

---

# Plasma Etch of GaN using Panasonic Etcher

8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

---

# Experiment

## Material:

□ Un-doped, GaN epitaxial layer (~2- $\mu\text{m}$  in thickness) on a 2-inch sapphire substrate.

## Methods:

□ An 0.4- $\mu\text{m}$ -thick  $\text{SiO}_2$  layer grown on top of GaN using Unaxis ICP Deposition Tool at 250  $^{\circ}\text{C}$ .

□ Photo-resist ridge patterns, with different widths and separations, formed using stepper mask aligner.

□ Transferring the patterns into the  $\text{SiO}_2$  layer using Panasonic ICP Etcher with  $\text{CHF}_3$  chemistry.

□ Samples with a size of  $\sim 0.8 \times 0.8 \text{ cm}^2$ , diced and etched using Panasonic ICP Etcher [Pre-etch native oxide removal:  $\text{H}_2\text{SO}_4:\text{H}_2\text{O}_2$  (3:1), 1 minute].

□ Samples cleaved and examined by SEM.

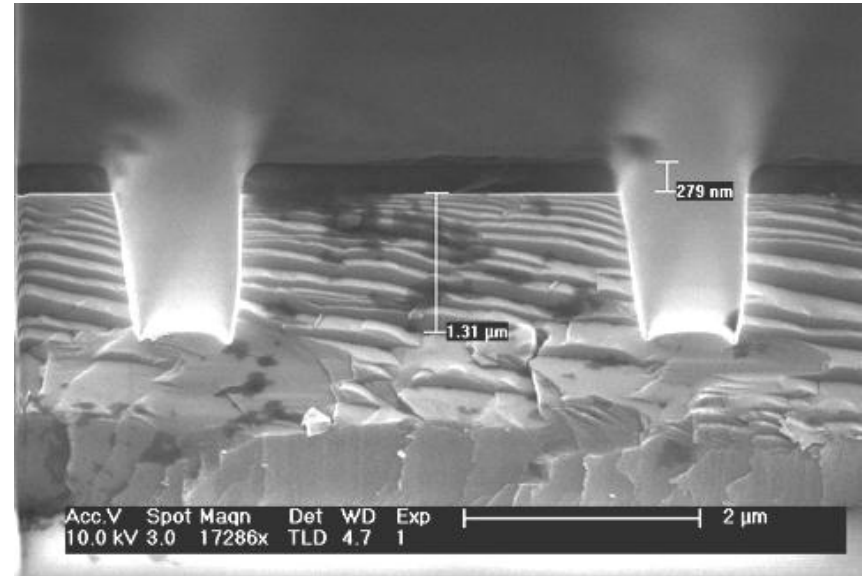
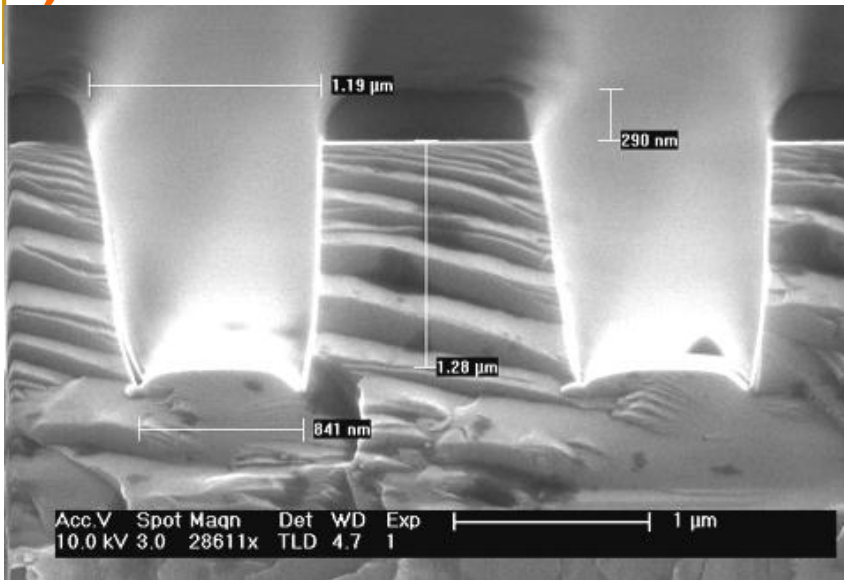
## GaN Etch using Panasonic ICP Etcher @Room Temperature

Sample #	Gas Flow Rate (sccm)		Pressure (Pa)	Bias Power (W)	ICP Power (W)	Etch Rate ( $\mu\text{m}/\text{min.}$ )	Etch Selectivity (GaN/SiO <sub>2</sub> )	Side-wall Angle ( $^{\circ}$ )
	Cl <sub>2</sub>	N <sub>2</sub>						
GaN#38	37.5	12.5	1.2	200	500	0.645	13.3	85.2
GaN#46	7	43	0.7	100	500	0.116	5.8	83.1
GaN#30	12.5	37.5	0.7	100	500	0.16	7.1	82.5
GaN#32	12.5	37.5	0.7	200	500	0.26	6.2	79.9
GaN#27	25	25	0.7	100	500	0.202	7.6	83.2
GaN#31	25	25	0.7	200	500	0.35	6.7	85.1
GaN#33	37.5	12.5	0.7	200	500	0.503	7.6	85.4
GaN#34	37.5	12.5	0.35	200	500	0.45	7.1	84.3
GaN#36	37.5	(BCl <sub>3</sub> =12.5)	0.35	200	500	0.48	7.9	86.9
GaN#35	50	0	0.35	200	500	0.432	5	82.8
GaN#43	22.5	(Ar=7.5)	0.3	200	500	0.504	4.6	80.3
GaN#40	22.5	7.5	0.2	100	500	0.268	14.3	84.7
GaN#37	22.5	7.5	0.2	200	500	0.336	5.5	86.2
GaN#41	22.5	7.5	0.2	200	900	0.345	6.7	85.8
GaN#42	22.5	7.5	0.2	300	500	0.605	6.2	86
GaN#39	30	0	0.2	200	500	0.44	5.8	83.8
GaN#47	11	33	0.2	50	900	0.0826	5.7	83.3
GaN#44	22.5	7.5	0.15	200	500	0.367	5.4	85.4
GaN#45	22.5	7.5	0.1	200	500	0.356	6.1	86.7
GaN#48	Cl <sub>2</sub> /BCl <sub>3</sub> /Ar:20/8/5		0.67	100	500	0.213	3.8	71.9

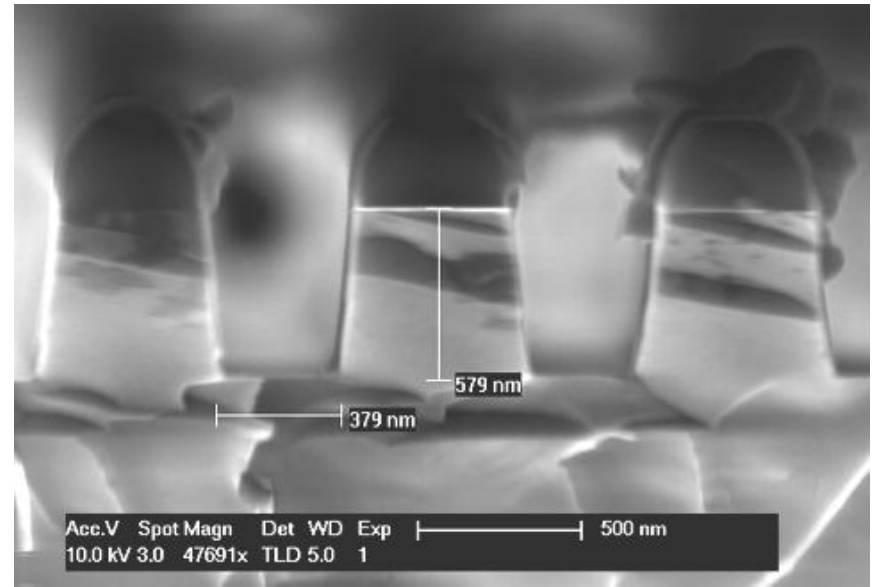
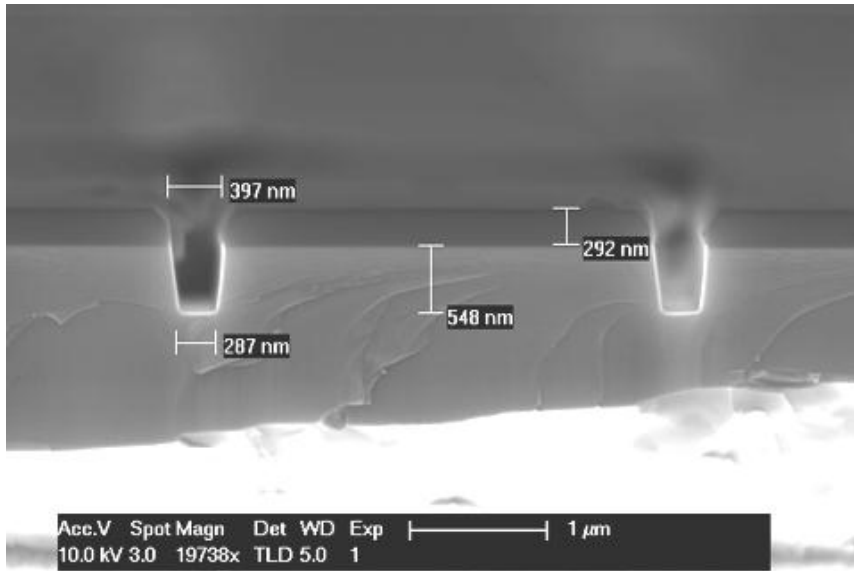
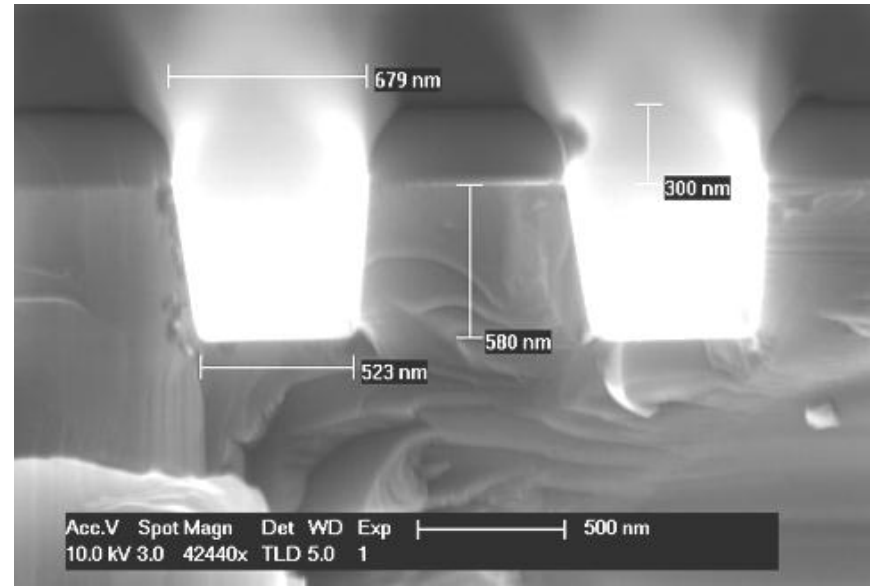
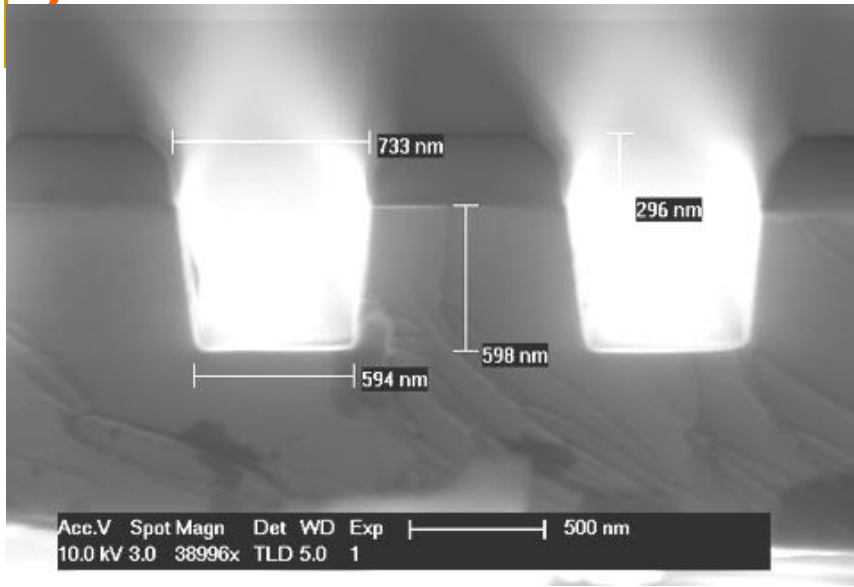
8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

