

Brief reports of catalyst-free growth of GaAs nanowires

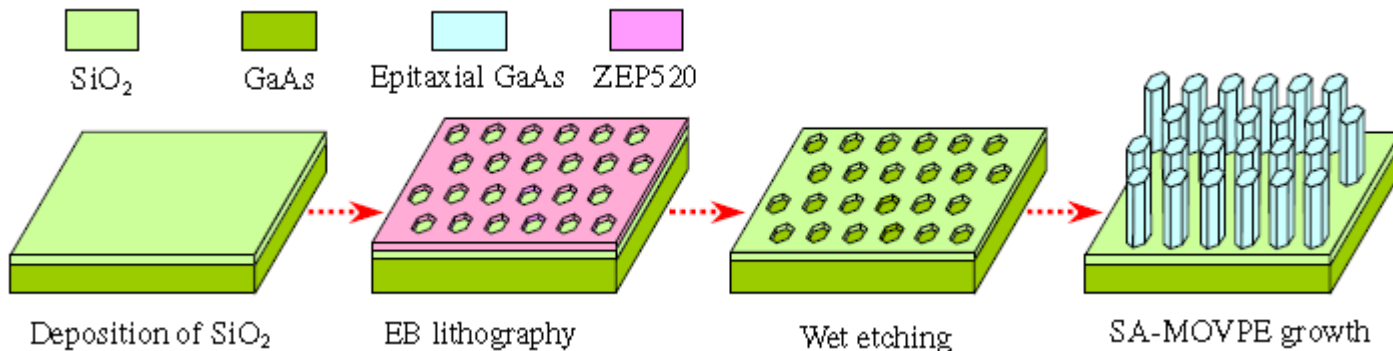
Pingping Chen

29-8-2011

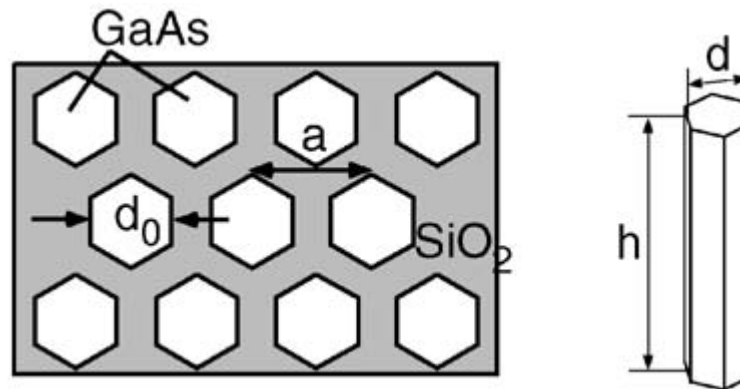
1: SAMOCVD growth of GaAs nanowires

2: MOCVD growth GaAs nanowire on SiO₂/GaAs (111)B

1: SAMOCVD growth of GaAs nanowires



Schematic fabrication procedure for selective-area MOCVD growth of nanowires



d_0 : opening diameter (design), a : pitch ,
 d : diameter of *nanowire*, h : height of *nanowire*

- $d_0=50\text{nm}$ $a= 500\text{nm}, 1000\text{nm}, 2000\text{nm}$
- $d_0=100\text{nm}$ $a= 500\text{nm}, 1000\text{nm}, 2000\text{nm}$
- $d_0= 250\text{nm}$ $a= 1000\text{nm}, 2000\text{nm}$

Condition (pattern substrate):

Substrate: GaAs (111) B, SiOx: 30nm by PECVD ($T_s=300^\circ\text{C}$)

Resist: ZEP: Anisole=1:2, spin@4000rpm 45s,

baked at 170°C in oven for 30 min, thickness of 80nm.

EBL: beam of 10kV, $10\mu\text{m}$, based dose $40\mu\text{C}/\text{cm}^2$

Develop: ZED 30s Rinse: IPA for 30s

Wet etching: HF(48%):H₂O= 1:50 (60-75s)

Cleaned ZEP stripper (~30min),

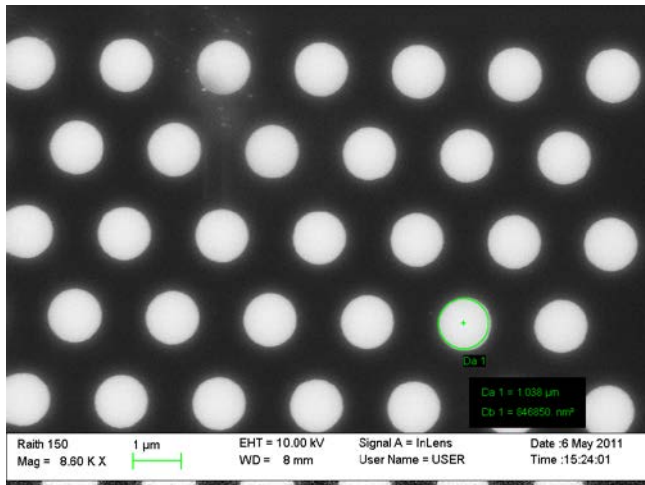
O plasma cleaning 2min (100W)

etched : 10% HCl to remove native oxide; 10% H₂SO₄ etch several ML GaAs

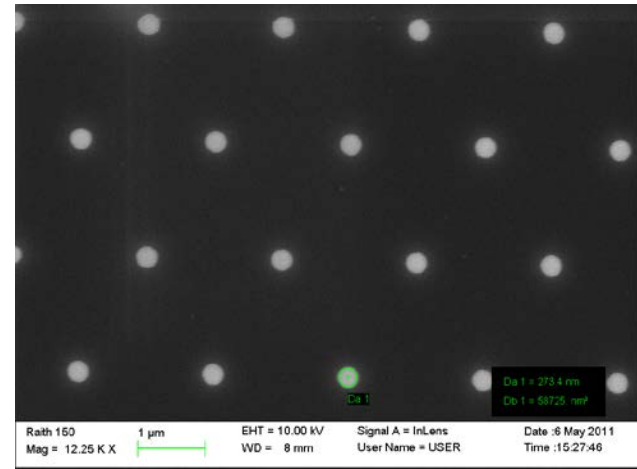
Cleaned with D.I water

MOCVD condition:

