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XRD Characterization of GaN(0002) on Si(111) films Grown by RF-MBE

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Objective

Aiming at hetero epitaxial growth of high quality and low cost GaN on Si (GoS)

- **Characterization of GoS films by XRD method**
- **Graded composiotion double buffer layer (G-DBL) and AM-MEE (Activity modulation migration enhanced epitaxy)**

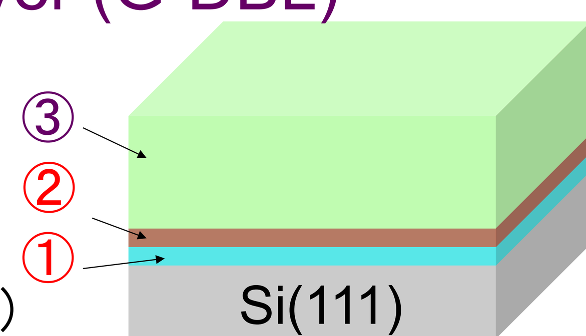
Method

[1] Growth graded Doubl buffer Layer (G-DBL) GaN/AlGaN/AlN/β-Si_3N_4/Si(111)

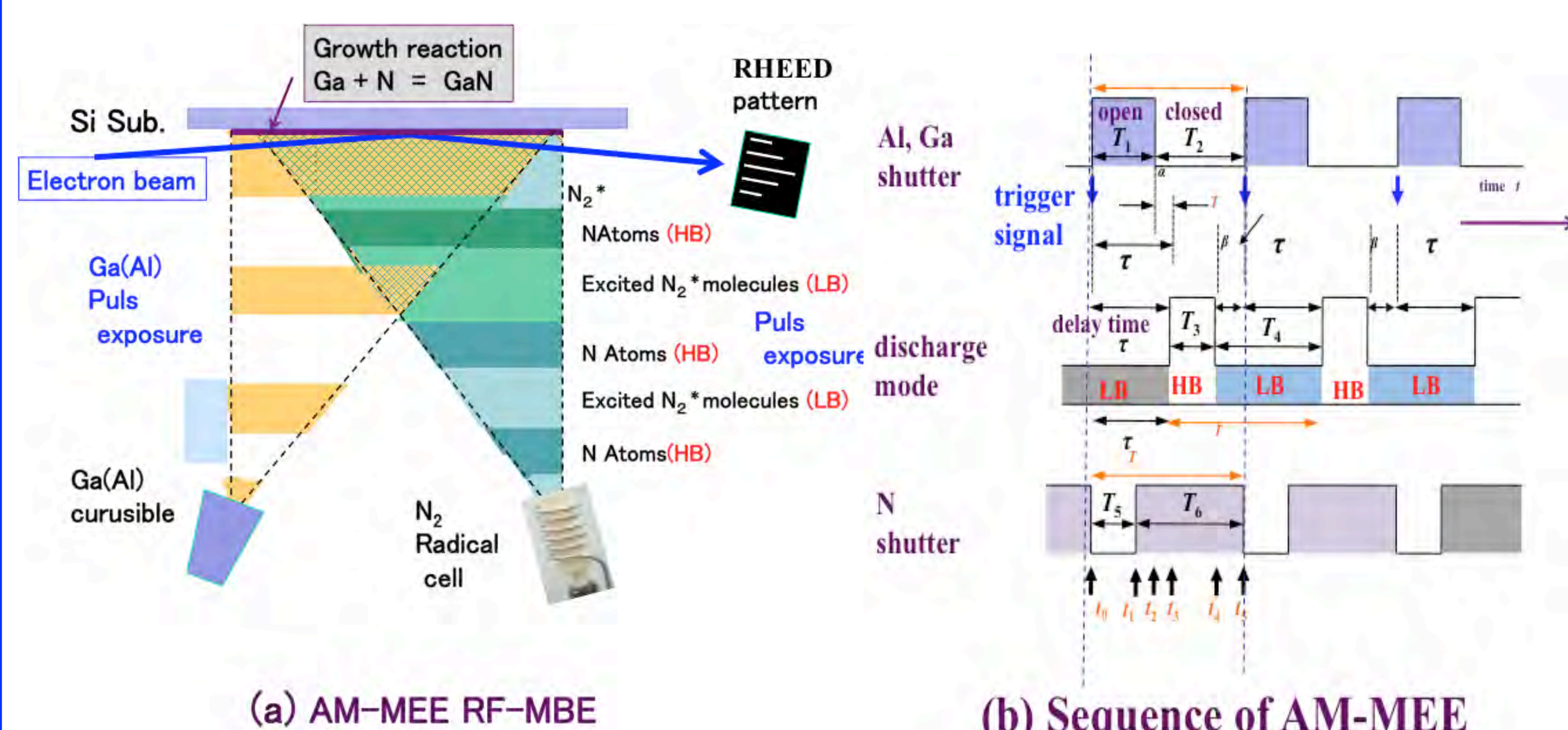
① AlN DBL : AlN/β-Si_3N_4/Si

② Graded composition AlGaN growth G-DBL (Activity Modulationb(AM) MEE)