# 1) GaN#38



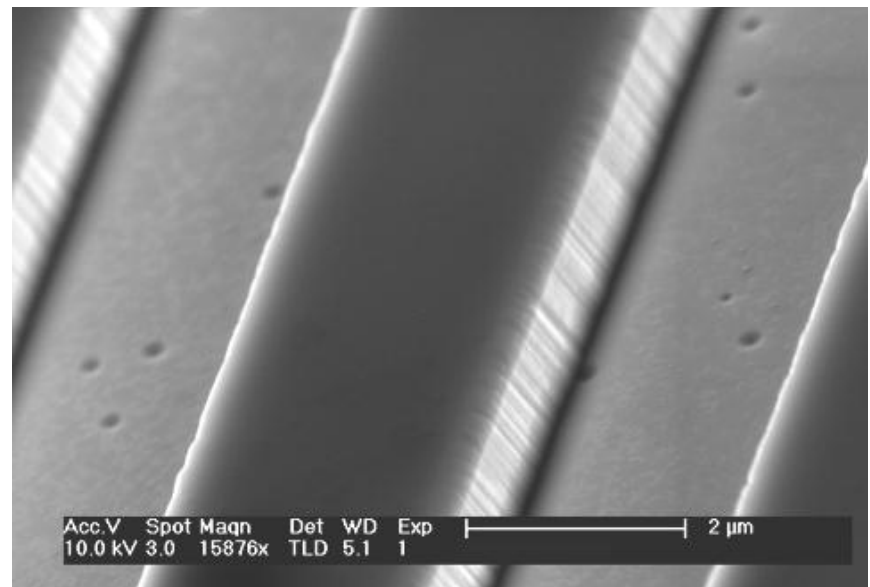
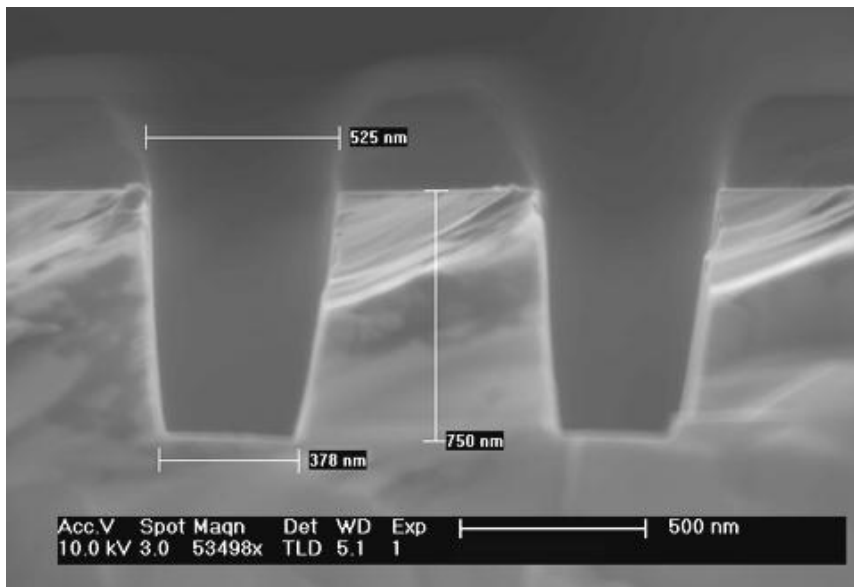
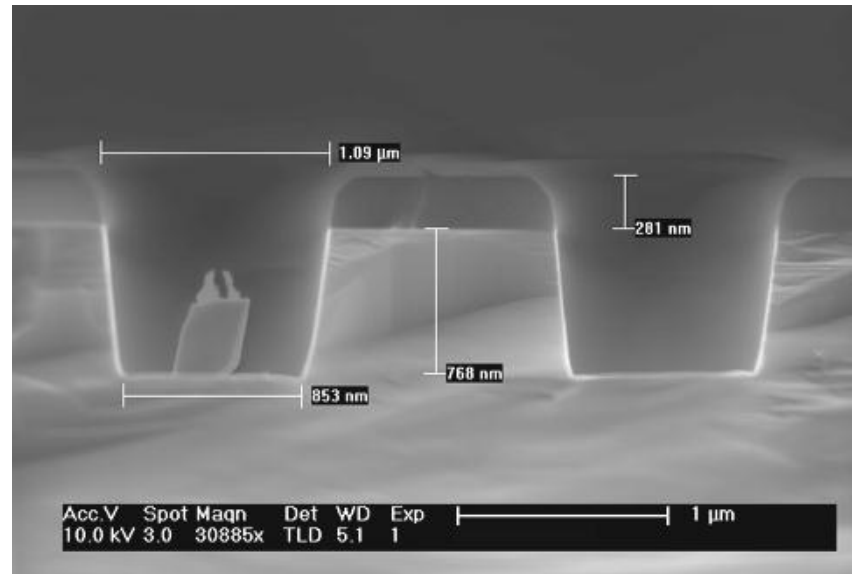
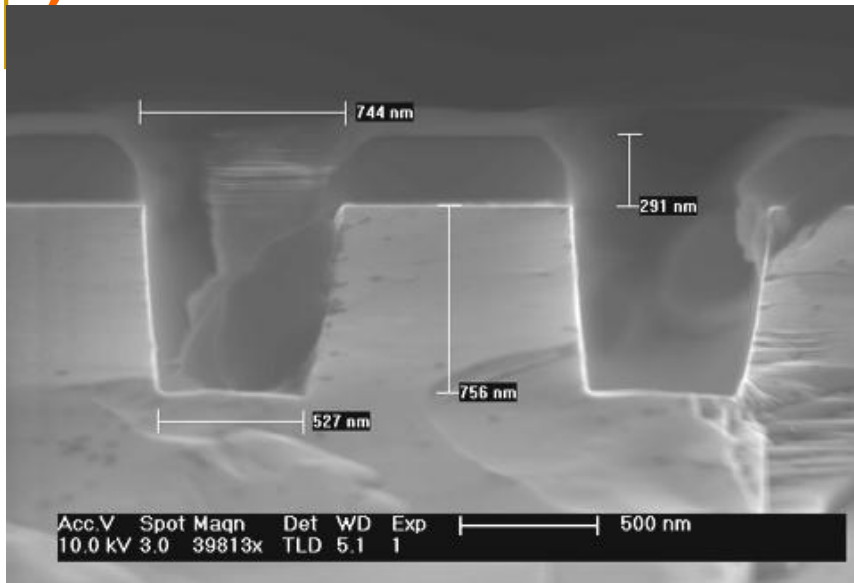
## 2) GaN#46



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

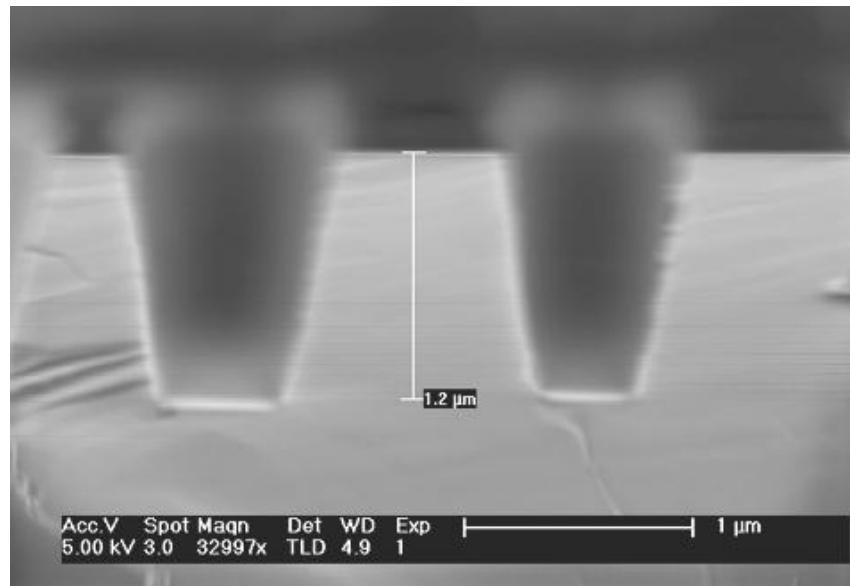
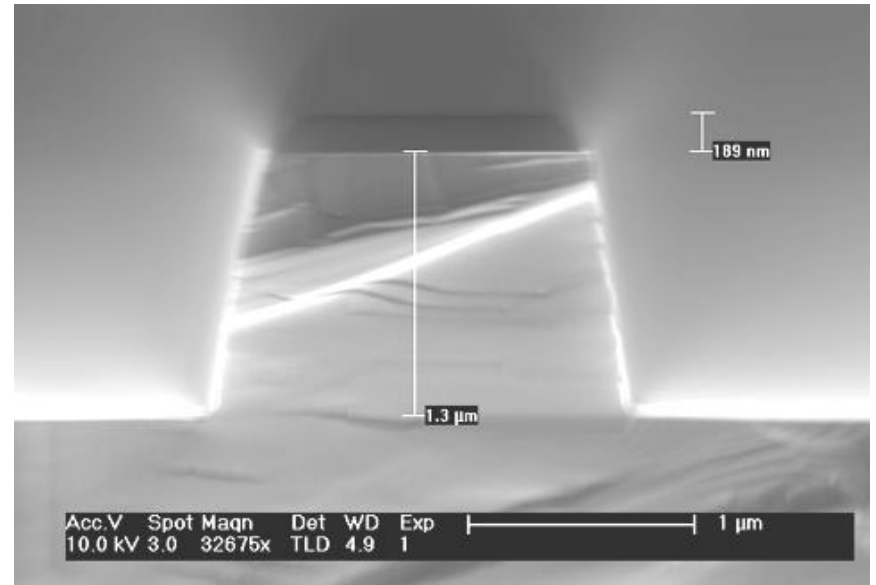
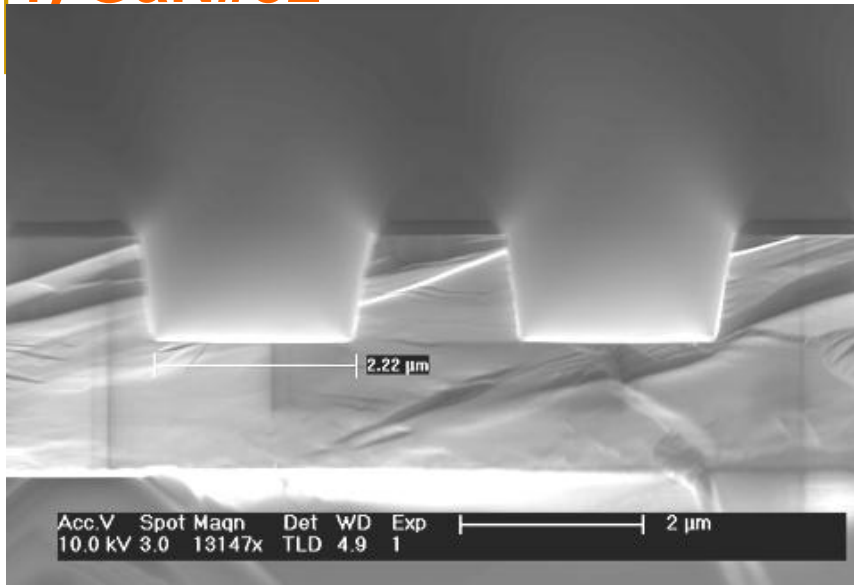
### 3) GaN#30



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

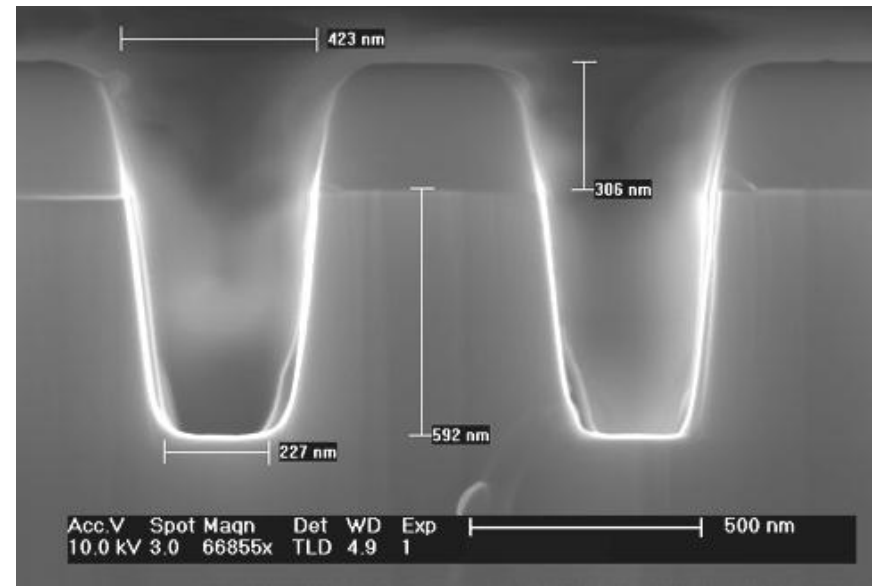
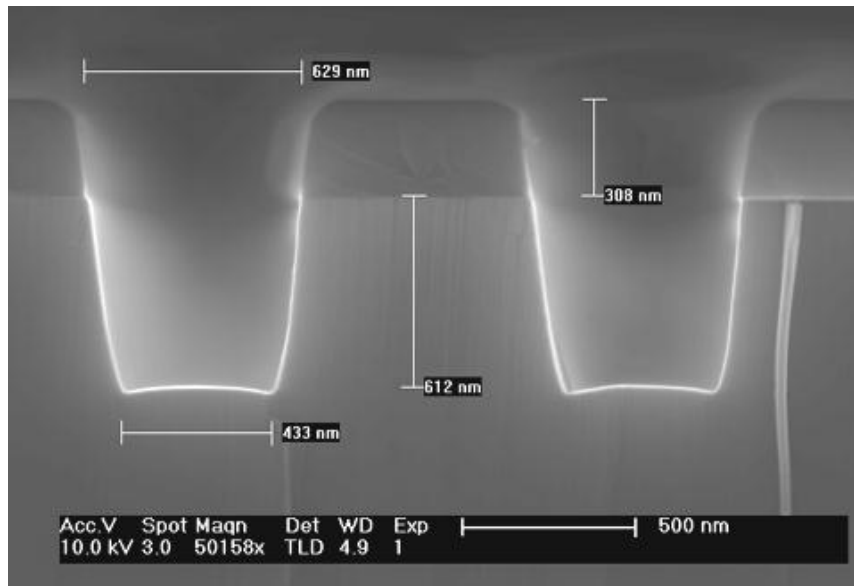
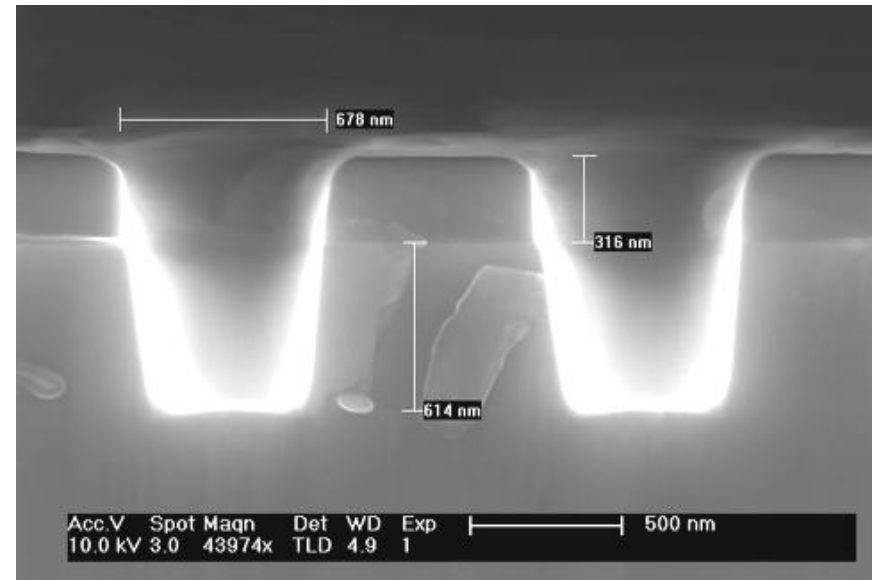
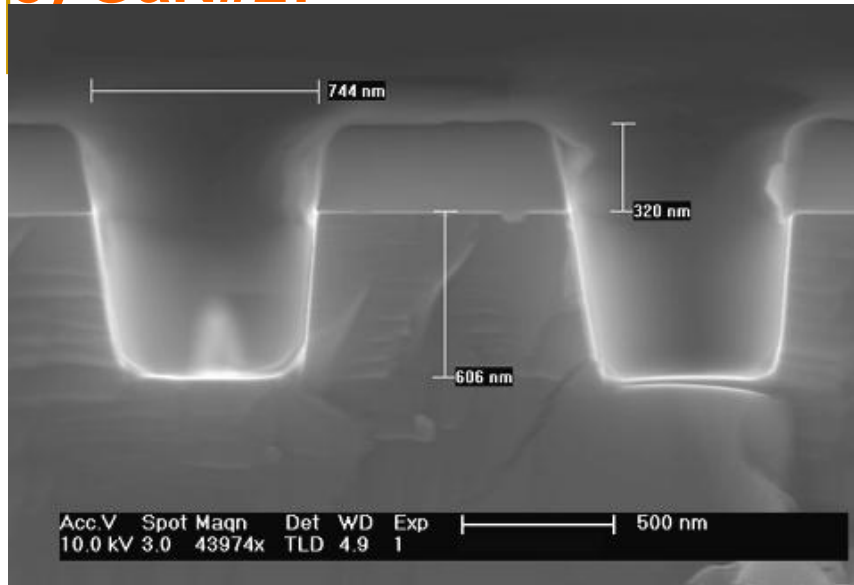
## 4) GaN#32