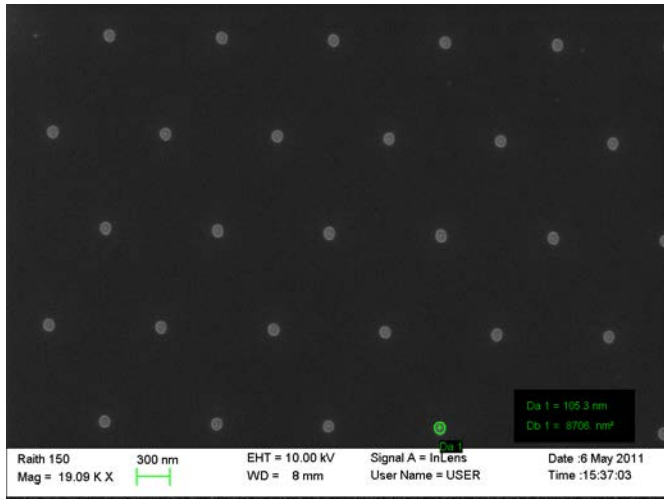
sample	TMGa mol/min	TM Al mol/min	AsH3 mol/min	III:V	time min	Ts(°C)	
371-	2.5E-05		2.5E-03	1:100	60	750	
372-	2.5E-05		7.5E-03	1:300	30	750	
373-	2.5E-05		8.3E-04	1:30	60	750	
391-	7.5E-05		7.5E-03	1:100	20min	750	
392- (core) (shell)	2.5E-05		2.5E-03	1:100	60min	750	
	2.5E-05	8E-06	2.5E-03		3.7min		



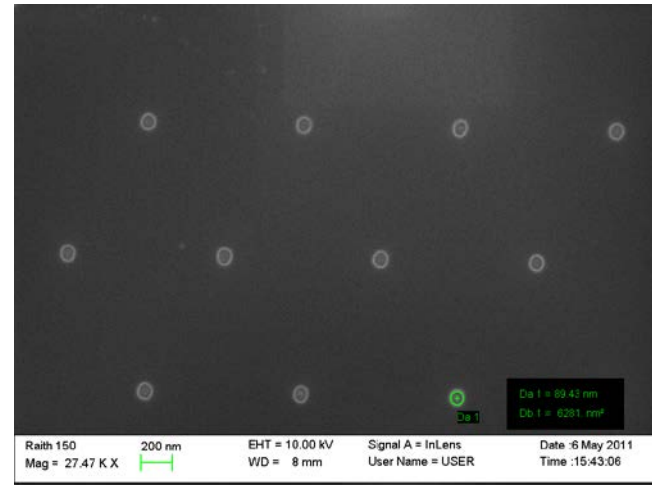
$d_0 = 1000\text{nm}$



$d_0 = 250\text{nm}$



$d_0 = 100\text{nm}$

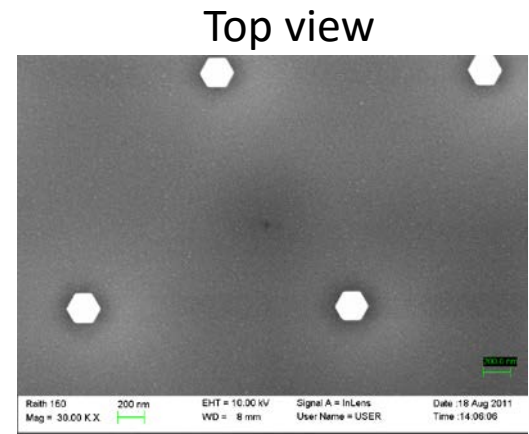
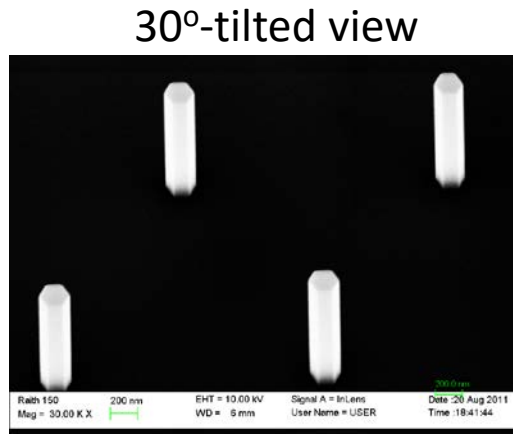


$d_0 = 50\text{nm}$

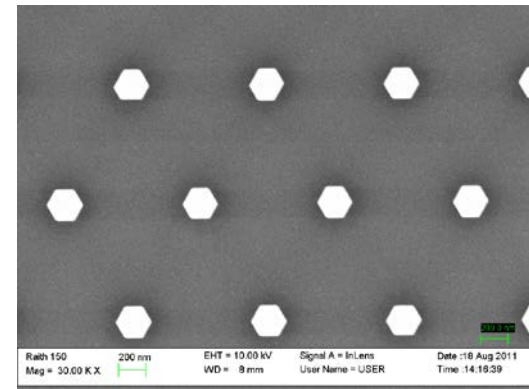
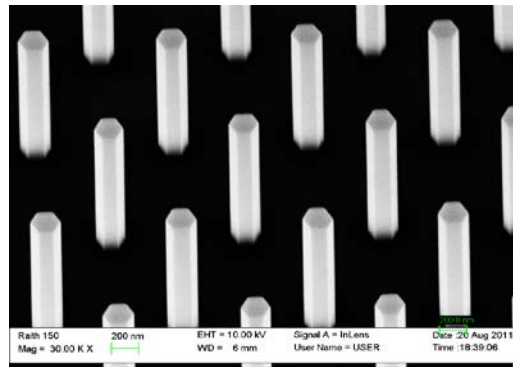
Different EBL patterns (before etching) for SAMOCVD



