Appendix A

Wafer inventory

In this Appendix we present the various heterostructures used in this thesis. All values for density and mobility were measured at 4.2 K with samples cooled down in the dark. We present the layer structure from top down.

A.1 WSUMI301612

This wafer was purchased from Sumitomo Electric Industries, Ltd. Devices from this wafer were used for experiments on quantum fluctuations in the non-local resistance in Chapter 6 and for studies on ohmic contact formation to a 2DEG in Chapter 7. Quantum point contacts fabricated on this wafer never showed any sign of spin splitting in a large in-plane magnetic field.

- 2DEG depth: 75 nm
- Density: 2.78×10^{15} m^{-2}
- Mobility: 19.5 m^2/Vs
- Layer structure:
  - 5 nm GaAs
  - 40 nm $Al_{0.27}Ga_{0.73}As$ (n-doped with Si at 2×10^{18} cm^{-3})
  - 30 nm $Al_{0.27}Ga_{0.73}As$
  - 800 nm GaAs

A.2 WREUT1098

This wafer was grown in the group of D. Reuter and A. D. Wieck at the Ruhr-Universität in Bochum, Germany. Devices from this wafer were used for experiments on point contacts and quantum dots in Chapters 3 and 4, and for studies on ohmic contact formation to a 2DEG in Chapter 7.

- 2DEG Depth: 114 nm
- Density: 1.5×10^{15} m^{-2}
- Mobility: 159 m^2/Vs
- Layer structure:
  - 5.5 nm GaAs
  - 71.9 nm $Al_{0.32}Ga_{0.68}As$ (n-doped with Si at 1×10^{18} cm^{-3})
  - 36.8 nm $Al_{0.32}Ga_{0.68}As$
  - 933 nm GaAs

A.3 WREUT12570

This wafer was grown in the group of D. Reuter and A. D. Wieck at the Ruhr-Universität in Bochum, Germany. Devices from this wafer were used only for studies on ohmic contact formation to a 2DEG in Chapter 7.

- 2DEG Depth: 180 nm
- Density: 4.54×10^{15} m^{-2}
- Mobility: 22.9 m^2/Vs
- Layer structure:
  - 5 nm GaAs
  - 70 nm $Al_{0.35}Ga_{0.65}As$
  - 70 nm $Al_{0.35}Ga_{0.65}As$ (n-doped with Si at 1×10^{18} cm^{-3})
  - 35 nm $Al_{0.35}Ga_{0.65}As$
  - 650 nm GaAs

Appendix B

Device fabrication

In this Appendix we will describe the fabrication procedure for the devices that were used in this thesis.

B.1 Alignment markers

- Preparation:
  - Clean in boiling acetone (10')
  - Rinse in IPA (30")
  - Spin dry
- Resist:
  - Spin 250 nm 950K PMMA (4% in Chlorobenzene) - 4000 rpm (60")
  - Bake at 180 ^{o}C (15')
- Exposure:
  - Beam voltage: 10 keV
  - Aperture: 10 μm
  - Working area: 200 x 200 μm
  - E-beam dose: 200 μC/cm^2
- Developing:
  - Develop in 1:3 MIBK / IPA (60")
  - Rinse in IPA (30")

  - Spin dry

- Evaporation:
  - 5 nm Ti
  - 50 nm Au
- Lift-off:
  - Lift-off in acetone (several hours) / acetone spray
  - Rinse in IPA (30")
  - Spin dry

B.2 Mesa etching

- Preparation:
  - Clean in boiling acetone (10')
  - Rinse in IPA (30")
  - Spin dry
- Resist:
  - Spin 70 nm 950K PMMA (2% in Ethyl lactate) - 4000 rpm (60")
  - Bake at 180 °C (15')
- Exposure:
  - Beam voltage: 10 keV
  - Aperture: 120 μm
  - Working area: 2000 x 2000 μm
  - E-beam dose: 150 μC/cm^2
- Developing:
  - Develop in 1:3 MIBK / IPA (35")
  - Rinse in IPA (30")
  - Spin dry

- Etching:
  - Etch in a 1:1:50 solution of H_2SO_4 / H_2O_2 / H_2O (50"). The etching rate is approximately 2 nm/s
  - Rinse in H_2O (30")
  - Spin dry
- Cleaning:
  - Clean in boiling acetone (10')
  - Rinse in IPA (30")
  - Spin dry

B.3 Ohmic contacts

- Preparation:
  - Clean in boiling acetone (10')
  - Rinse in IPA (30")
  - Spin dry
- Resist:
  - Spin 400 nm 50K PMMA (9% in Chlorobenzene) - 4000 rpm (60")
  - Bake at 180 °C (15')
  - Spin 70 nm 950K PMMA (2% in Ethyl lactate) - 4000 rpm (60")
  - Bake at 180 °C (15')
- Exposure:
  - Beam voltage: 10 keV
  - Aperture: 120 μm
  - Working area: 2000 x 2000 μm
  - E-beam dose: 200 μC/cm^2
- Developing:
  - Develop in 1:3 MIBK / IPA (60")

  - Rinse in IPA (30")
  - Spin dry

- Evaporation:
  - 120nm AuGe
  - 30nm Ni
  - 20nm Au

- Lift-off:
  - Lift-off in acetone (several hours) / acetone spray
  - Rinse in IPA (30")
  - Spin dry

- Annealing:
  - Anneal in N_2 atmosphere (50 ml/s) in the oven at 450 °C for typically 5 minutes (see Chapter 7 for more details)

B.4 Fine gates

- Preparation:
  - Clean in boiling acetone (10')
  - Rinse in IPA (30")
  - Spin dry

- Resist:
  - Spin 70 nm 950K PMMA (2% in Ethyl lactate) - 4000 rpm (60")
  - Bake at 180 °C (15')

- Exposure:
  - Beam voltage: 30 keV
  - Aperture: 10 μm
  - Working area: 200 x 200 μm

  - E-beam dose: 450 μC/cm^2

- Developing:
  - Develop in 1:3 MIBK / IPA (35")
  - Rinse in IPA (30")
  - Spin dry

- Evaporation:
  - 5 nm Ti
  - 15 nm Au

- Lift-off:
  - Lift-off in acetone (overnight) / acetone spray
  - Rinse in IPA (30")
  - Spin dry

B.5 Large gates

- Preparation:
  - Clean in boiling acetone (10')
  - Rinse in IPA (30")
  - Spin dry

- Resist:
  - Spin 400 nm 50K PMMA (9% in Chlorobenzene) - 4000 rpm (60")
  - Bake at 180 °C (15')
  - Spin 70 nm 950K PMMA (2% in Ethyl lactate) - 4000 rpm (60")
  - Bake at 180 °C (15')

- Exposure:
  - Beam voltage: 10 keV
  - Aperture: 120 μm

  - Working area: 2000 x 2000 μm
  - E-beam dose: 200 μC/cm^2

- Developing:
  - Develop in 1:3 MIBK / IPA (60")
  - Rinse in IPA (30")
  - Spin dry
- Evaporation:
  - 5 nm Ti
  - 150 nm Au
- Lift-off:
  - Lift-off in acetone (several hours) / acetone spray
  - Rinse in IPA (30")
  - Spin dry