③ GaN growth by AM-MEE

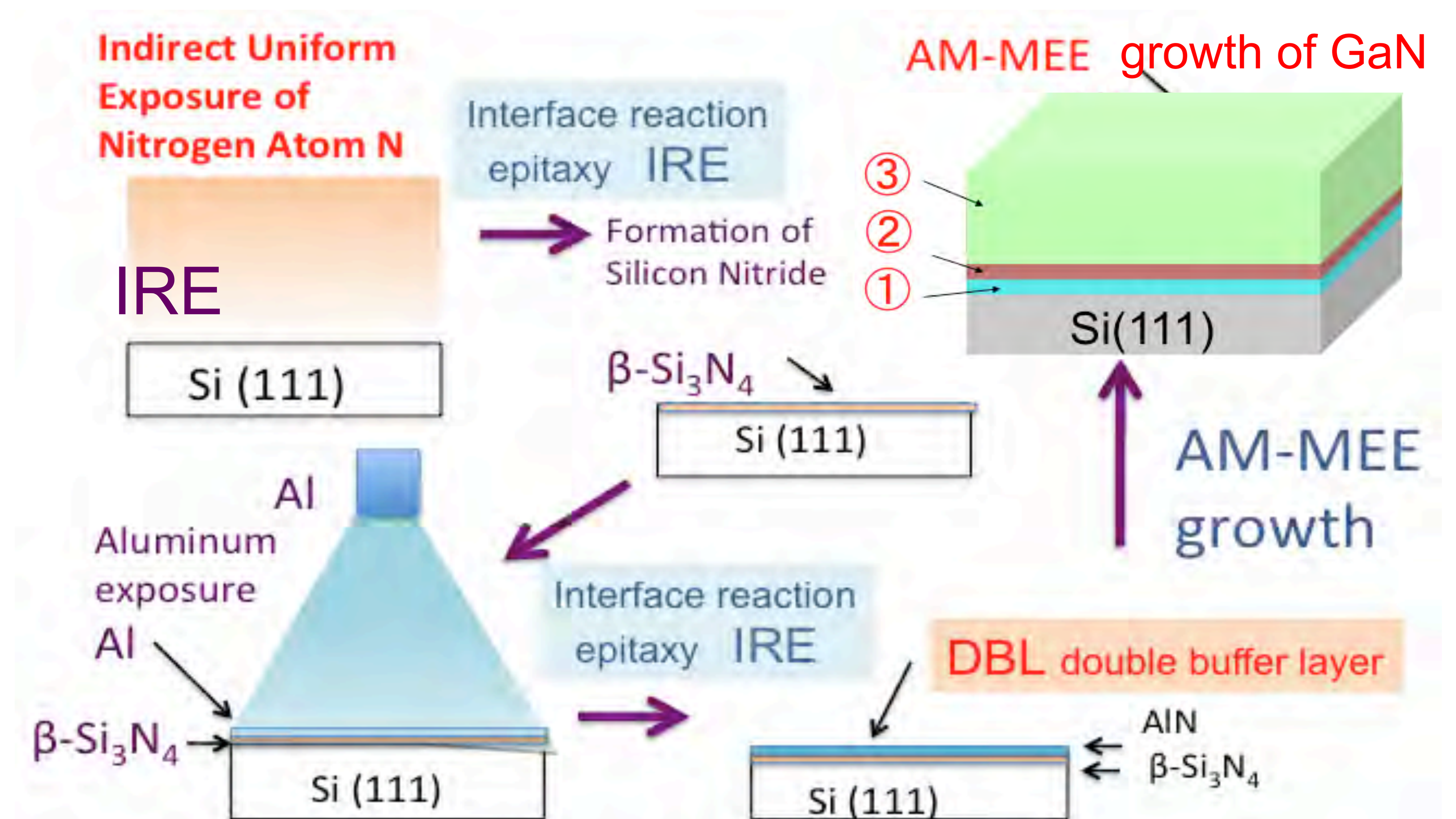


[2] Activity Modulation (AM) MEE



(a) AM-MEE RF-MBE (b) Sequence of AM-MEE

[3] Interface reaction epitaxy of β-Si_3N_4 on Si , graded double buffer layer, and AM-MEE growth of GaN



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

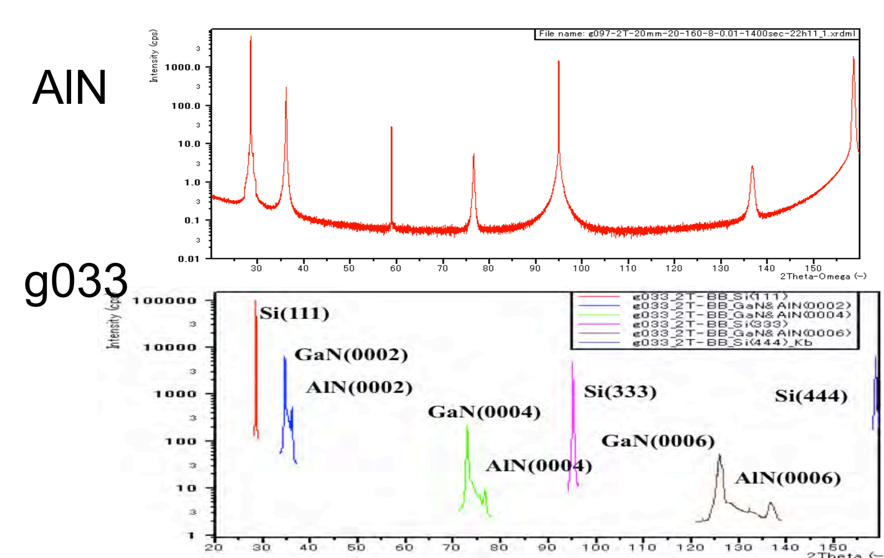
[4] Samples

GaN / AlN or AlGaN / Si(111)

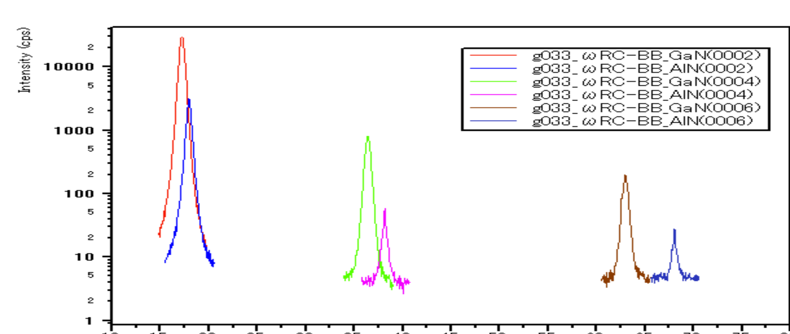
[nm]	g033	g404	f145
GaN	90	43	191
AlGaN	36		
AlN		40	46

Results

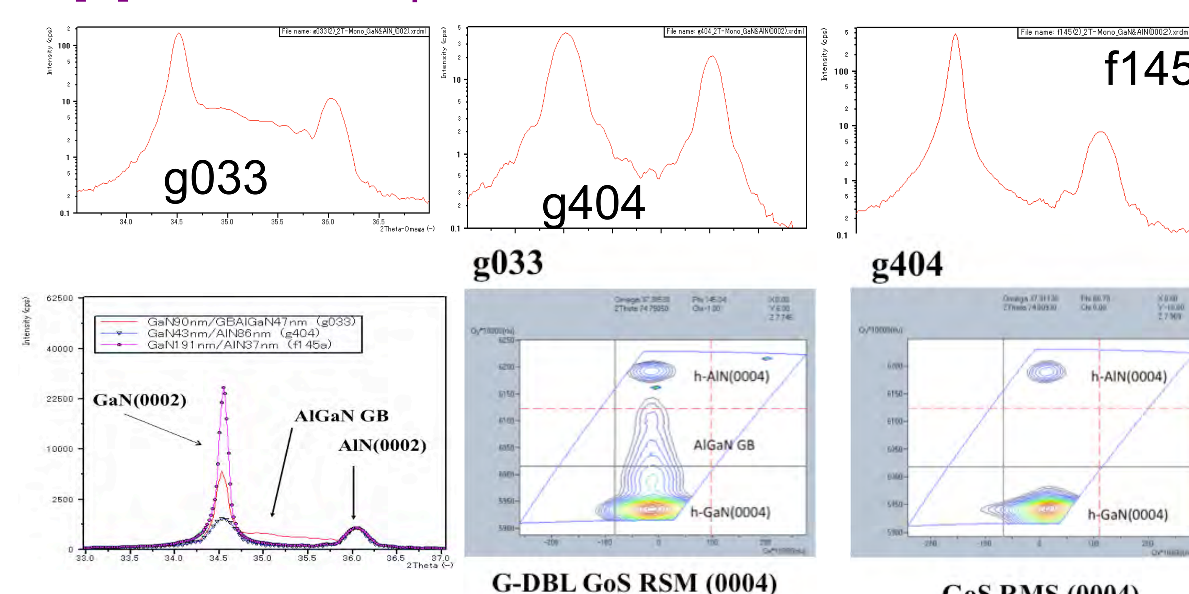
[1] Wide range of 2θ-ω XRD pattern



[2] ω rocking curves for g033

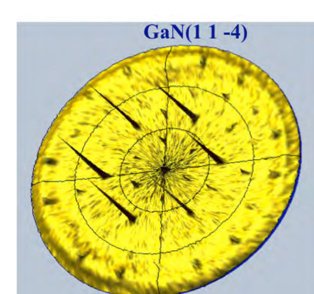


[3] 2θ-ω XRD pattern of G-DBR and RSM



G-DBL GoS RSM (0004) GoS RMS (0004)

[4] Pole figure of GaN(11-4) f145



[5] FWHM measured for GoS films

G033 90 nm

	GaN(0002)	AlN(0002)	GaN(0004)	AlN(0004)	GaN(0006)	AlN(0006)
ω	0.56	0.461	0.573	0.241	0.554	0.166
2θ	0.177	0.251	0.358	0.421	0.918	1.303

g404 43 nm

	GaN(0002)	AlN(0002)	GaN(0004)	AlN(0004)	GaN(0006)	AlN(0006)
ω	0.857	0.698	0.855	0.567	0.882	0.403
2θ	0.281	0.232	0.511	0.47		1.1

f145 191 nm

	GaN(0002)	AlN(0002)	GaN(0004)	AlN(0004)	GaN(0006)	AlN(0006)
ω	0.322	0.364	0.348	0.347	0.345	0.292
2θ	0.091	0.239	0.159	0.377	0.412	

Discussion

Thickness of an initial AlN layer is not small gor g033 G-DBL. Thicker AlN or GaN layer make smaller FWHM of rocking curves. From point of graded composition double buffer layer, thinner AlN layer may give advantage to be able to thicker GaN layer growth.

References

[1] N. Yamabe, H. Shimomura, T. Shimamura, and T. Ohachi, J. Cryst. Growth 311, 3049 (2009).
[2] N. Yamabe, Y. Yamamoto, and T. Ohachi, Phys. Status Solidi C 8, 1552 (2011).
[3] T. Ohachi, N. Yamabe, Y. Yamamoto, M. Wada, and O. Ariyada J. Jpn. Appl. Phys. 50, 01AE01(1)-(8) (2011).
[4] T. Ohachi, Y. Yamamoto, O. Ariyada, Y. Sato, S. Yoshikado, and M. Wada, P hys. Status Solidi C 10, No. 3, 429–432 (2013).
[5] Y. Yamamoto, N. Yamabe, and T. Ohachi, J. Cryst. Growth 318, 474 (2011).

Conclusion

- Graded double buffer layer GaN/AlGaN/AlN/β-Si_3N_4/Si was effectively operated to reduce FWFM for GaN layer.
- AM-MEE Growth under Ga excess condition will help to reduce FWFM as loke as liquid layer epitaxial mode.