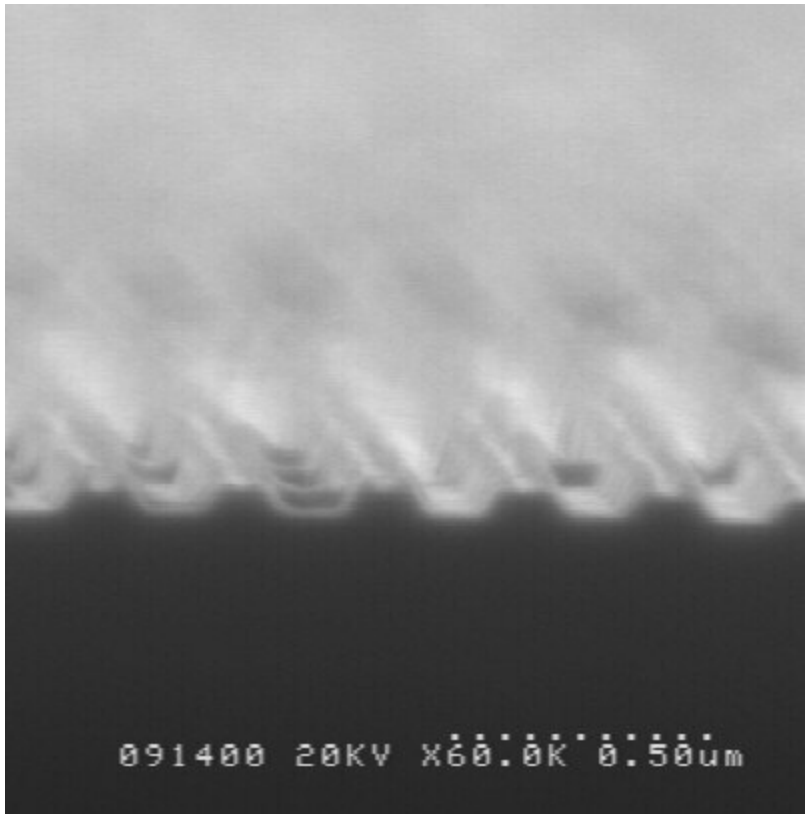
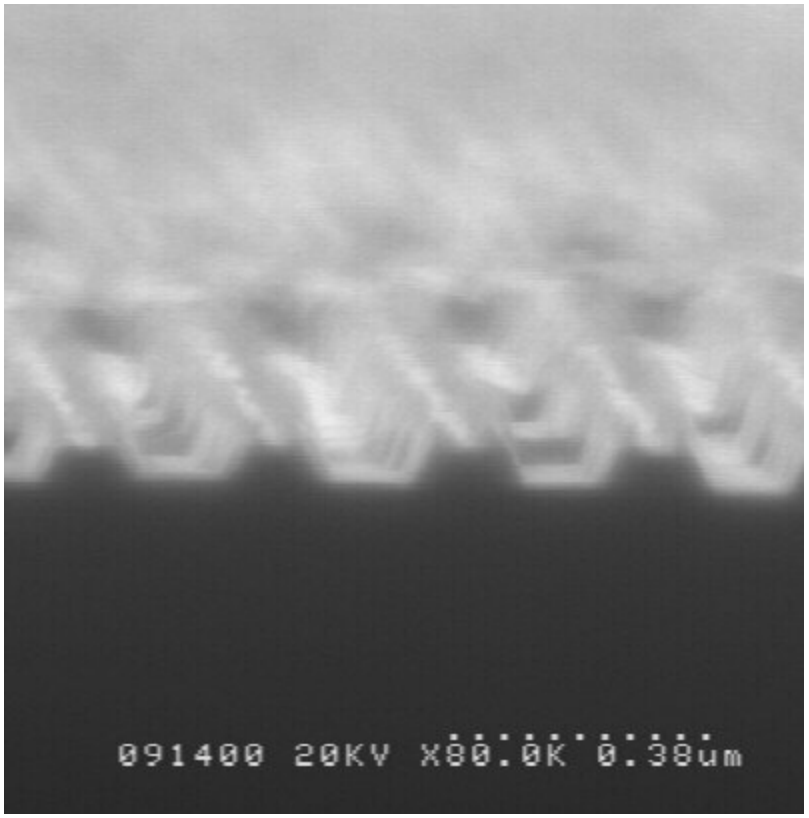
# IBE Gratings – Surface Clean Up Experiment

- Problem:  IBE gratings had bat ears
- Experiment Goal:  Develop process to eliminate bat ears

SEM pictures courtesy of Photodigm, Inc.