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

## 5) GaN#27

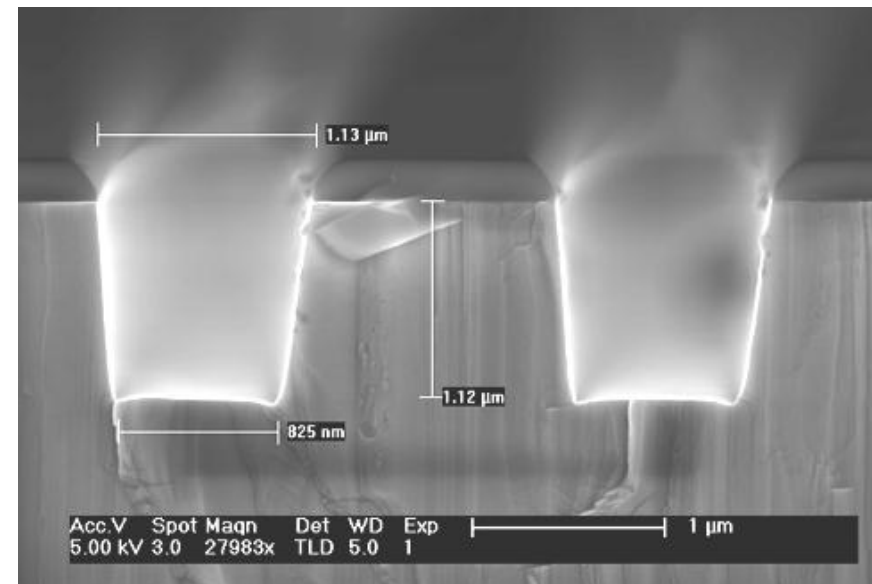
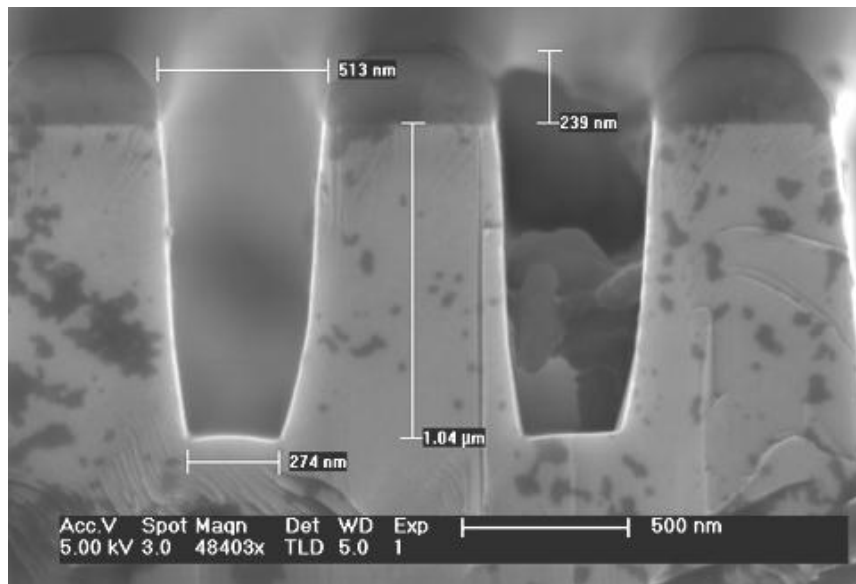
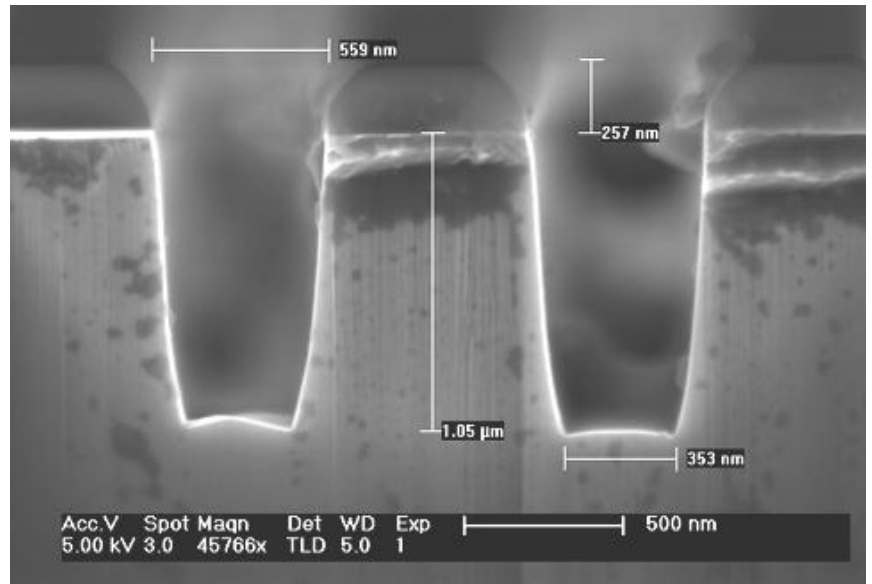


8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB



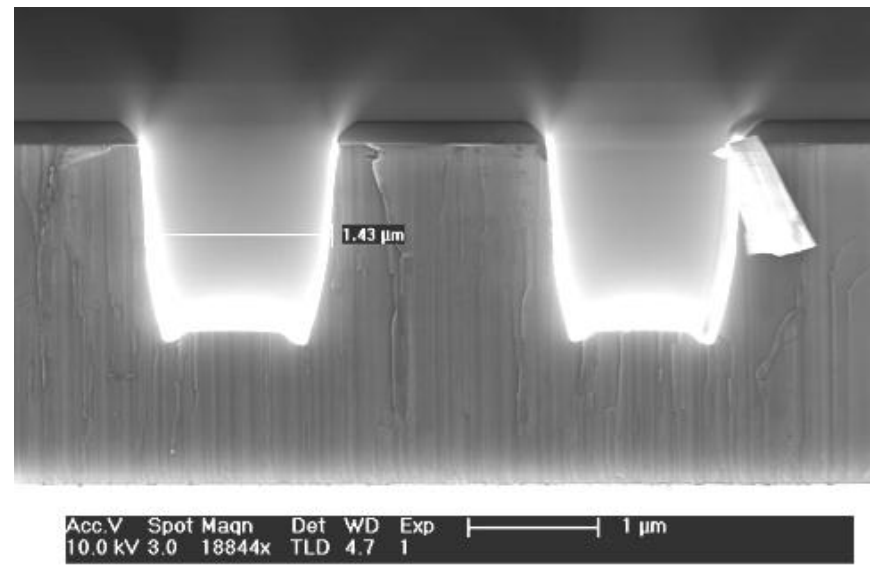
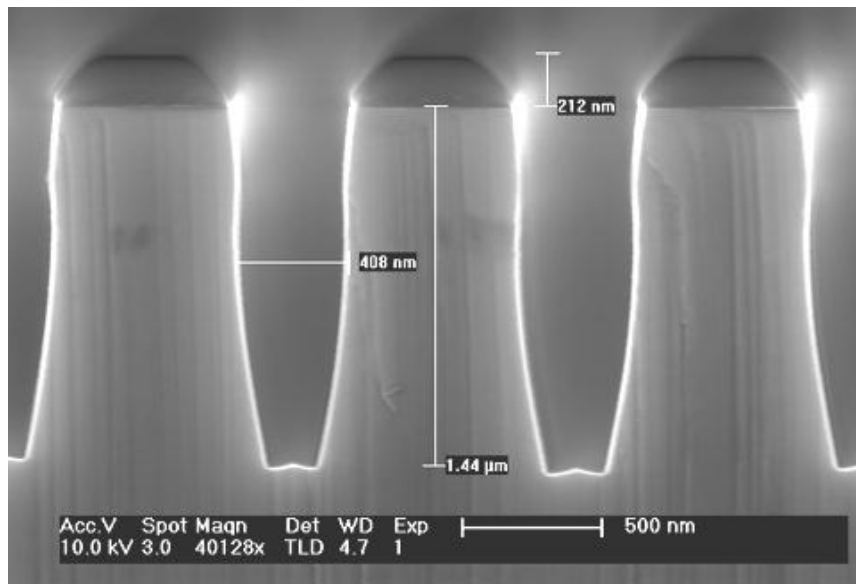
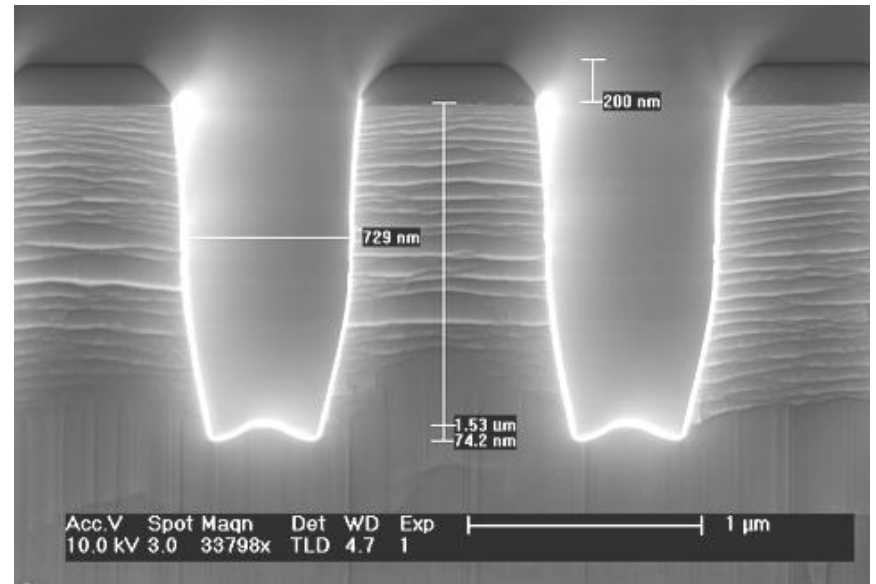
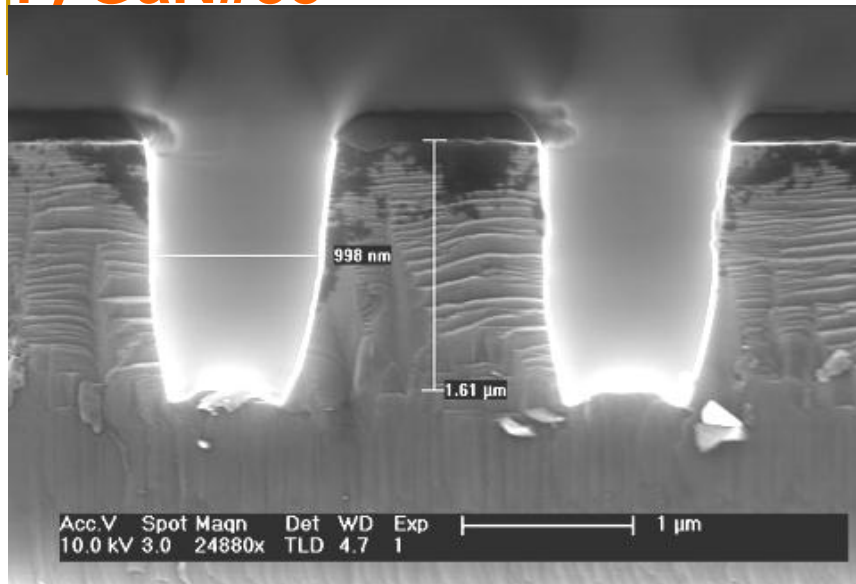
## 6) GaN#31



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

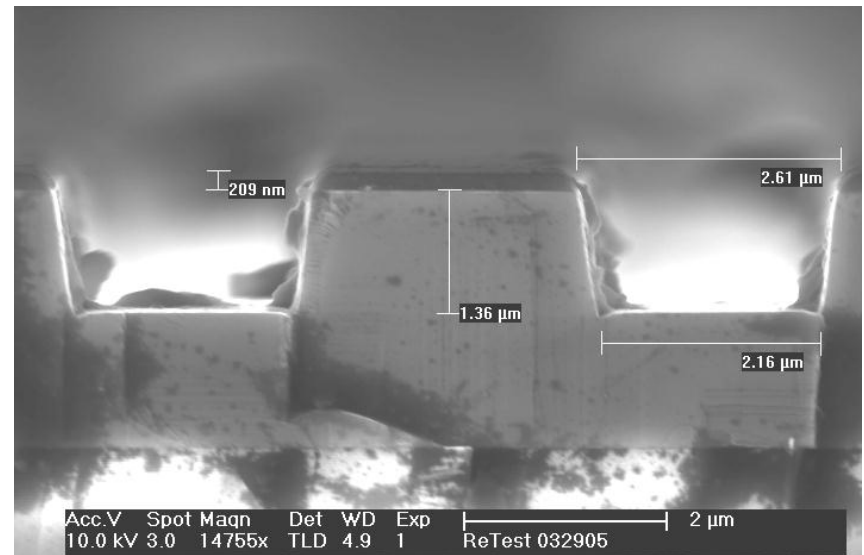
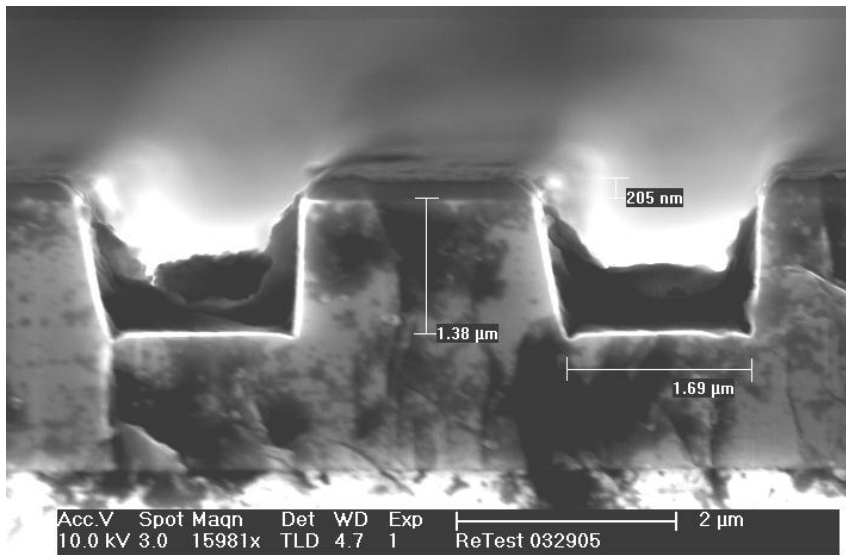
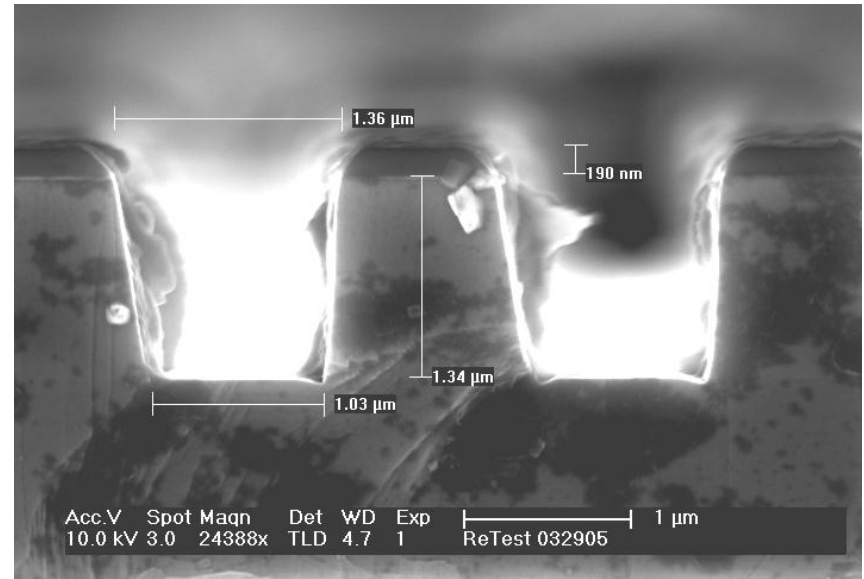
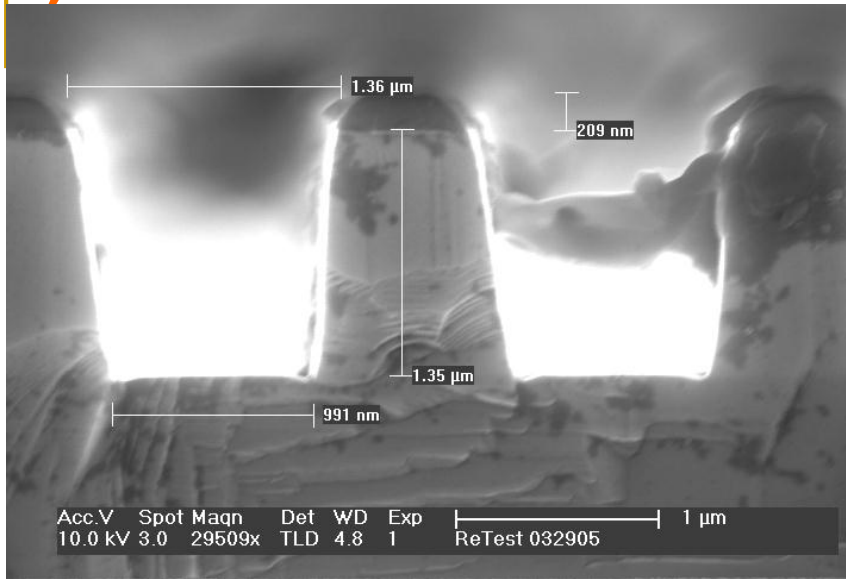
## 7) GaN#33