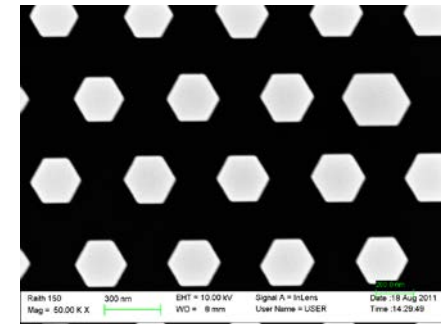
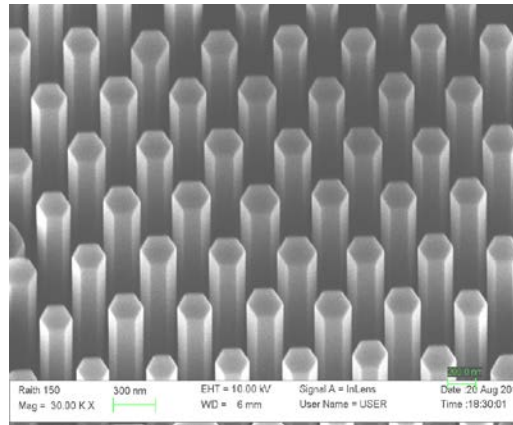
a=2 μ m



a=1 μ m



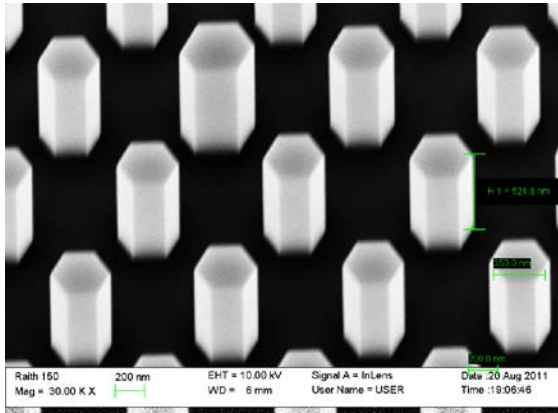
a=500nm



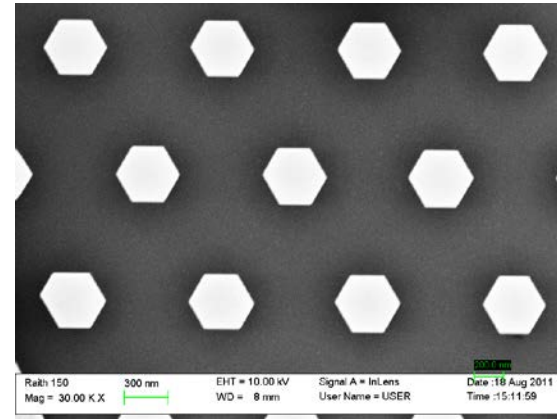
371 2-100nm-65s

SEM images of GaAs NW s with different pitches

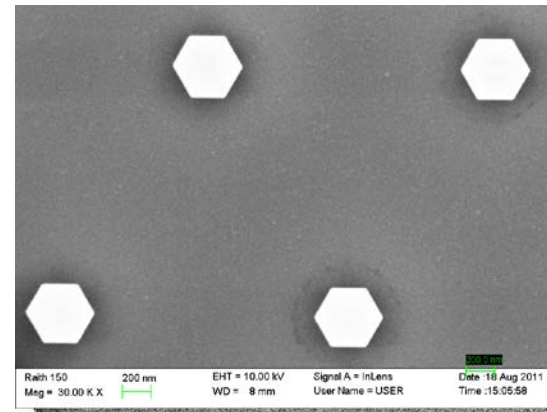
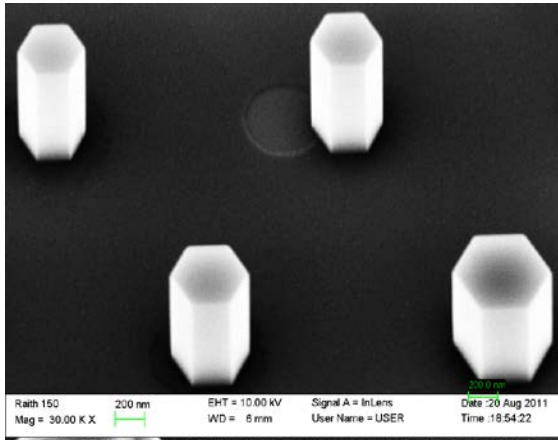
30°-tilted view