# Bat Ears




Duty cycle ~ 36%, Grating Depth ~ 500 Å



Presented by: Susan Wilson
Advisor: Dr. Gary Evans

# IBE and Photo Resist Removal

IBE Run 08/15/04

- IBE Process
  - Using Epi-Grade GaAs with positive resist grating mask
  - Hard Bake 5 min. at 95ºC
  - Flowing Ar, 300 V, Beam Current 50 mA
  - Etch time 2 min, 11 sec (Grating target depth 700 Angstroms)

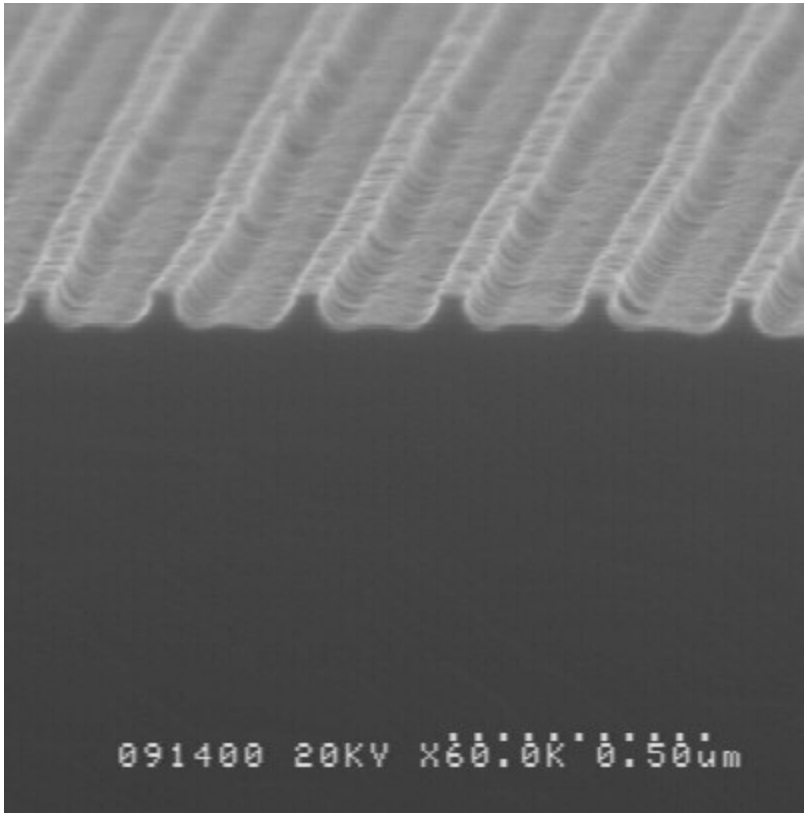
- Positive Photo Resist Removal
  - O2 Ashed for 15 min at 125 W and 0.58 torr
  - Acetone/IPA/nitrogen dry
  - O2 Ashed for 10 min at 125 W and 0.58 torr

- After photo resist removal, I cleaved the piece into two pieces. (A and B)

# Surface Cleans

- **Piece A was cleaned as follows:**
  - Acetone Boil – 10 min at 150 degrees C
  - Acetone/IPA/Nitrogen
  - Ash 5 min
  - BOE 1:10 for 30 sec
  - Bake at 95 degree C for 3 min
  - Wet etched H2S04:H202:H20 (1:8:160) for 10 sec