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

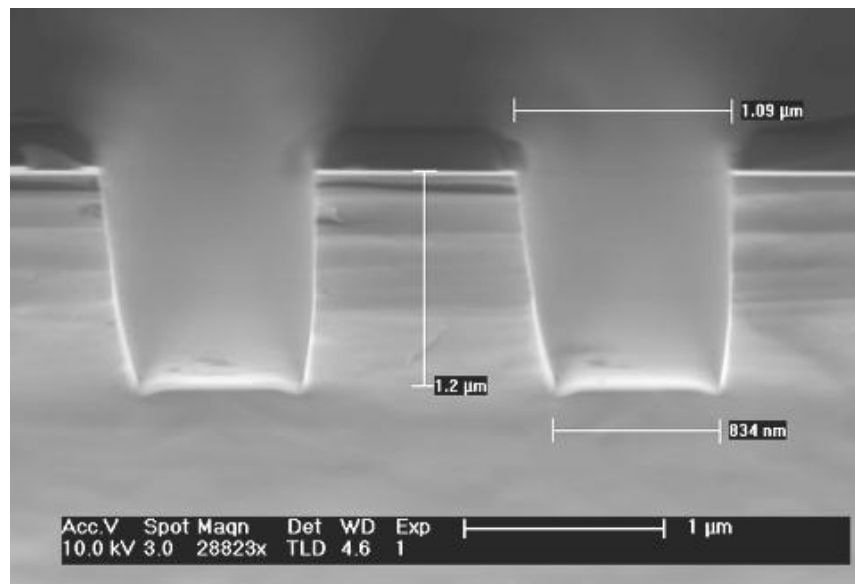
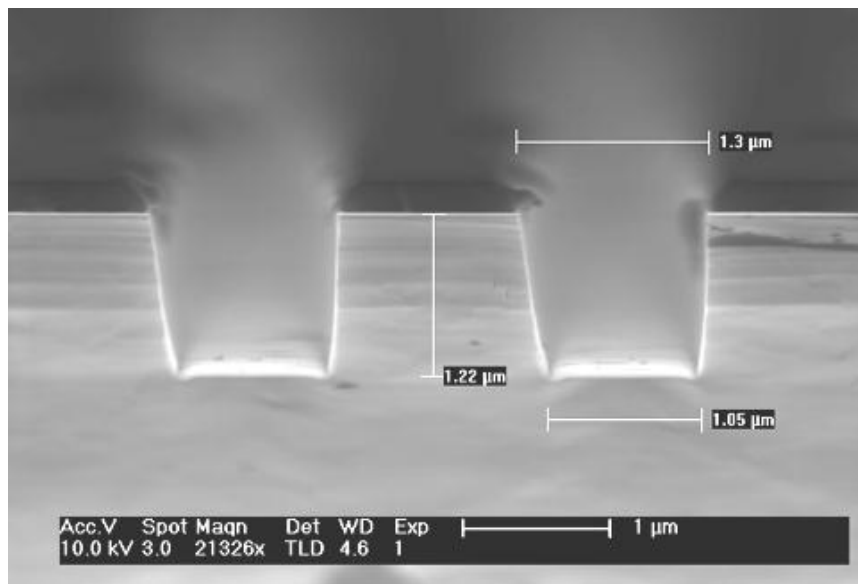
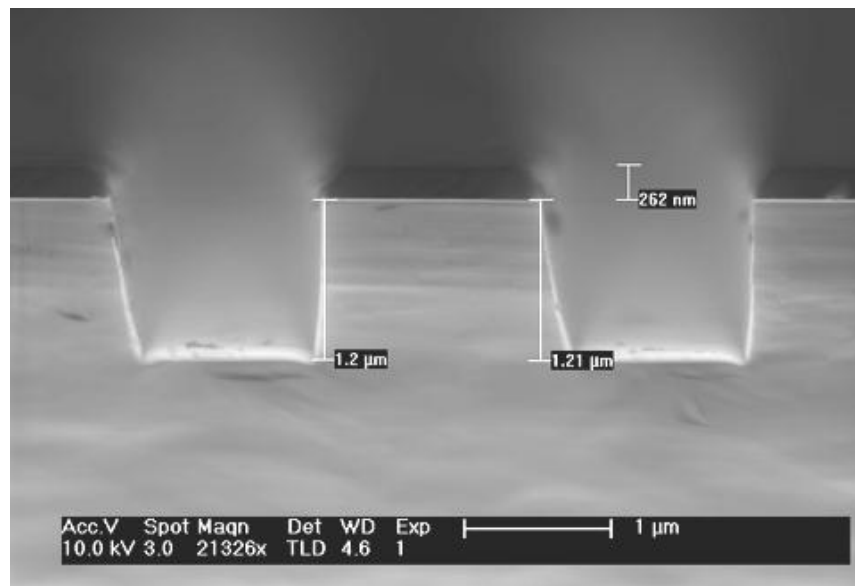
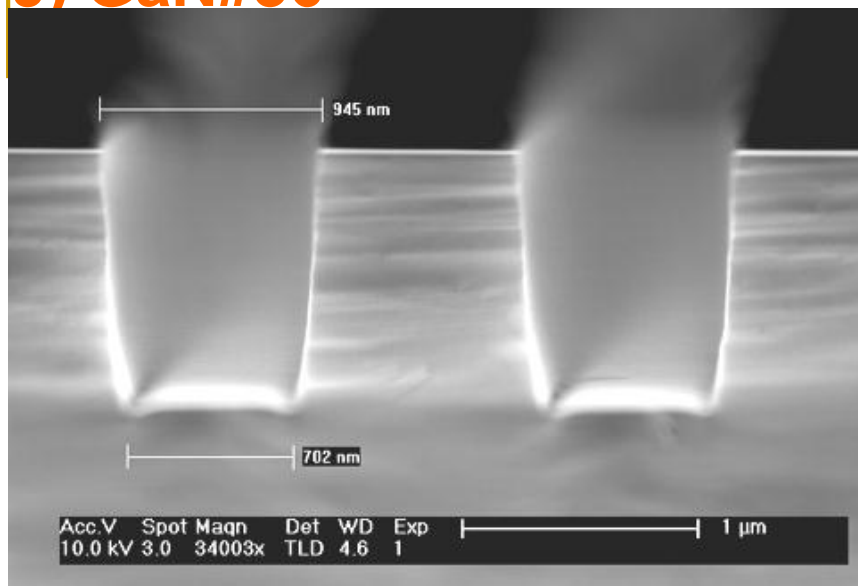
## 8) GaN#34



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

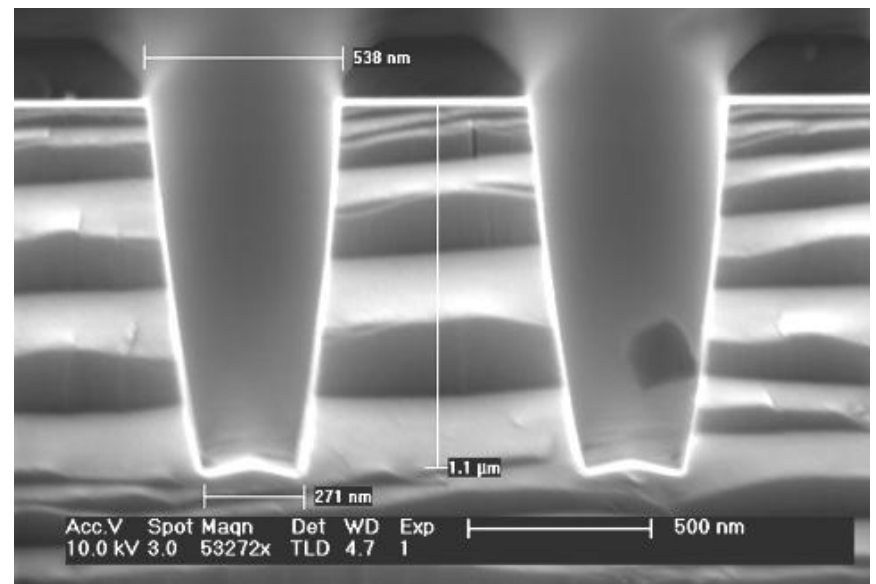
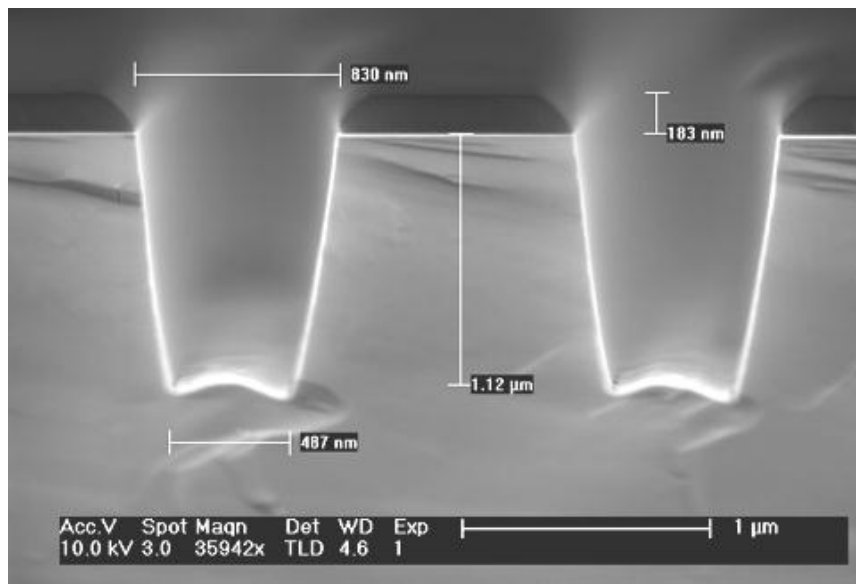
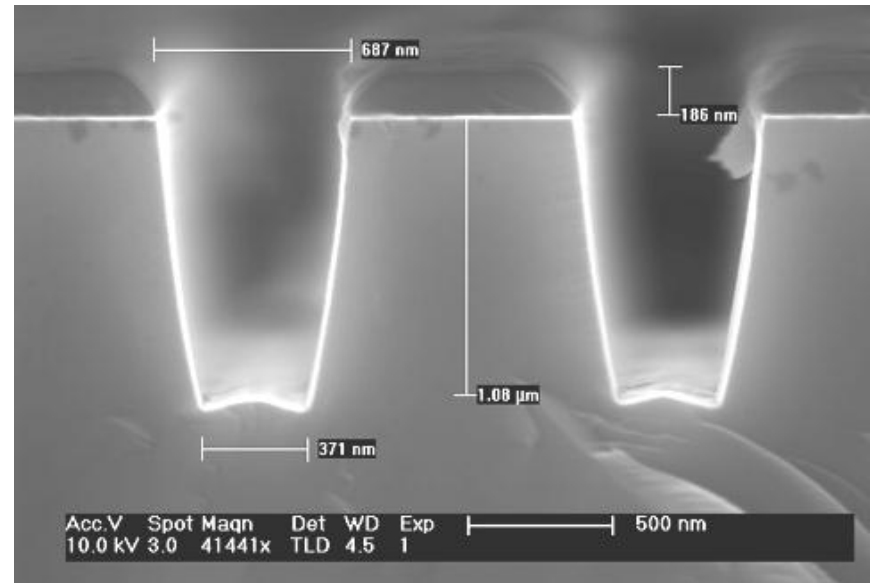
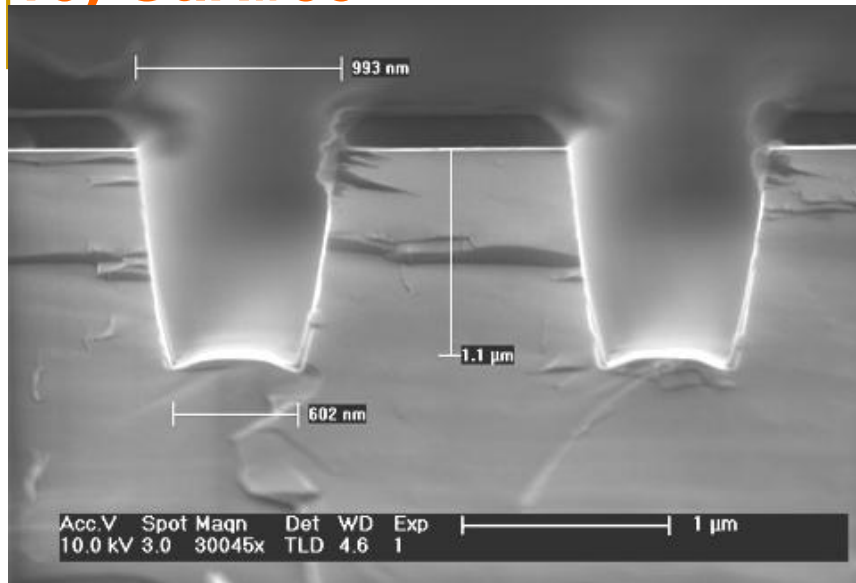
## 9) GaN#36



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

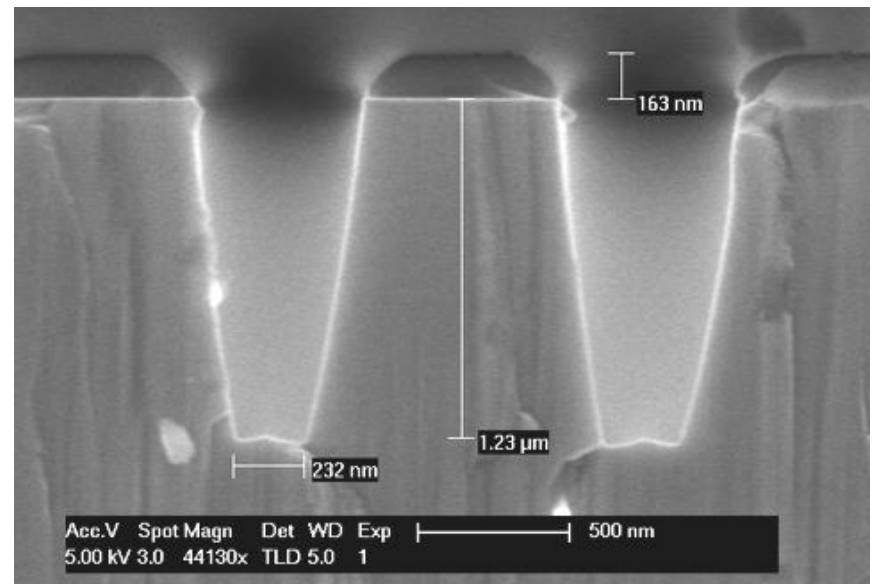
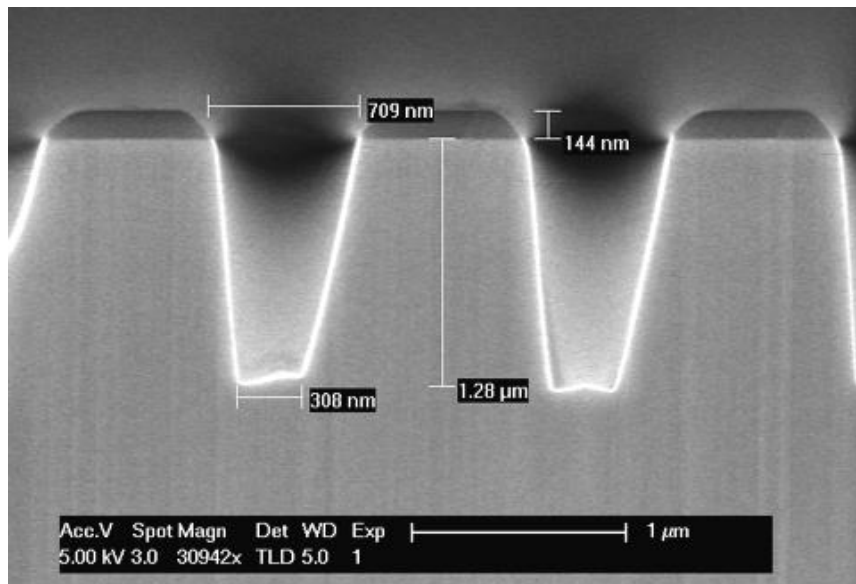
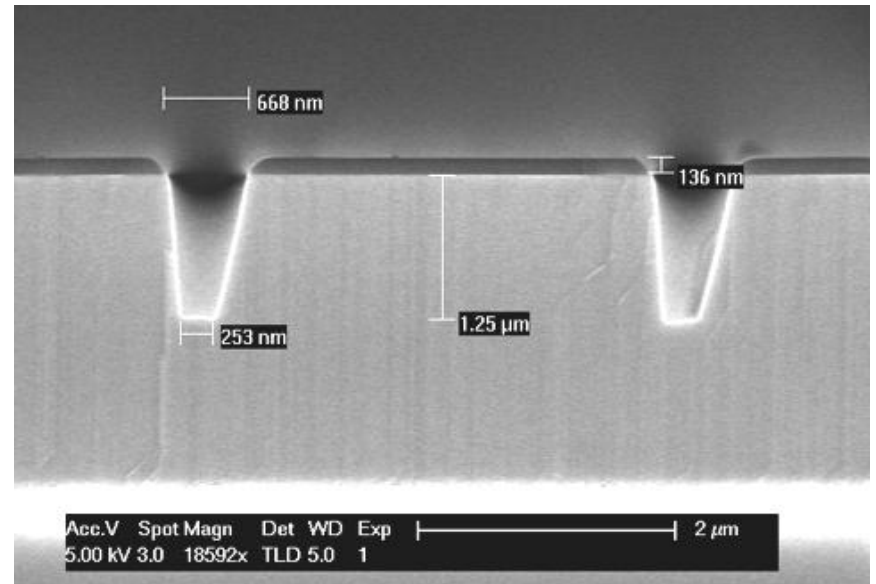
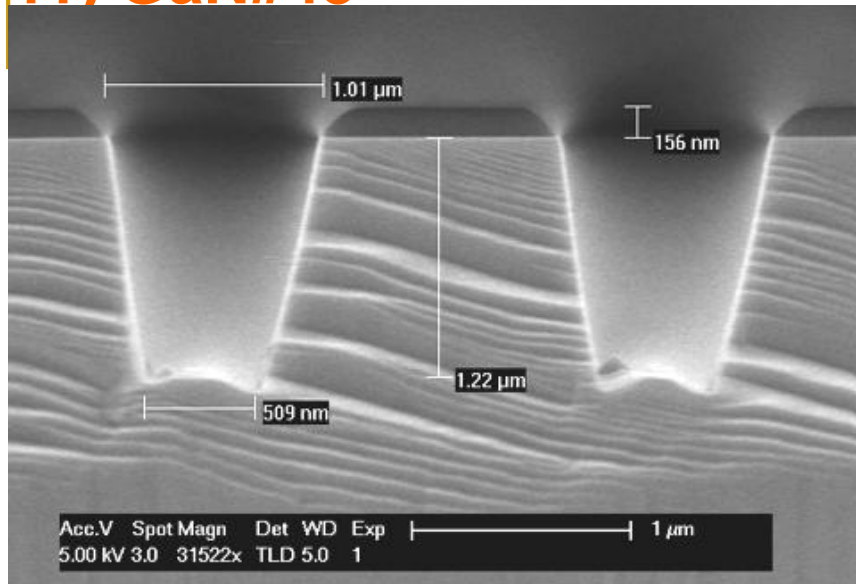
# 10) GaN#35



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

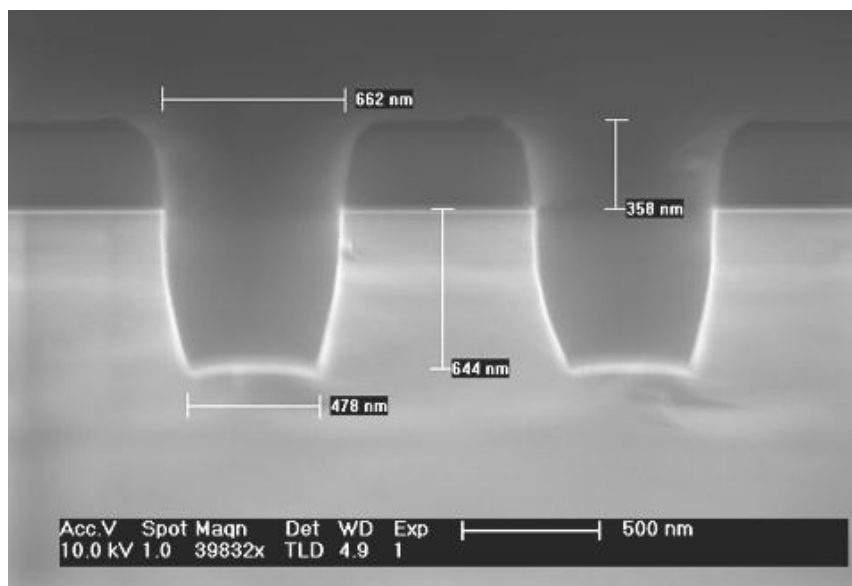
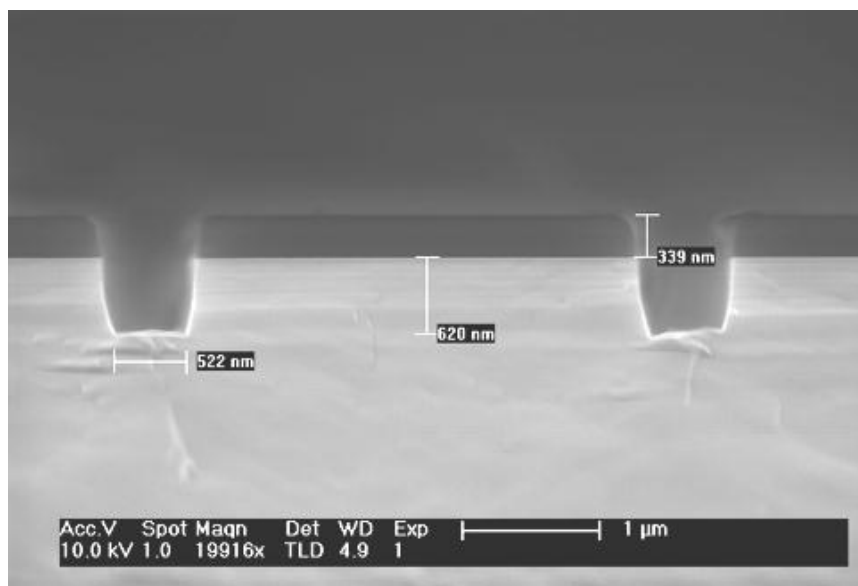
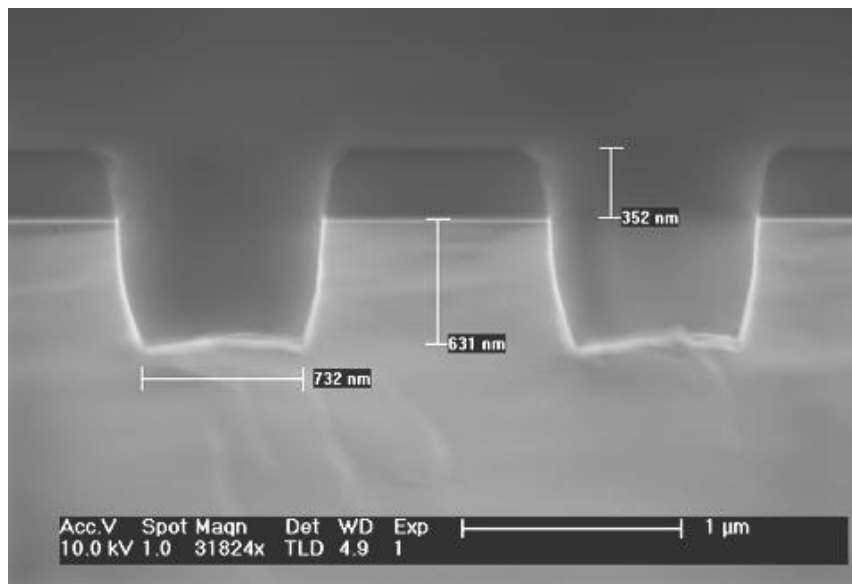
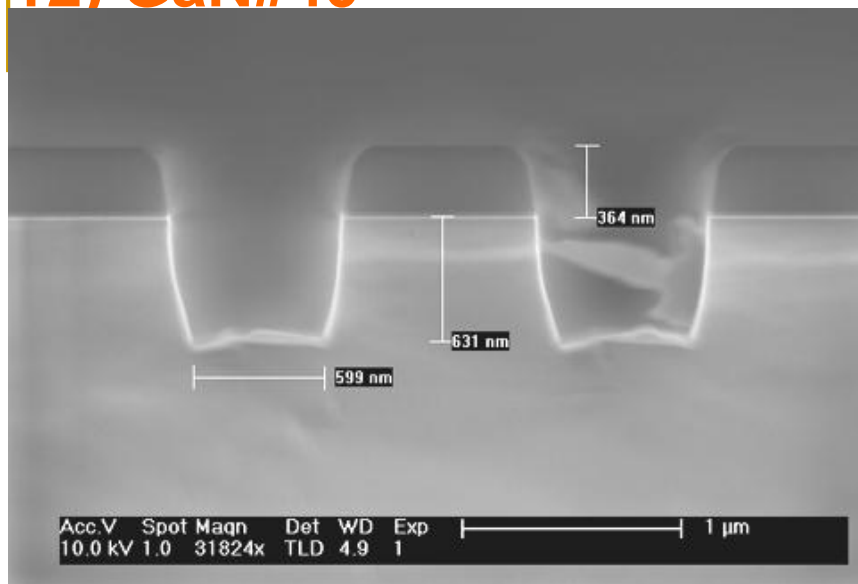
# 11) GaN#43



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

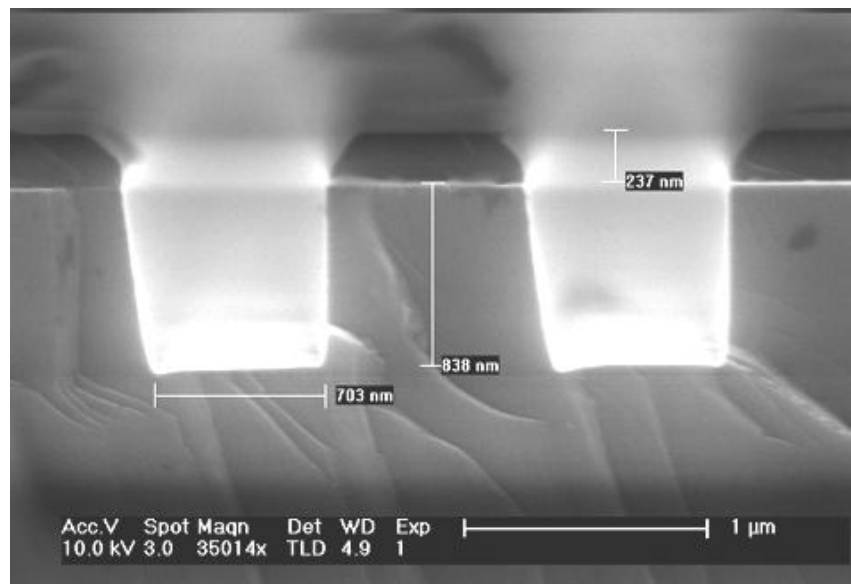
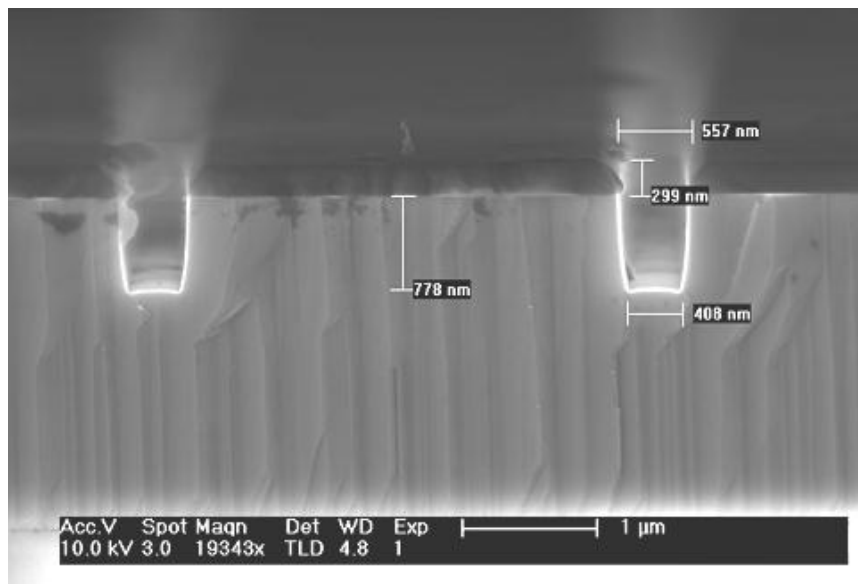
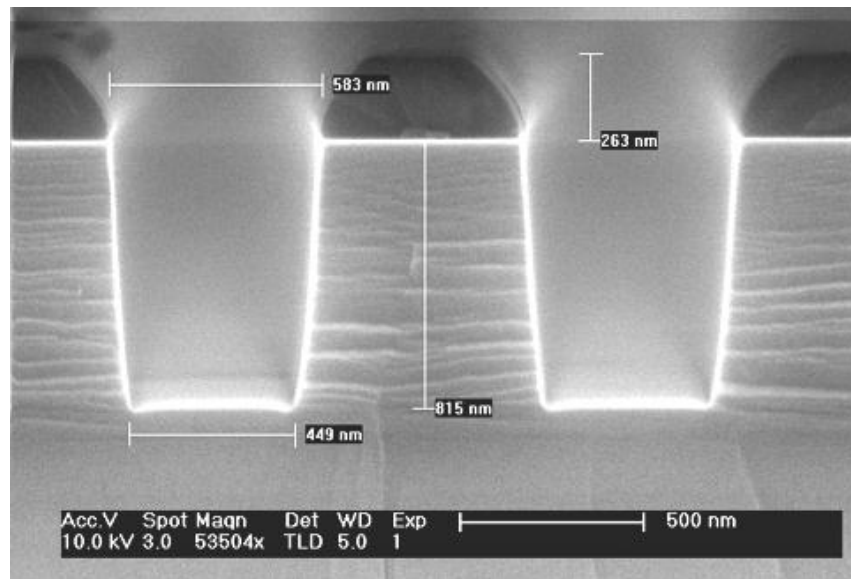
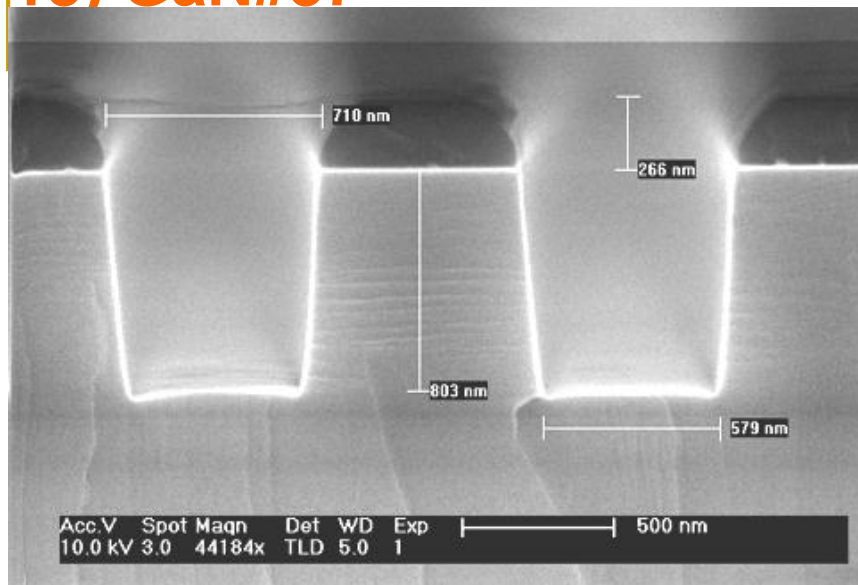
## 12) GaN#40



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

# 13) GaN#37

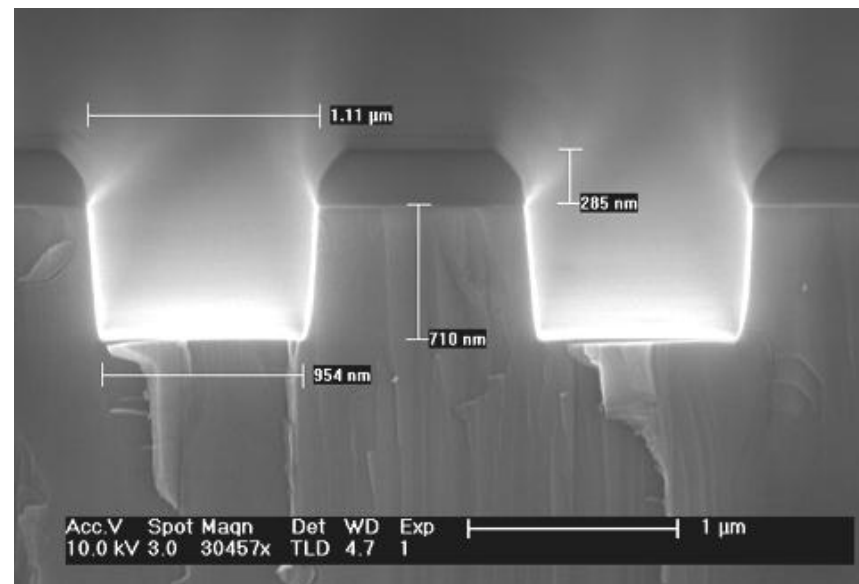
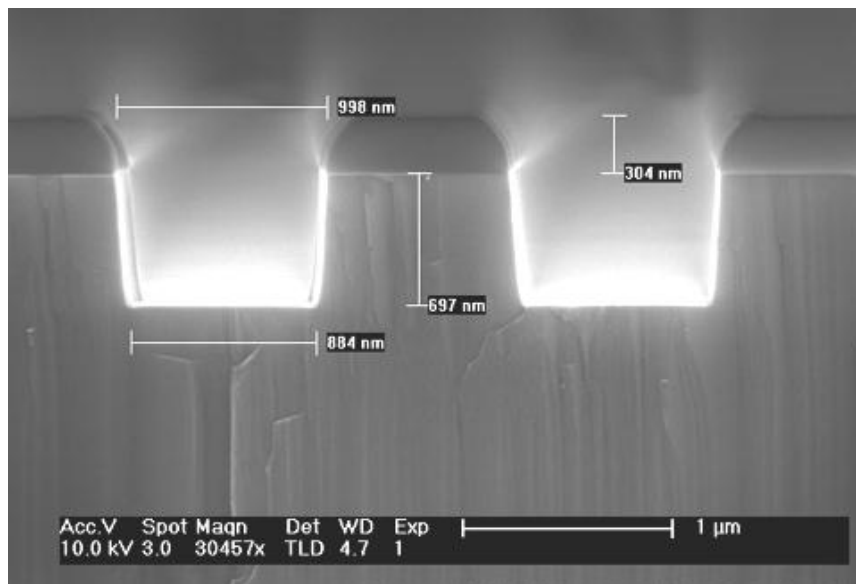
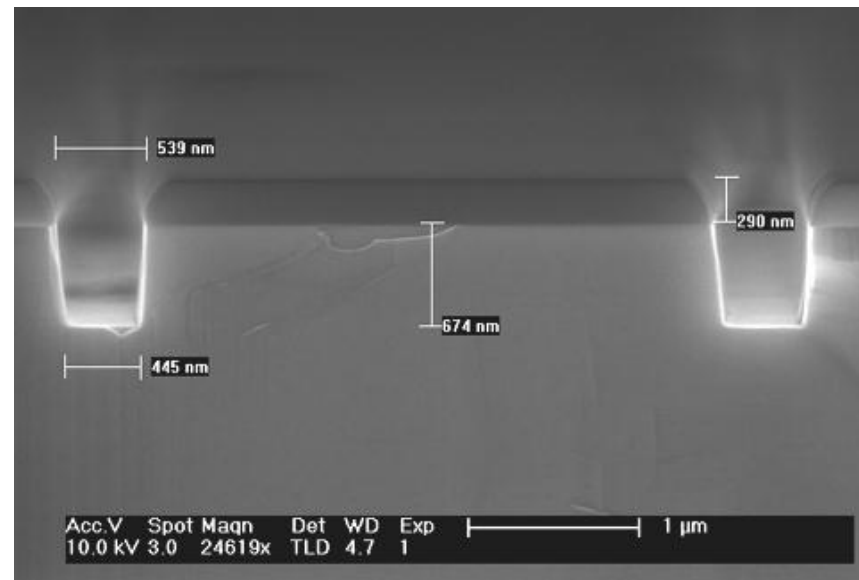


8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB



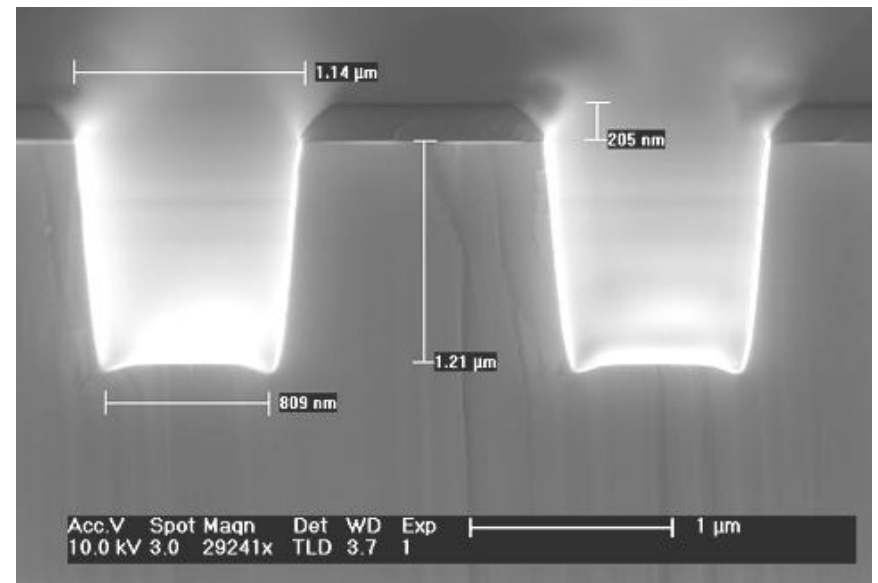
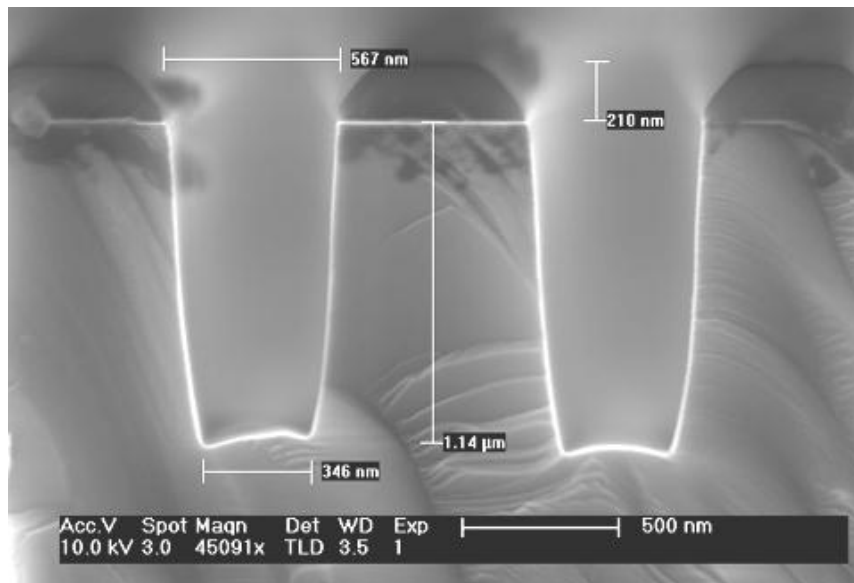
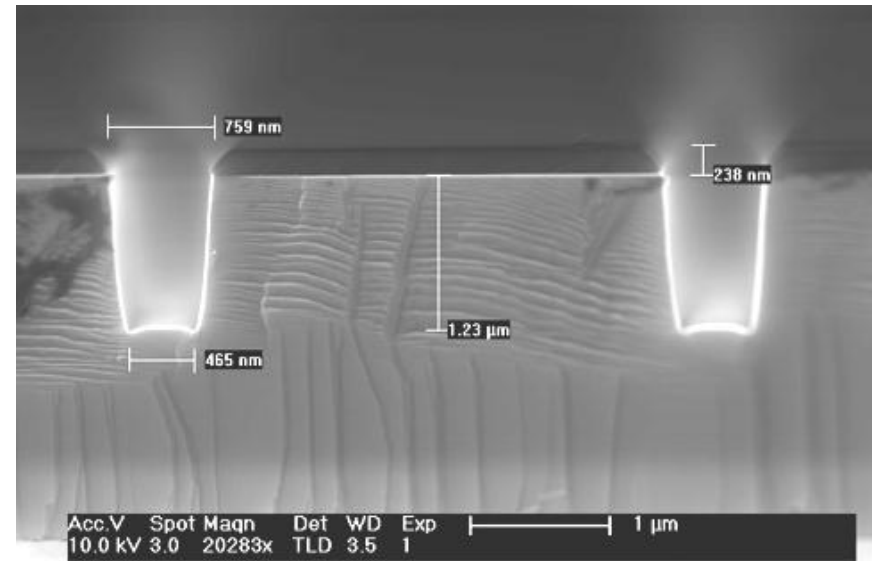
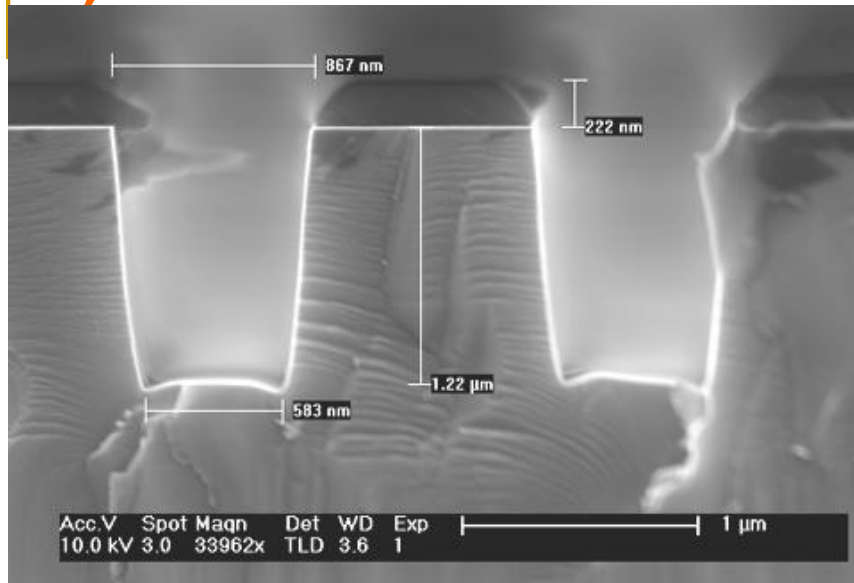
# 14) GaN#41



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

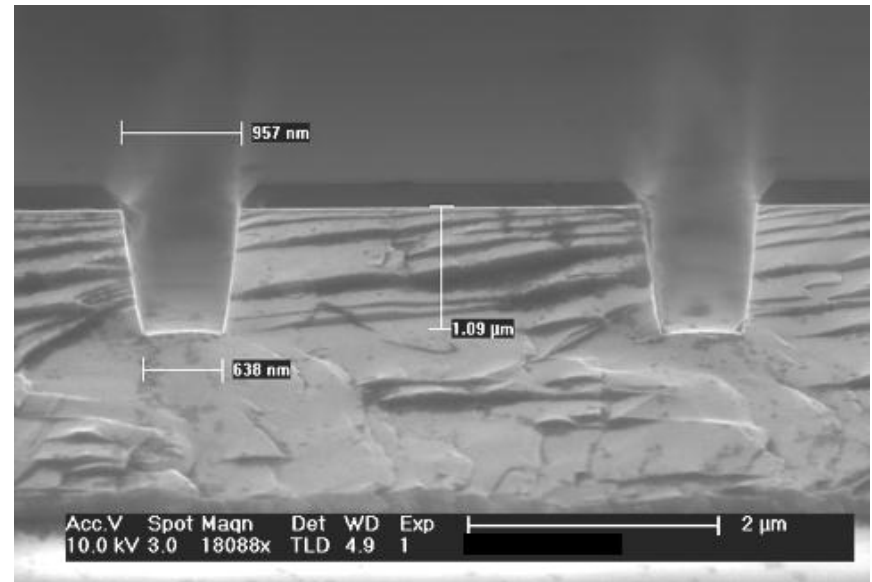
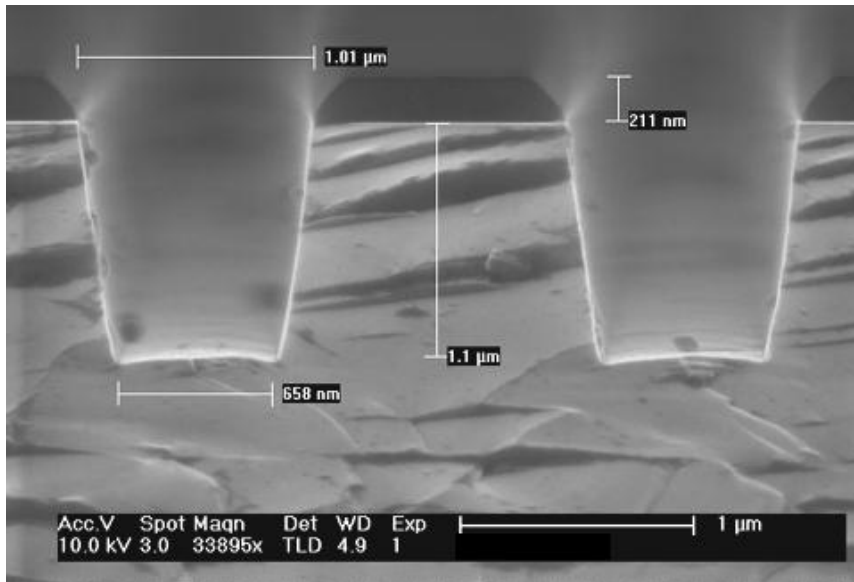
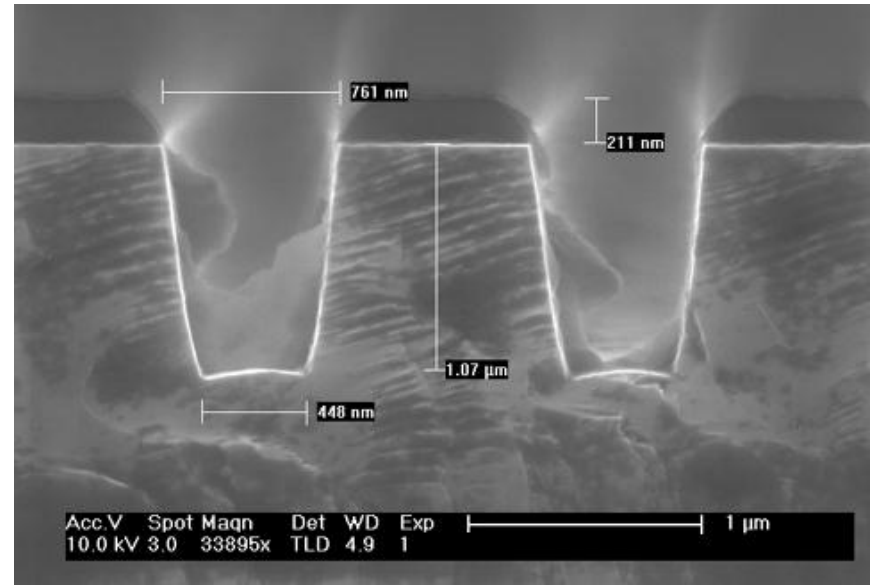
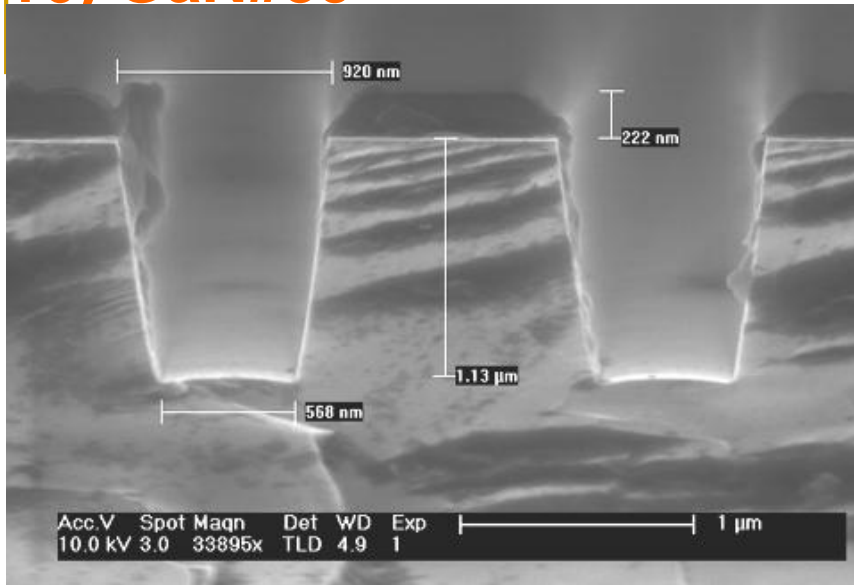
# 15) GaN#42



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

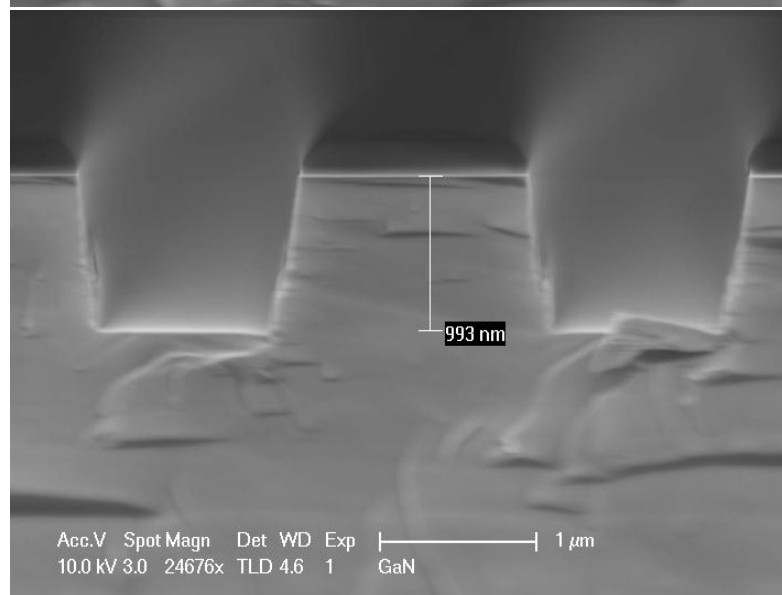
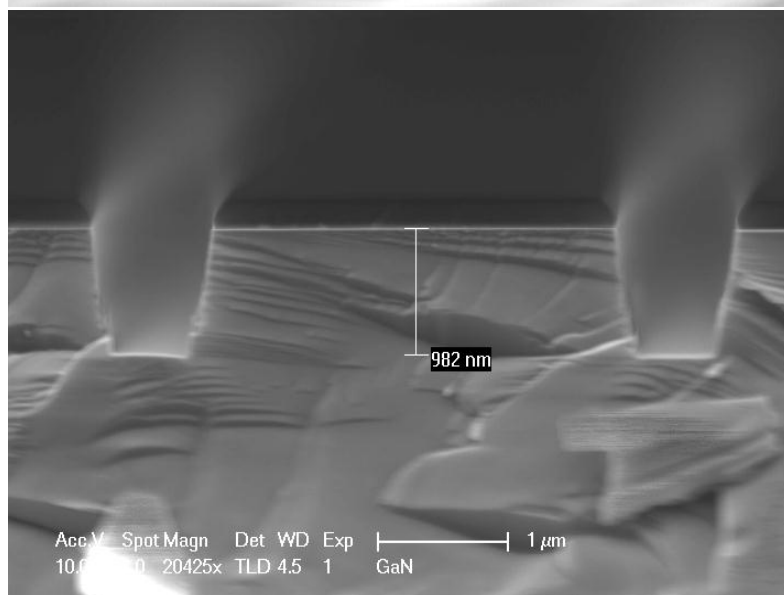
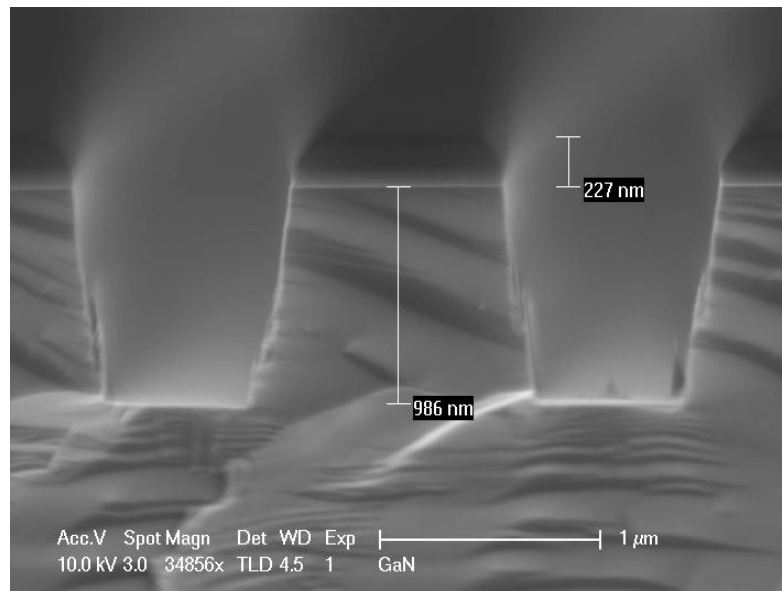
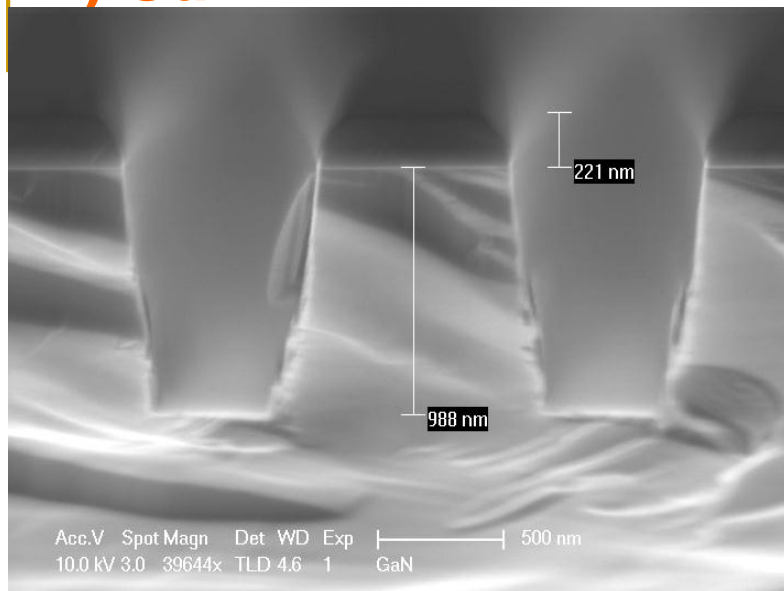
# 16) GaN#39



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

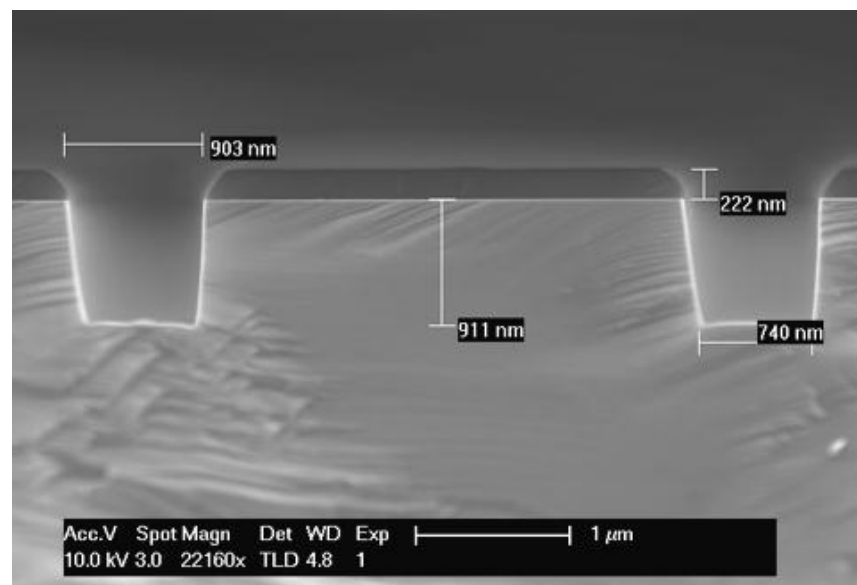
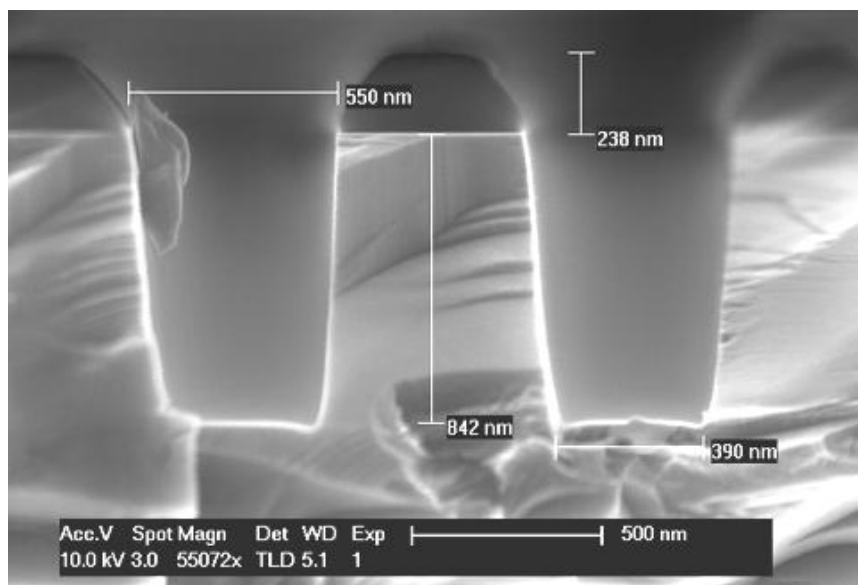
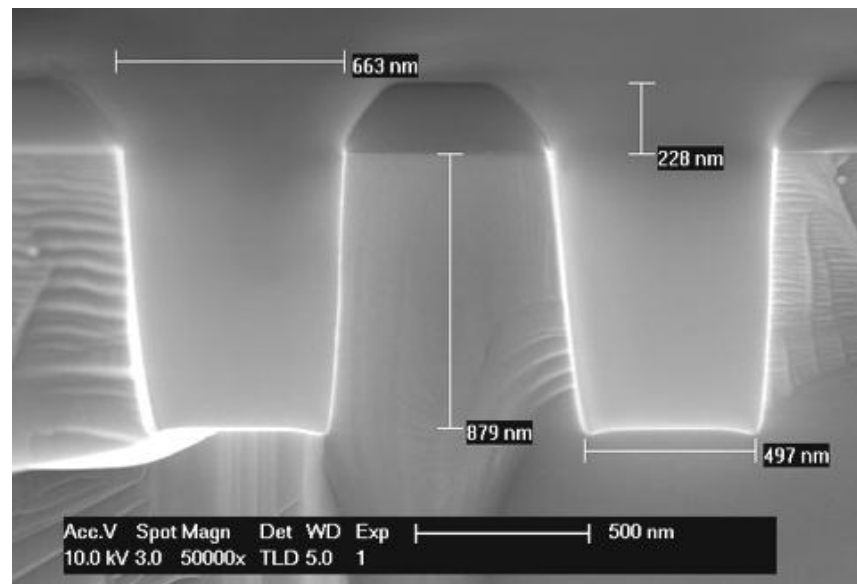
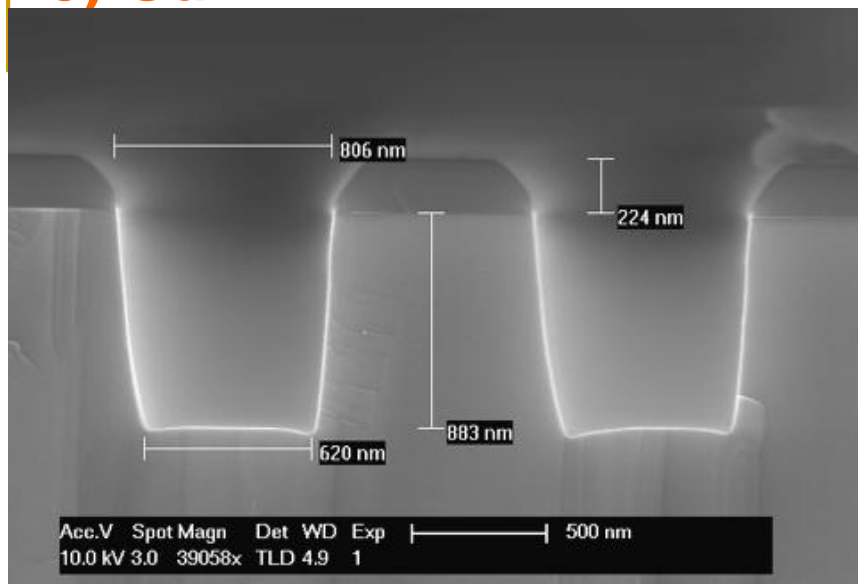
# 17) GaN#47