Top view



$a=1\mu\text{m}$



$a=2\mu\text{m}$

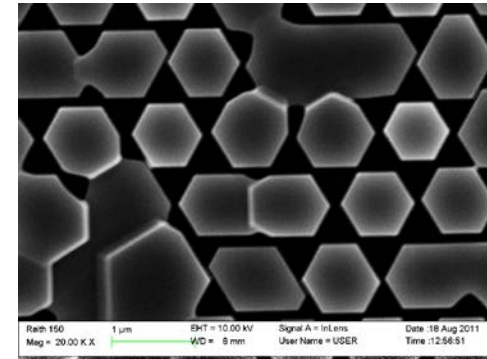
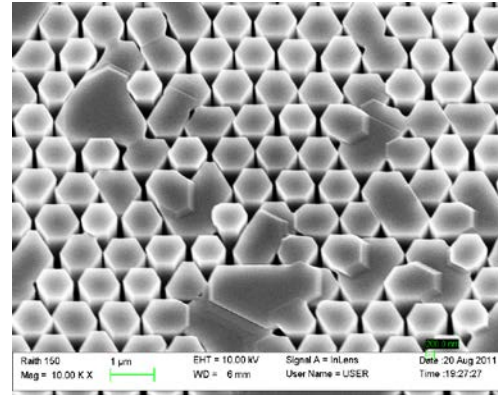
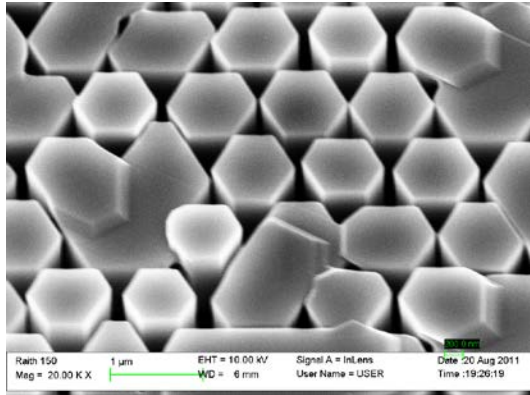
371-3-250nm-75s

SEM images of GaAs NW s with different pitches

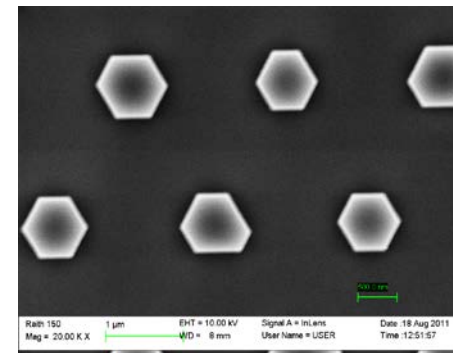
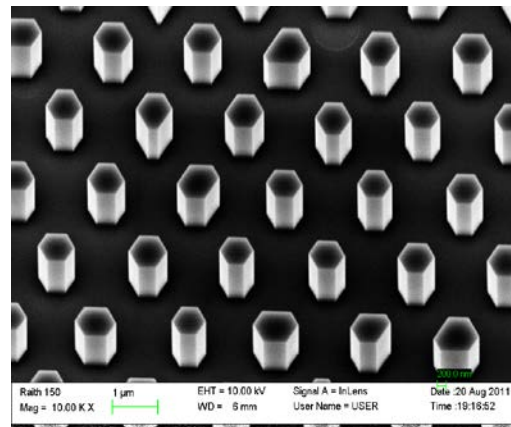
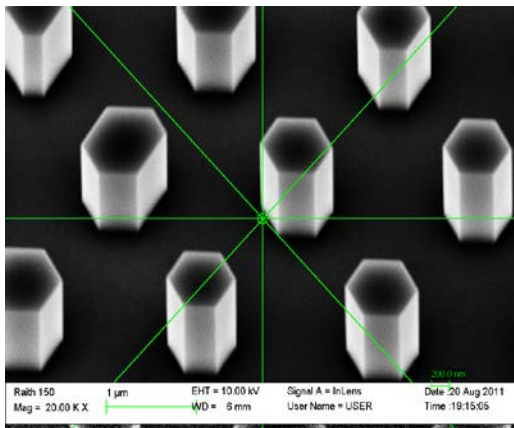
30°-tilted view

Top view

a=1um



a=2um

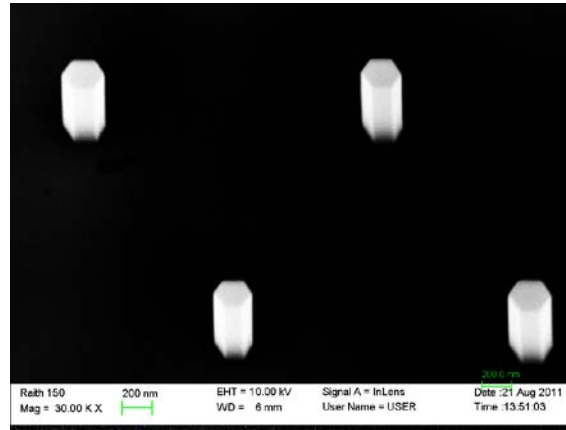
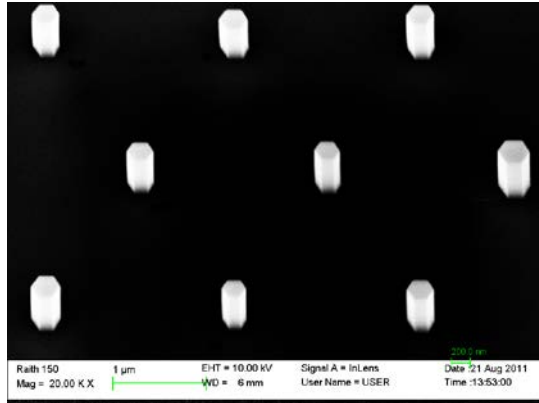


371-4-50nm-75s

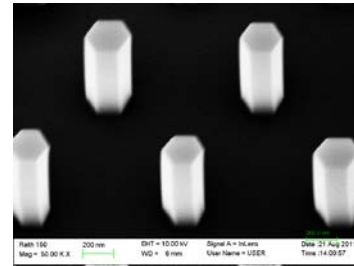
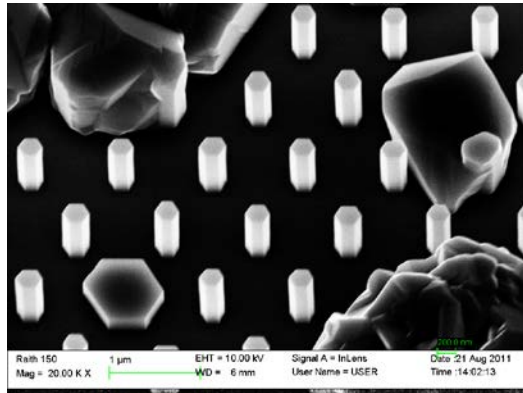
SEM images of GaAs NW s with different pitches

30°-tilted view

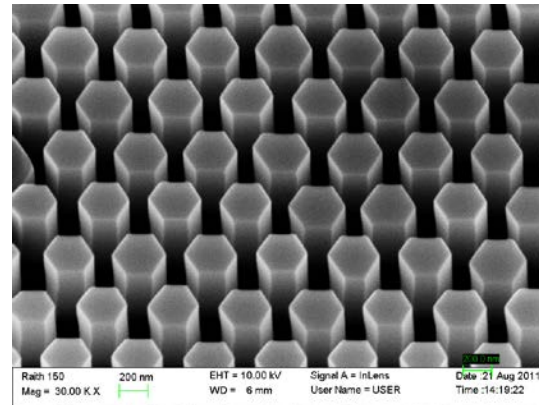
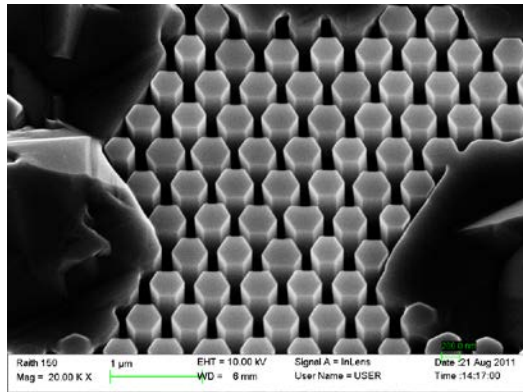
2um



1um



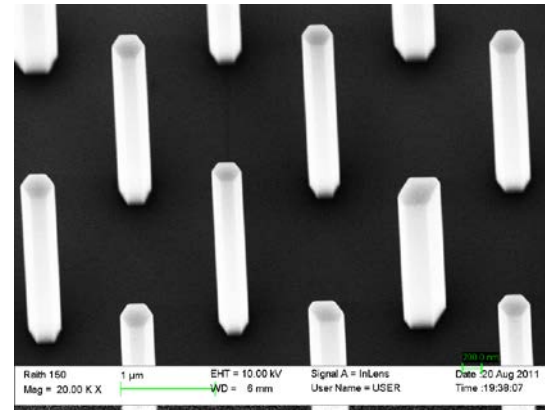
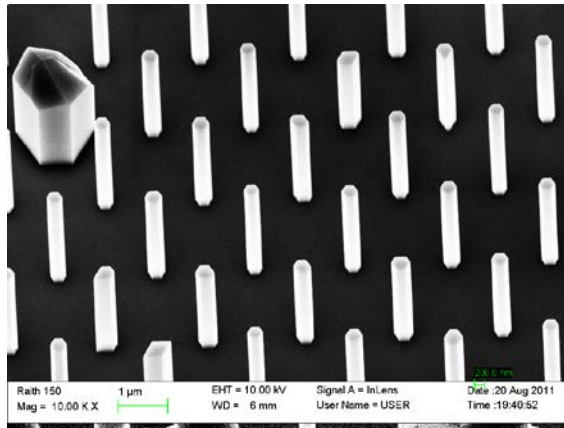
500 nm



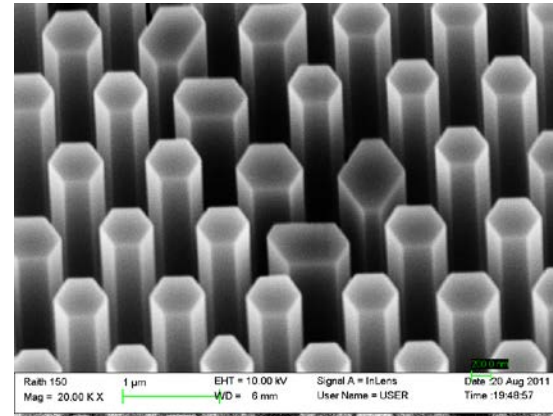
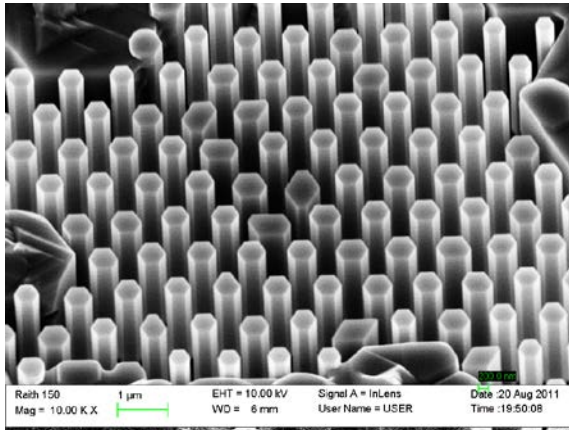
372-2- 50nm-75s