- **Piece B was cleaned as follows:**
  - Scrubbed with q-tip in acetone bath ~ 5 min
  - Acetone/IPA/Nitrogen
  - Ash 5 min
  - BOE 1:10 for 30 sec
  - Bake at 95 degree C for 3 min
  - Wet etched H2S04:H202:H20 (1:8:160) for 10 sec

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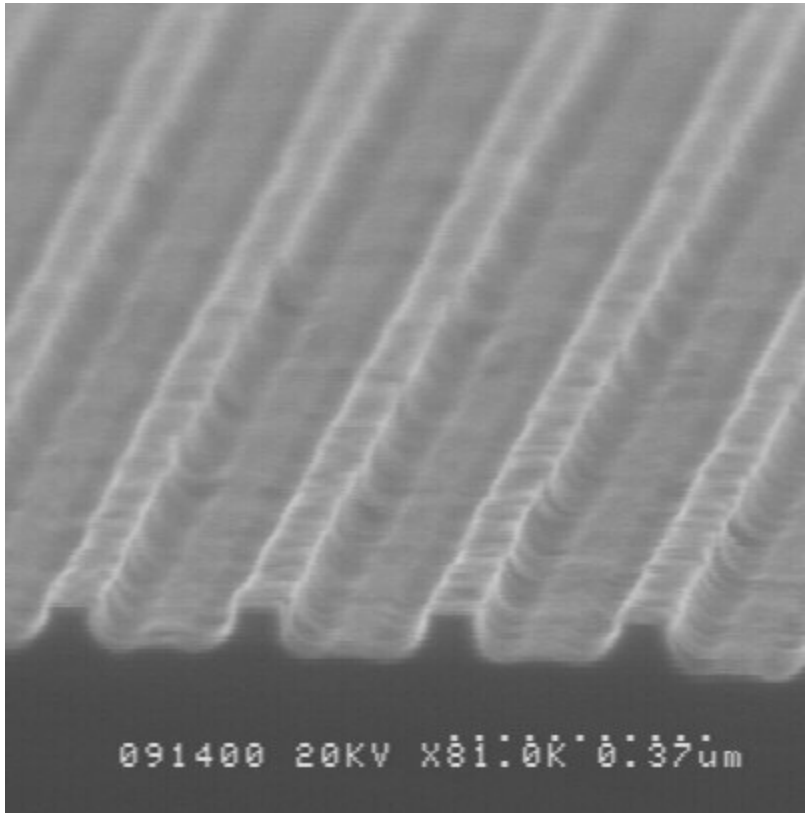


