N + N$_2^*$
- As maximum power of power supply is $5\,\text{kW}$, mode change control is possible under about 120 Pa

Mode control for AM-MEE:

- Physically: migration and evaporation
- Chemically: chemical reaction

Physical and Chemical Activities:

Mode control for AM-MEE:

- Shutter sequences:
- AM-MEE sequences:

Effect of AM-MEE: evaporation + migration

Polarity control of 2H-AIN

2H-AIN grown on DBL by AM-MEE

Results and Discussion

- N shutter open at LB mode
- N shutter close at HB mode
- N excess

2H-GaN grown on AIN by AM-MEE

Conclusions

AM-MEE able to control the growth of group III nitrides and their alloy.
Further improvement of AM-MEE growth using PA-MBE is required to produce high quality films.

References: