ThP-CR-20(Poster) IWNS2018 Kanazawa 2018.11.11 - 16

Characterisation of a GaN{0001} Substrate using X-ray Multiple Difraction in Crystal by Renninger Scan

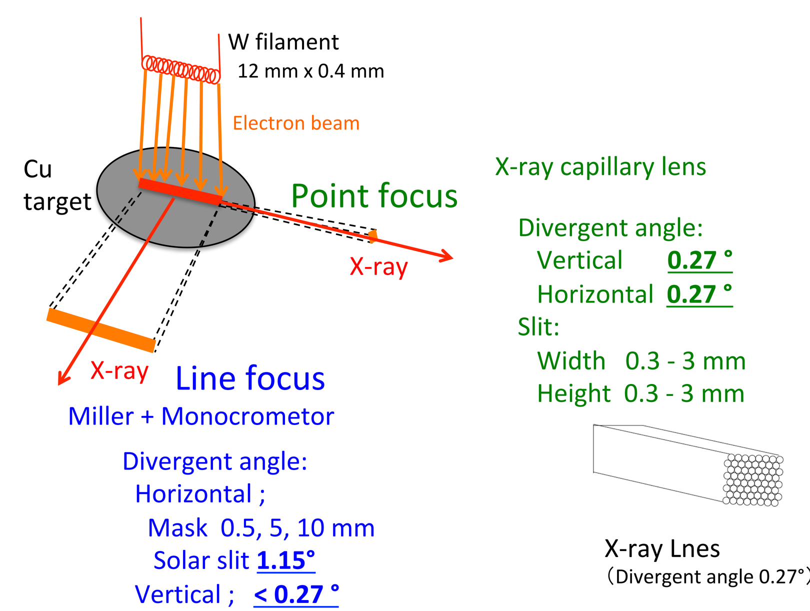
T. Ohachi[1,2), Y. Sato[2), K. Takemoto[1), Y. Hagi[3), M. Wada[2), S. Yoshikado[2)

Interface Reaction Epitxy Laboratory[1) Doshisha University[2) Sumiden Semiconductor Materials Co. Ltd.[3)

1. Introduction

FCP (Fixed Chi Phi) Scan [Renninger Scan][1), which is X-ray Maltiple Diffraction (XRMD), is able to characterize crystal quality and polarity of c-GaN. The FCP Scan pattern intensity and shape dependence on wave lengrh of X-ray, divergence angle of parallel X-ray, were measured for different samples.

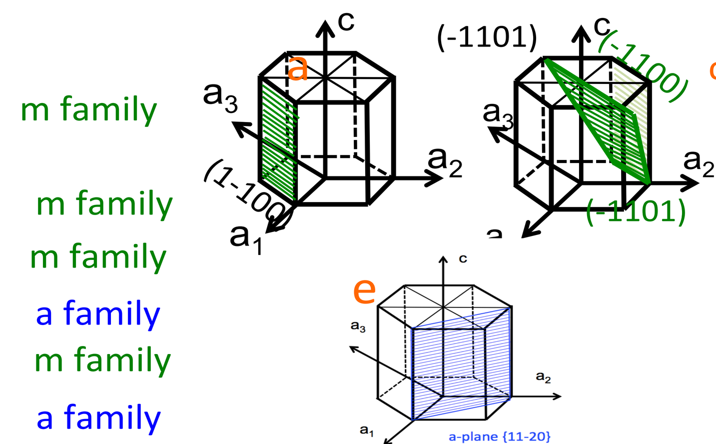
2. FCP Scan [Renninger Scan] Pattern



3. GaNSubstrate

GaN Powder Bragg diffraction peaks

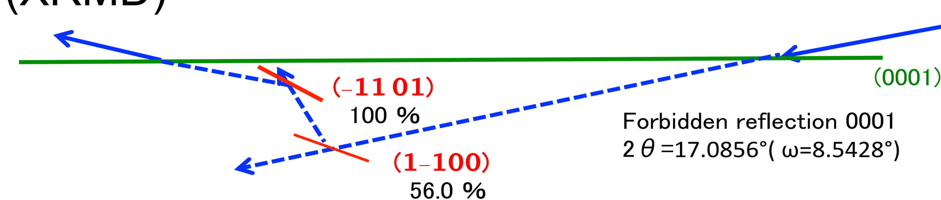
#	Index	2θ(Cu $K_{\alpha 1}$)	Intensity (%)	
a	01−10	32.388	56.0	m family
b	0002	34.563	45.0	
c	01−11	36.853	100.0	m family
d	01−12	48.077	19.0	m family
e	11−20	57.776	31.0	a family
f	01−13	63.449	27.0	m family
g	11−22	69.103	22.0	a family
h	02−21	70.51	12.0	



Index of FCP pattern for GaN

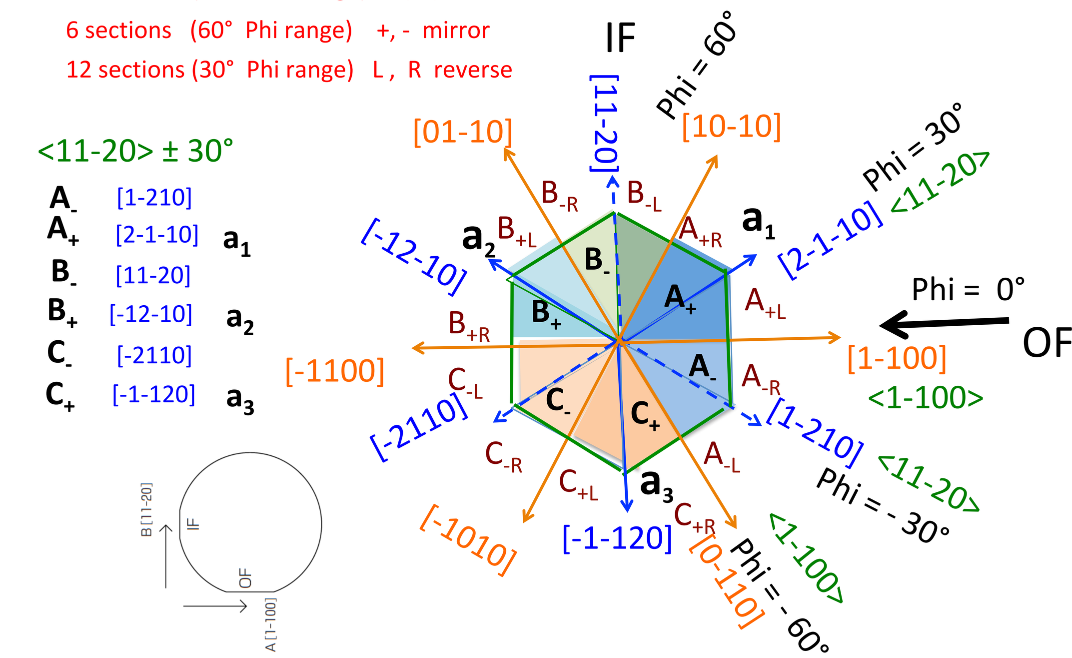
Peak No.	Indexed Peaks by Blasnig & Krost	Phi [degree]	Relative Intensity [%]	refrection type
1	P1	0.87	15.0	(3−1−10)/(−3211)
2		2.47	11.5	
3	P2	2.87	2.6	(3−1−2−2)/(−3123)
4	P3	3.81	60.8	(1−10−1)/(−1102)
5		4.45	34.4	
6		4.73	13.3	
7	P5	10.15	24.1	(02−21)/(0−220)
8	P6	13.65	100.0	(1−100)/(−1101)
9		17.13	11.9	
10	P7	18.99	12.1	(12−33)/(−1−23−2)
11		19.3		
12	P8	19.67	46.0	(01−13)/(0−11−2)
13	P9	22.67	15.5	(3−120)/(−31−21)
14	P10	23.55	19.3	(02−23) /(0−22−2)

X-ray multiple diffraction (XRMD) (Umweganregung)



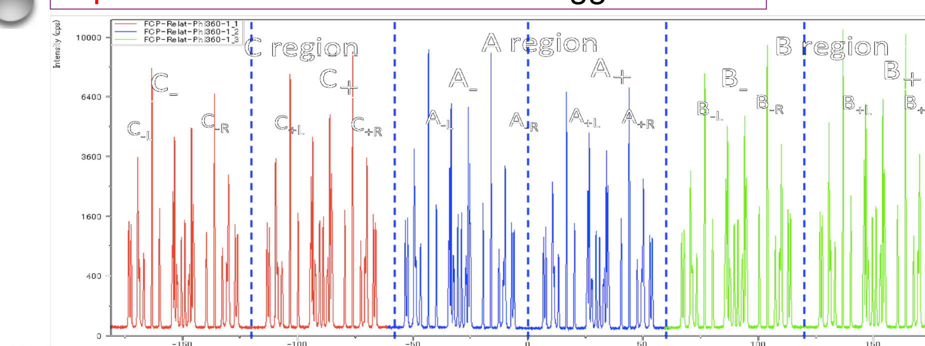
1) M. Renninger, Z. Phys. 106, 141 (1937).
2) M. Renninger, Act. Cryst. 8 597 (1955) .
3) K.Inaba, Rigaku Journal, 44(2) 7-15 (2013) (in Japanese).
4) J.B Bläsing and A. Krost, phys. stat. sol., (a)201(4). R17-R20 (2004).
5) T. Matsumoto, Mineralogycal Journal 16(1)99～108(1983)(in Japanese).

Names for sections



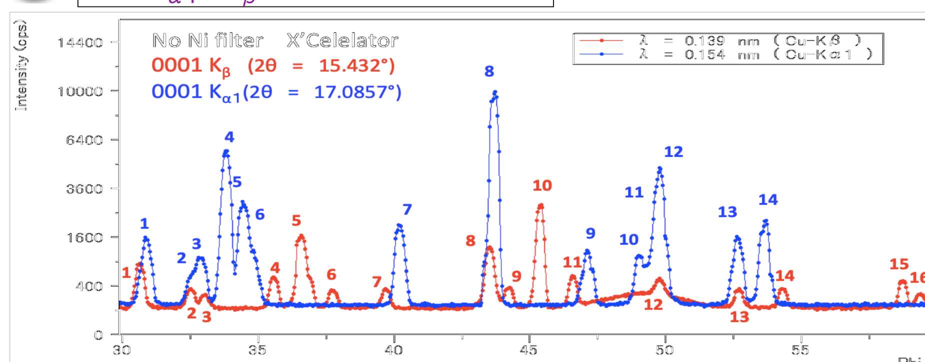
4. Results

Square Root 0001 Forbidden Bragg reflecton



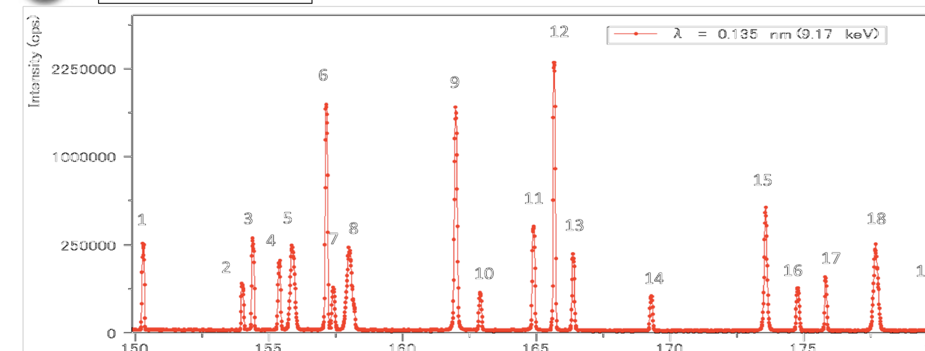
Φ360° FCP Scan Pattern of c-GaN (Renninger Scan pattern) Cu-$K_{\alpha 1}$ (0.154 nm) 12 sections

Cu−$K_{\alpha 1}$ K_{β} (Ni filter less)



φ30° FCP Scan Pattern of c-GaN (Renninger Scan pattern) Cu-K_{β} (0.139 nm:16) Cu-$K_{\alpha 1}$ (0.154 nm:14)

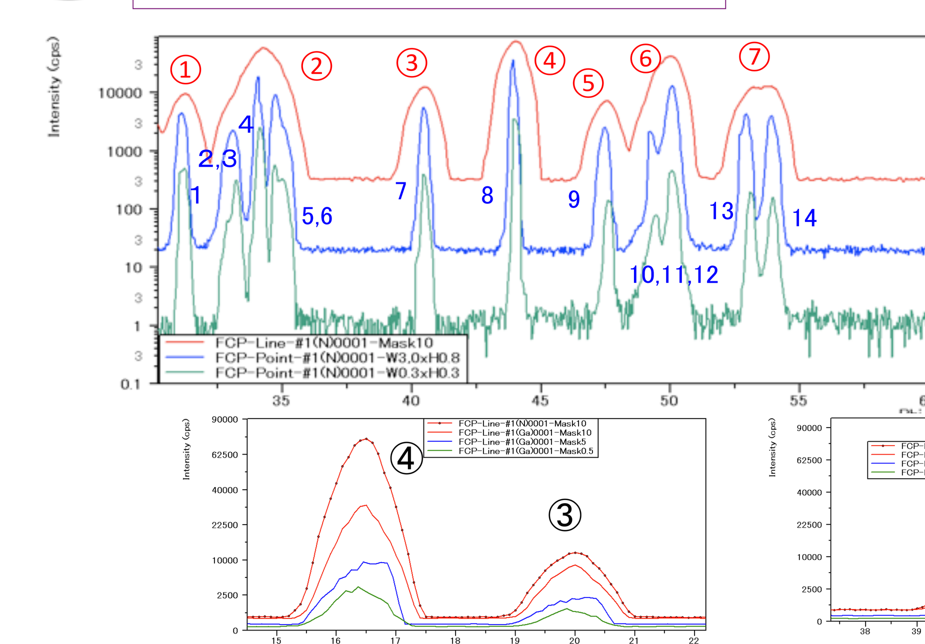
SR X-ray



φ30° FCP Scan Pattern of c-GaN (Renninger Scan pattern) SR X-ray (0.135 nm: 19)

Acknowledgement : AichiSR

Line and Point focus Results



φ30° FCP Scan Pattern of c-GaN (Renninger Scan pattern) Point focus :Cu-$K_{\alpha 1}$ (0.154 nm:14) Line focus : Cu-$K_{\alpha 1}$ (0.154 nm:7)

Peak ratio and back ground for characterization

		Peak 7	Peak 8	BG	Ratio 8/7	Ratio 8/BG
GaN #1[Ga]	Point W3.0xH0.8	4142	18650	12	4.50	1554
GaN #1[N]	Point W3.0xH0.8	6154	41869	23	6.80	1820
GaN #1[N]	Point W0.3xH03	396	3663	1	9.25	3663
		Peak ③	Peak ④	BG	Ratio④/③	Ratio④/BG
GaN #1[Ga]	Line Mask 10	8479	39823	349	4.70	114
GaN #1[Ga]	Line Mask 5	2150	10695	78	4.97	137
GaN #1[Ga]	Line Mask 0.5	551	2718	18.4	4.93	148
GaN #1[N]	Line Mask 10	12455	76793	320	6.17	240

5. Conclusions

Quality is judged by the ratio 8/BG or ④/BG
Polarity is judged by the ratio 8/7 or ④/③ [Ga] < 5.5