SEM images of GaAs NW s with different pitches

a=2um



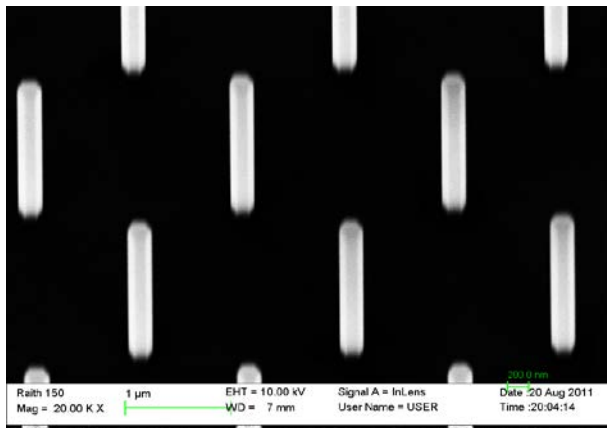
a=1um



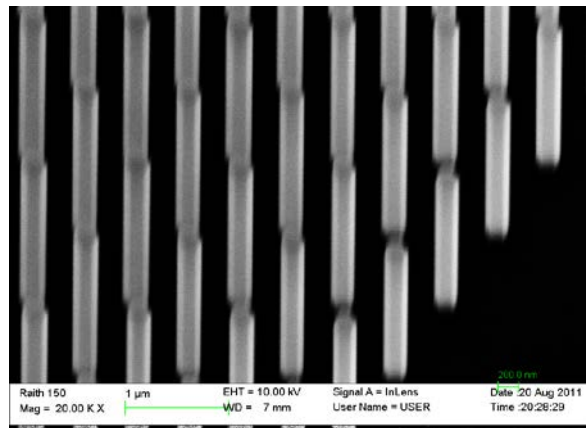
30°-tilted view

373-2-50-75

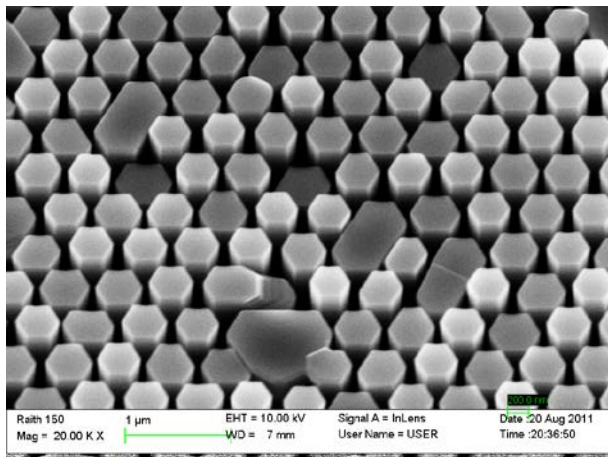
SEM images of GaAs NW s with different pitches



