Appendix 1

Device Fabrication Process

The fabrication process is given below.

1. Cleave a small piece (area ~ 0.5 cm^2) from wafer.
2. Degrease sample to remove organic contaminants with acetone / ethanol / de-ionized (DI) water / blow dry with dry nitrogen.
3. Bake for five minutes @ 125°C (drive off water vapor)
4. Mount sample on cover slip with glycophalate (white wax).
5. Spin on Microposit primer / adhesion promoter for 40 s @ 4000 rpm (let primer sit on sample for at least ten seconds before spinning).
6. Spin on AZ 5214E photoresist for 40 s @ 4000 rpm.
7. Prebake for 60 s @ 90°C (on aluminum block)
8. Use HTG aligner. Expose pattern (QWITT mask with different sized squares) for 20 - 25 s.
9. Develop in AZ 425 MIF aqueous developer for 60 s.
10. Do double DI water rinse. Blow dry with nitrogen.
11. Perform oxygen plasma ashing for one minute @ 1/4 power.
12. Examine developed pattern and measure linewidths with Nikon/HMOS microscope.
13. Perform a 15 sec surface preparation etch in (2:1) $HCl:H_20$. Then DI water rinse and blow dry.
14. Immediately place sample in metal evaporation chamber.
15. Metal deposition sequence.

    For n+ GaAs ohmic contacts: Specific contact resistance, p_c, of ~ 5 x 10^{-6} ohm-cm^2.
    - Ni: 50Å
    - AuGe: 1000Å
    - Ni: 200Å
    - Au: 300Å

    For n+ $In_{0.53}Ga_{0.47}As$ ohmic contacts: p_c of 10^{-6} ohm-cm^2.
    - Cr: 50Å

- Au: 1000Å

16. Rinse metallized chips in acetone until resist lifts off. If resist still doesn't lift-off, rinse for three to five seconds with ultrasonic agitation.
17. Once resist has lifted off, rinse chips in ethanol/DI water and blow dry.
18. Remount chips on cover slip with white wax.
19. Mesa isolation.

    For GaAs samples:

    - Prepare GaAs etch solution; (8:1:1) H_2SO_4:H_2O_2:H_2O. Nominal etch rate is 1.2 μm/min. Pour 80 ml H_2SO_4 into 10 ml H_20. Cool solution in ice water bath. Then, pour 10 ml H_2O_2 into mix and let cool for twenty minutes. Stir every five minutes.
    - Etch for 60 s.
    - Do a double DI water rinse and nitrogen blow dry.

    For $In_{0.53}Ga_{0.47}As$ samples:

    - Prepare etch solution; (1:8:40) H_3PO_4:H_2O_2:H_2O. Nominal etch rate is 150Å/sec.
    - Etch sample for 60 sec.
    - Do a double DI water rinse and blow dry with nitrogen.

20. Examine pattern under microscope.
21.. Demount chip off cover slip with acetone/ethanol/DI water/blow dry.
22. Bake @ 120°C for two minutes to dry wafer.
23. For GaAs samples: perform rapid thermal annealing @ 450°C for 35 sec. For $In_{0.53}Ga_{0.47}As$ samples: no annealing required since Cr/Au provides a low resistance, non-alloyed ohmic contact to n+ $In_{0.53}Ga_{0.47}As$.
24. Ready for electrical testing.