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9/3/2004

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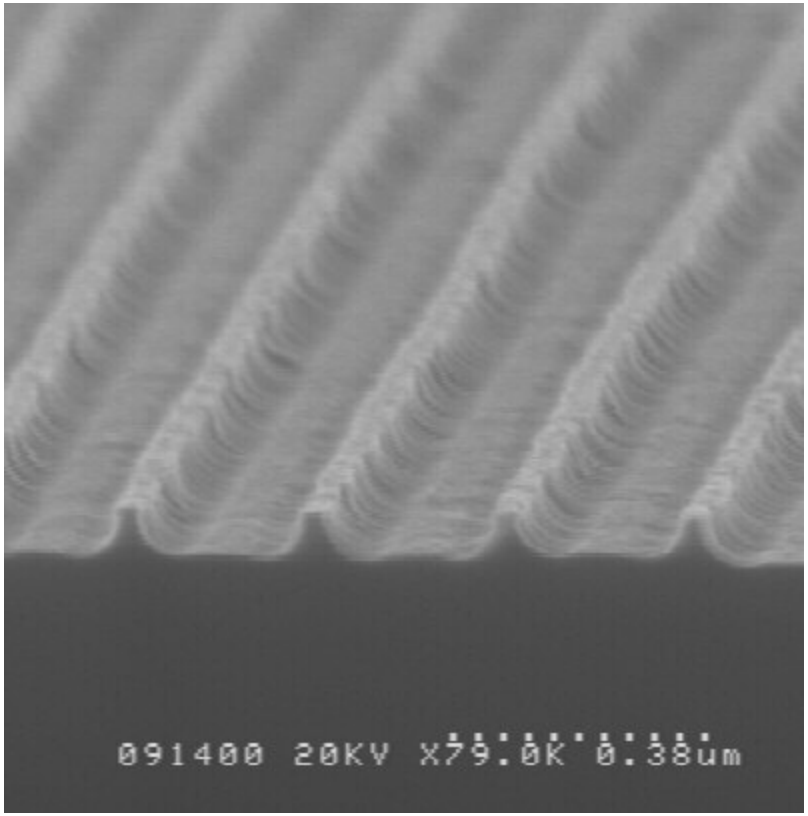
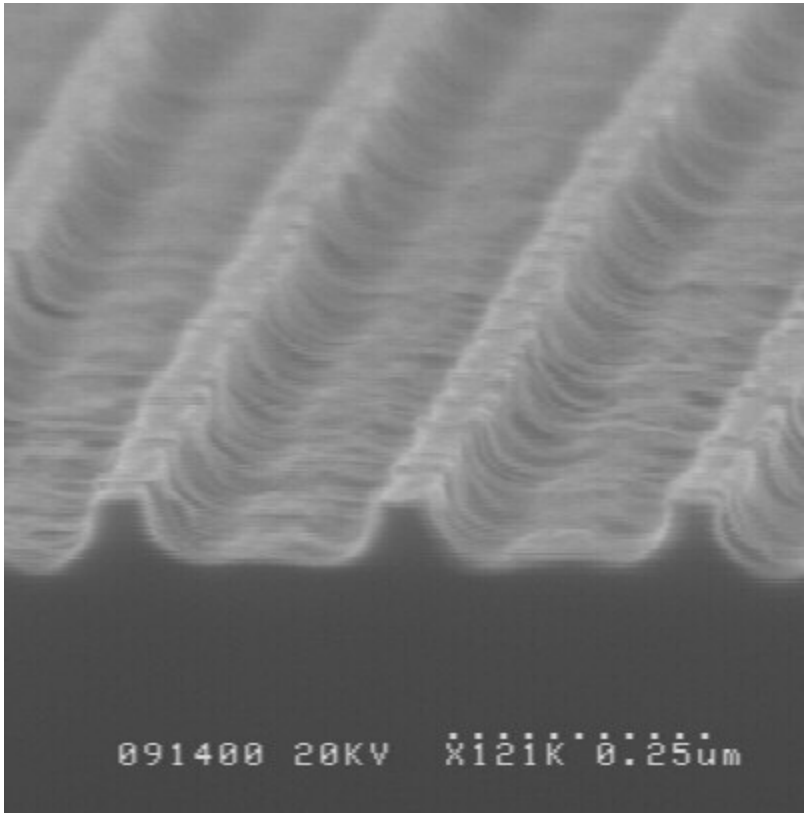



9070-B




9070-B2

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# Results

- Acetone Boil looks better than Acetone Scrub
- Duty Cycle is ~ 16 - 32% (Target is 40 – 60%)
- Grating Depth is ~ 600 – 722 Å
- Bat Ears are gone
- Estimate that the wet etch clean up removed ~ 400 Å of GaAs

# Second Experiment Run

- A different IBE process was run with higher beam current (123 mA) to reduce GaAs/Photo Resist selectivity to ~ 1:1
- Normaski inspection of witness etch piece showed increased surface roughness compared to lower beam current process
- Status:  Pending SEM pictures of gratings

# Third IBE Experiment

- Problem:  Low duty cycle
- Experiment Goal:  Improve duty cycle to 40 – 60% target range while eliminating bat ears and achieving smooth surface
- Status
  - Selected two grating samples
    - One piece at diffraction efficiency peak (28.2%)
    - Another piece on low side of peak (16.06%)
  - IBE at Beam Current 50 mA for 2 min
  - Pending surface cleans
    - Plan to vary wet etch times

# Future Work

- Get Experiment 2 and 3 Results (Sep 8)
- Run Real Epi and submit for regrowth (Sep 10)
- Continue learning Grating Software