2μm

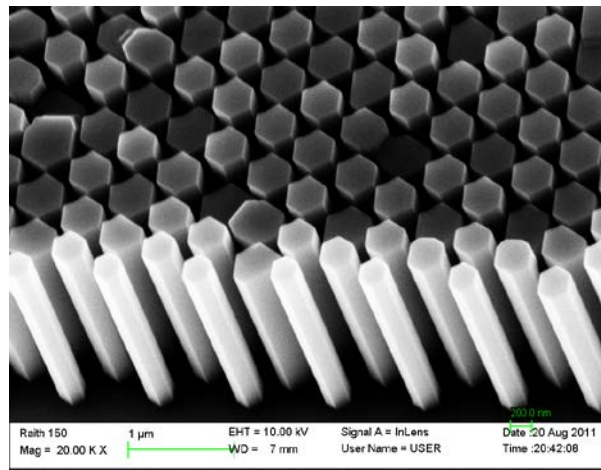


1μm



500nm

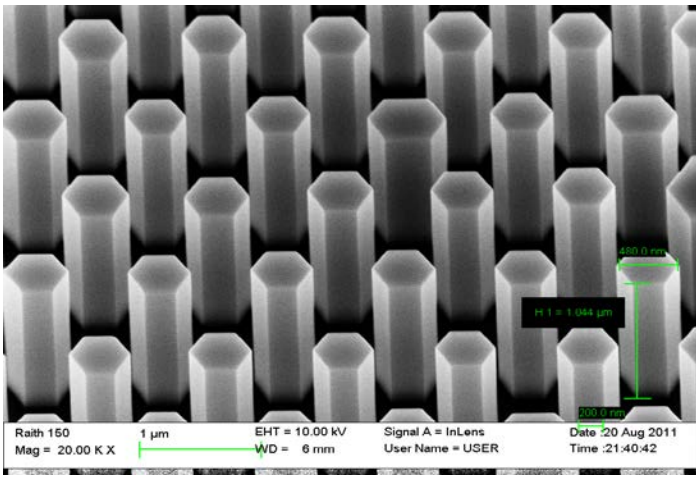
30°-tilted view



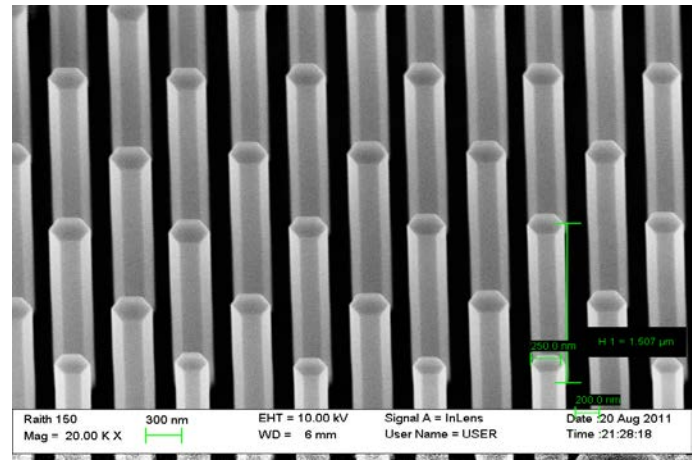
500nm

373-3-100-75s

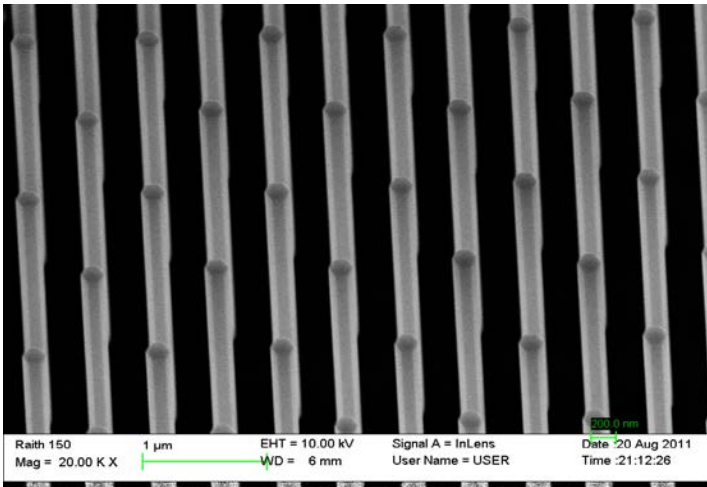
SEM images of GaAs NW s with different pitches



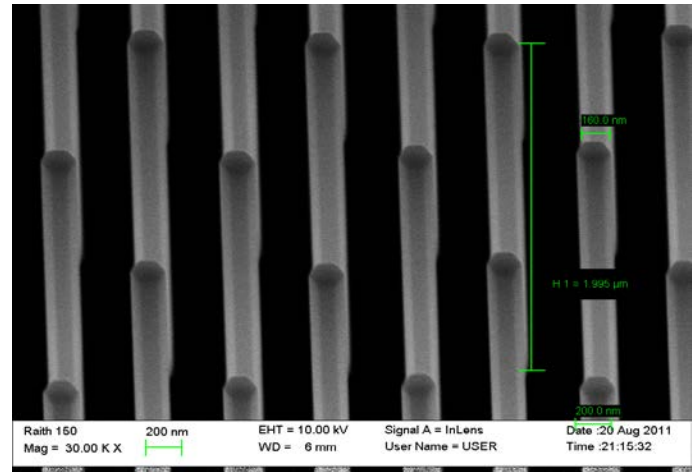
250 nm



100 nm



50 nm



373-6-a- 1um, 60s

30°-tilted view

SEM images of GaAs NWs of different size with same pitch (a=1um)

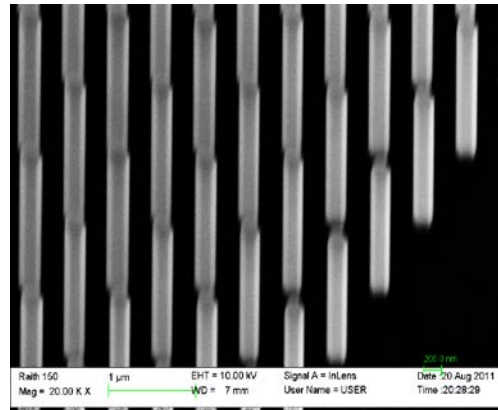
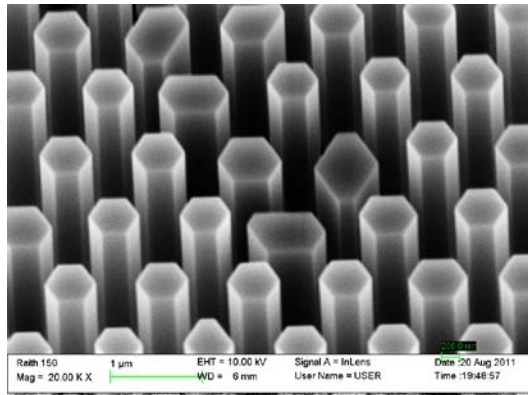
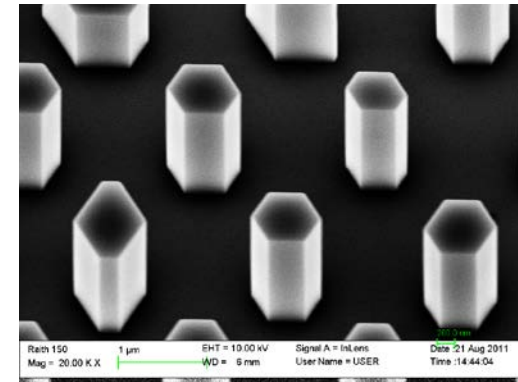
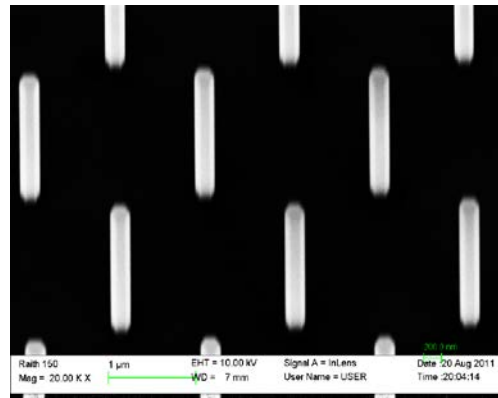
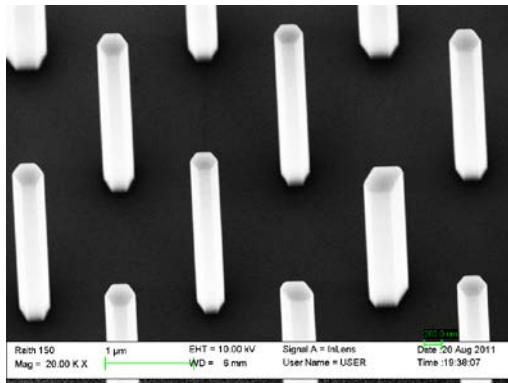
50nm

