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

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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 H2SO4:H2O2:H2O (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 H2SO4:H2O2:H2O (1:8:160) for 10 sec
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