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

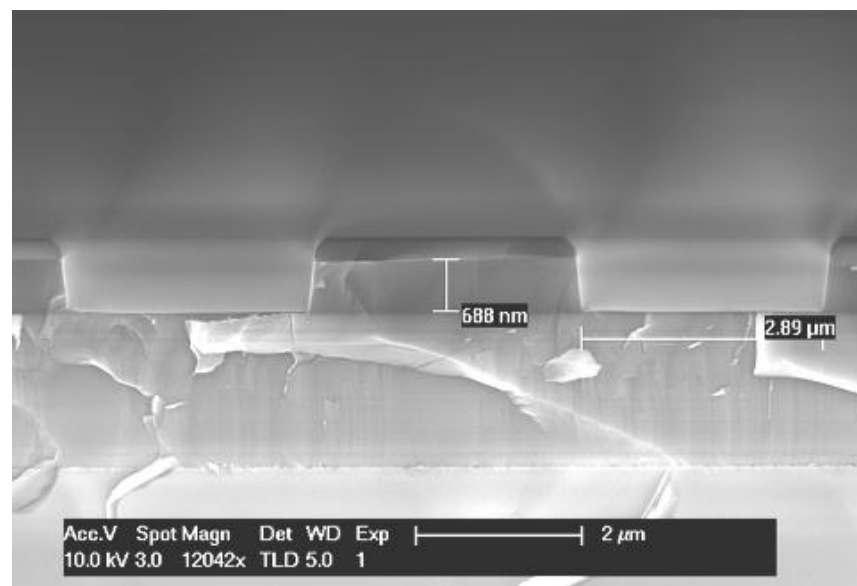
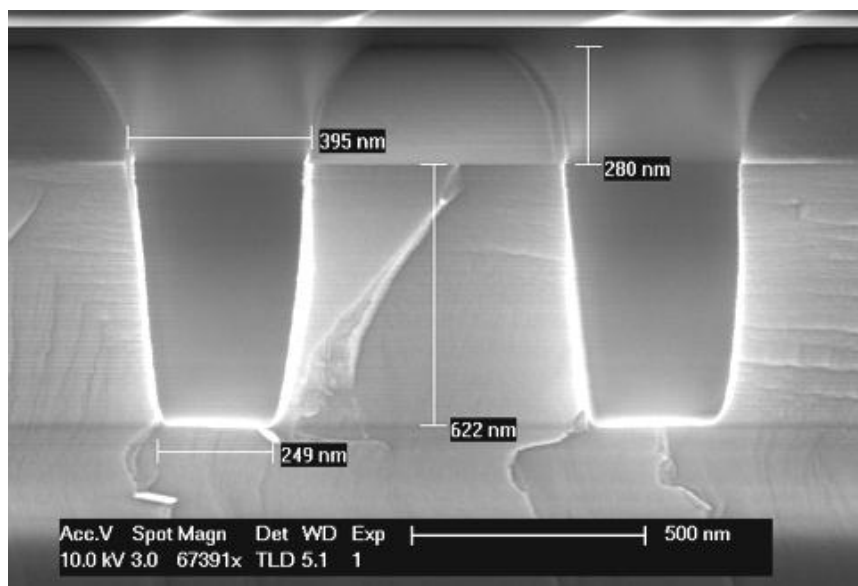
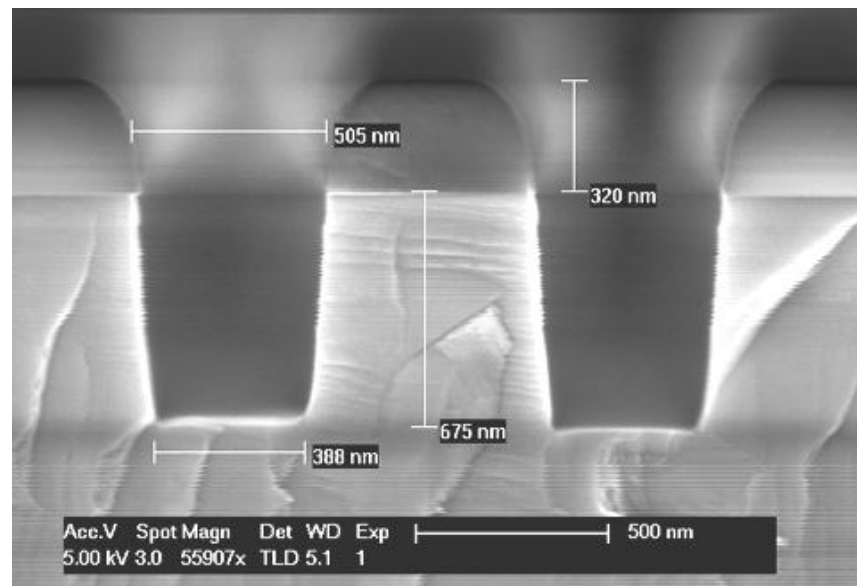
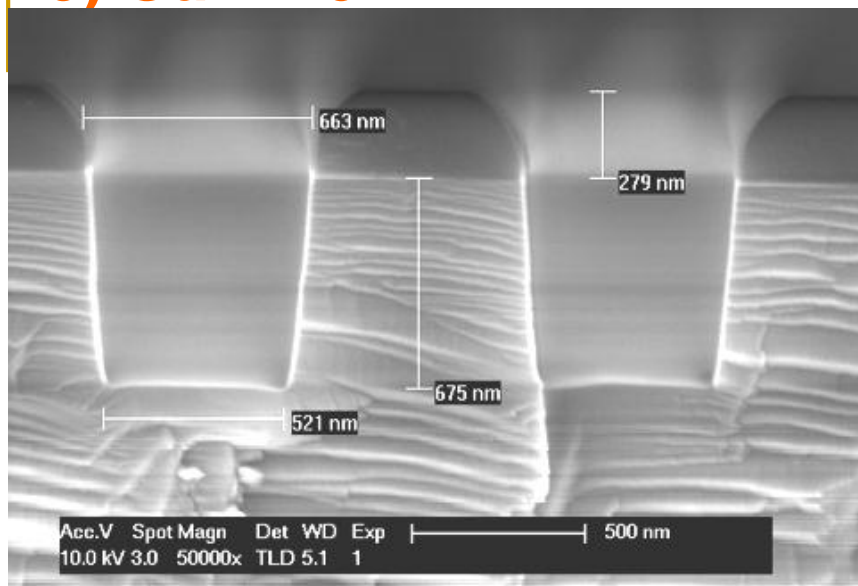
# 18) GaN#44



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

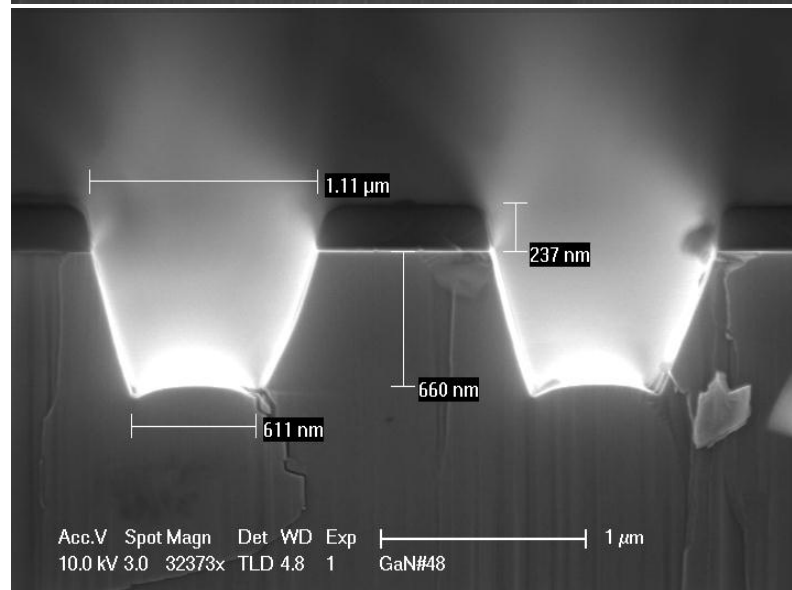
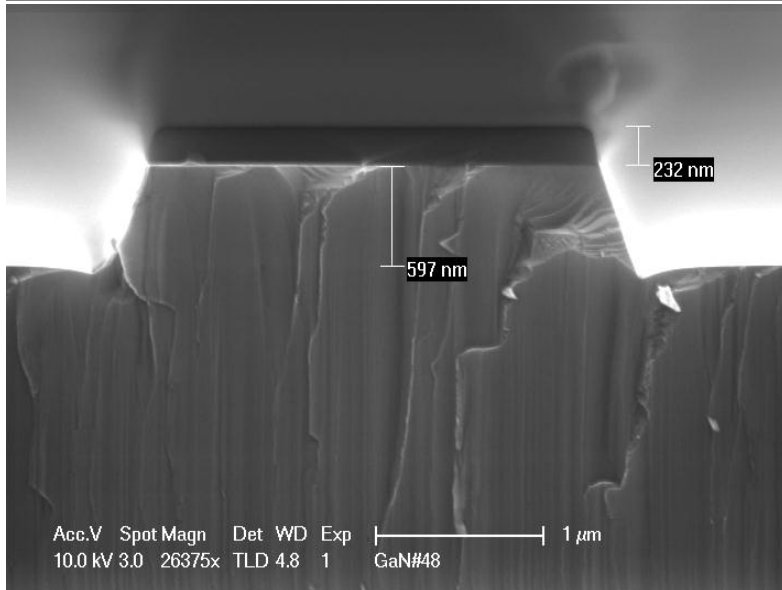
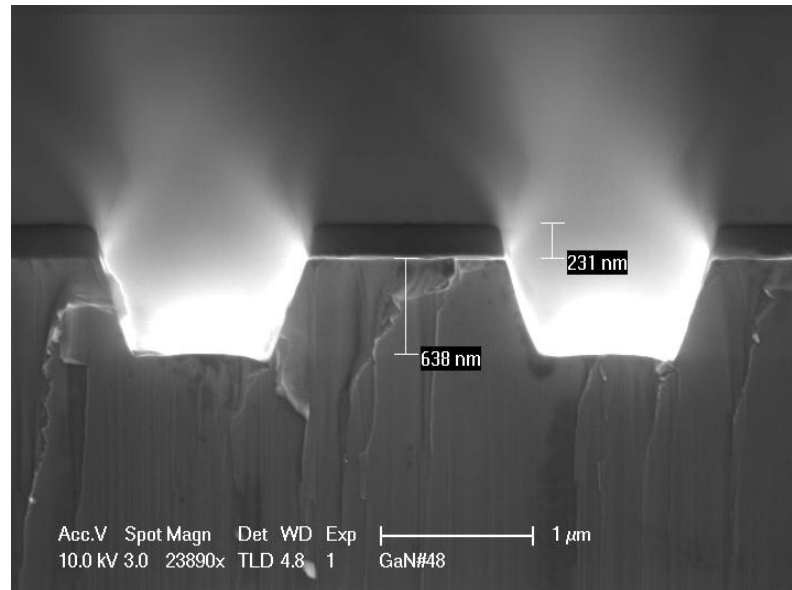
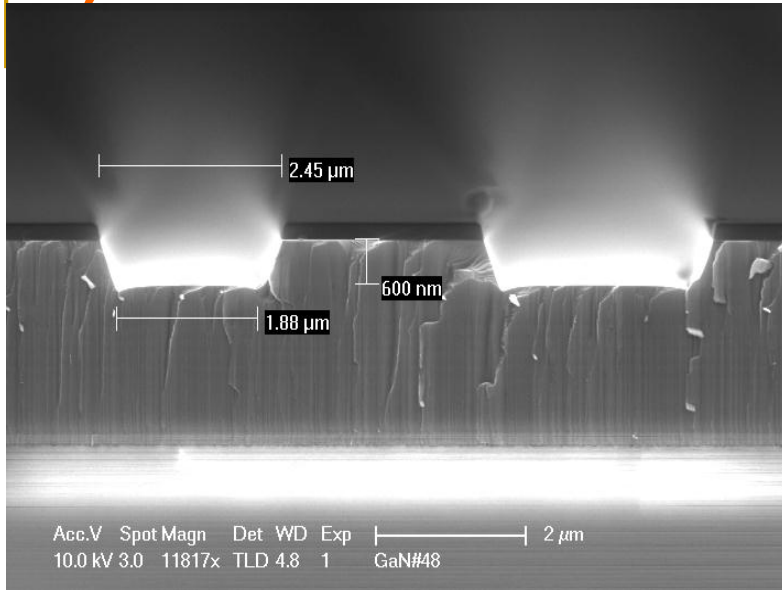
# 19) GaN#45



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB

## 20) GaN#48



8-31-2005

Ning Cao, Staff, Nanofab-Lab,  
UCSB