100nm

250nm



2um



1um

30°-tilted view

373:

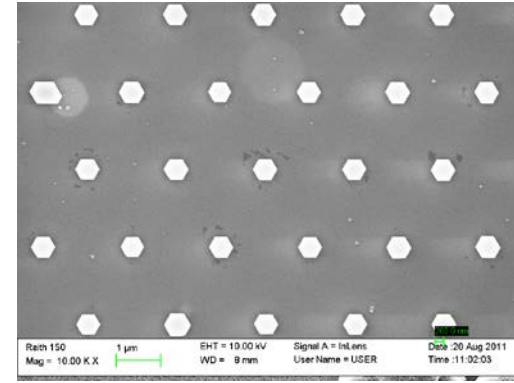
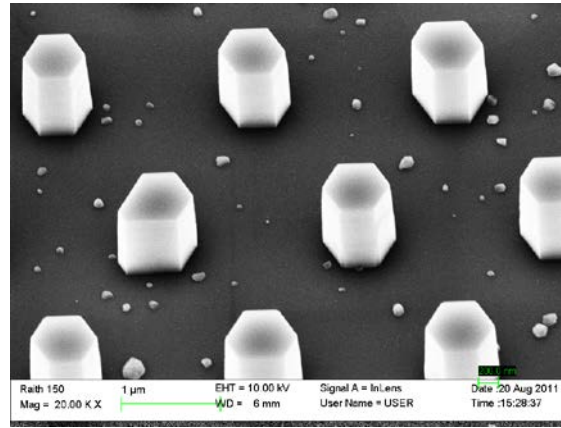
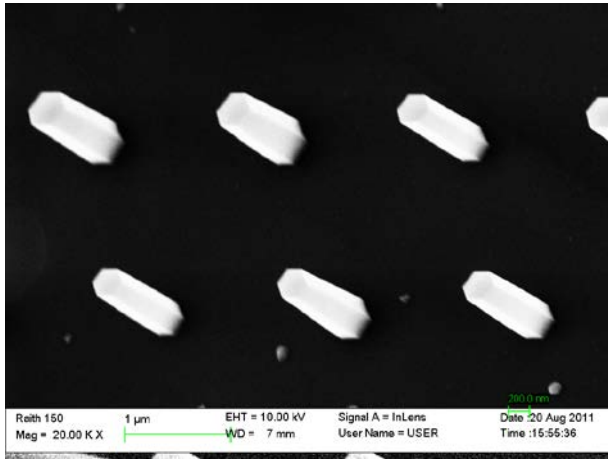
SEM images of GaAs NW s of different sizes and pitches

50nm

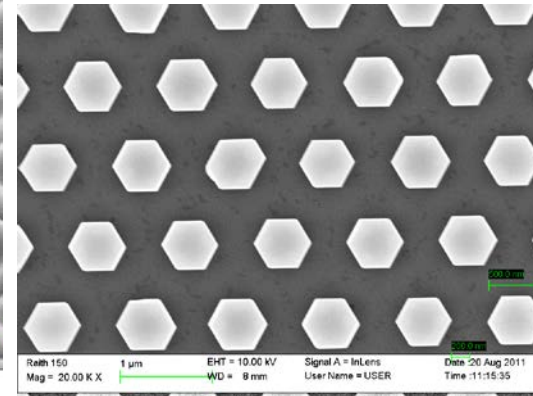
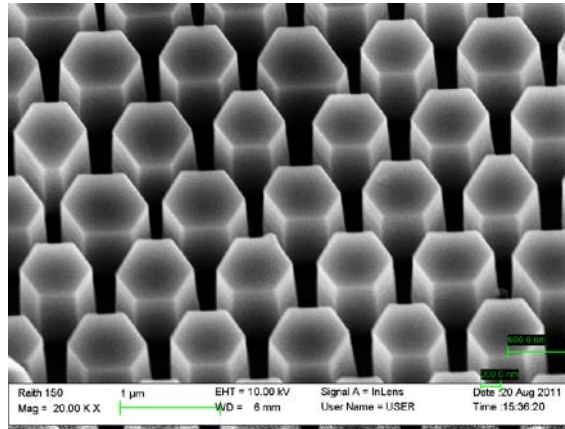
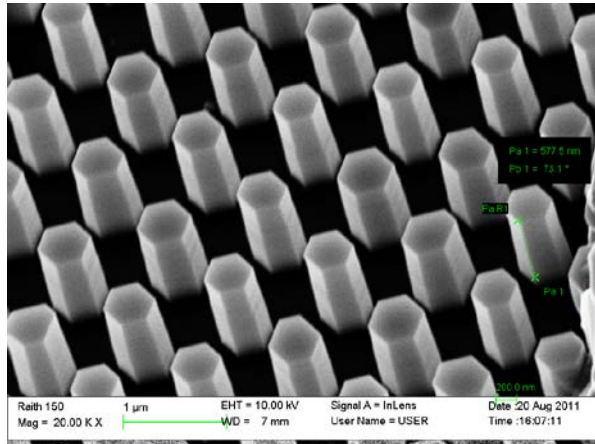
100nm

250 nm

a=2um



a=1um



392-75s

SEM images of GaAs NWs of different sizes and pitches (GaAs/AlGaAs Core shell ---392)