Guidelines for quantum hall effect measurement blockcourse

We are pleased to offer the quantum hall effect measurement block course in our lab. The objective of this blockcourse is to give an introduction to mesoscopic measurement system, to the field of and quantum hall effect and to the world of cryogenics. In this course we will see the mechanism and working of the dilution refrigerator, measure Hall resistance in a Hall bar fabricated with two dimensional electron gas systems (2DEG).

You will perform these tasks with the guidance and assistance of Charulata Barge.

The course work is organized as follows.

Task description

1. Introduction, reading material, preparation
2. Precool the dewar with liquid nitrogen (LN2).
3. Check connections. Load the sample. Pre pump the dilution refrigerator.
4. Remove the LN2 from dewar and pump the dewar.
5. Transfer liquid helium (LHe).
6. Put the insert in dewar.
7. Condense He-3, He-4
8. Measurements.
9. Warm up dilution refrigerator.
10. Remove the sample.
11. Results and analysis
12. Report.

Detailed description

2. Pre-cool the dewar with liquid nitrogen

   - Disconnect the dewar from recovery line.
   - Transfer liquid nitrogen in the bath and outer jacket of the dewar.
   - Monitor the changes in resistance at the dewar base, Rd

3. Check connection, load sample, pre pump dewar,

   - Make sure that the cold finger is at the center with respect to DR unit.
   - Check the wire connections on the sample holder with bonded chip carrier.
   - Ground the insert using grounding straps.
   - Load the sample in sample holder.
   - Verify the room temperature resistor values at 1K pot, still, mixing chamber, cold finger.
   - Close the IVC can and start pumping on IVC.
   - Connect all the pumping lines except ISO60.
   - Hand the insert and then connect ISO60.
   - Pump on all the lines.

4. Remove the LN2 from dewar and pump the dewar

   - Connect the the pump and the helium gas bottle to the dewar.
   - Transfer the liquid nitrogen from bath to the outer jacket of the dewar.
   - While transferring, observe the resistance Rd.
   - When all the LN2 is transfered, close the dewar, and start pumping.
   - Heat the heater at the base of the dewar to vaporize the LN2 in the base if there is any.
   - Watch the pressure in the dewar. If it goes below 100 $mbar$, then the dewar is free of N2.
   - Bach fill the dewar with Helium gas.

5. Transfer liquid helium.

   - Make sure that the dewar is connected to recovery.
   - Transfer liquid helium into the bath.

6. Put the insert in the dewar.

   - When the pressure is below 10-2 *mbar*, put exchange gas in both IVC and DR.
   - Fill the trap with LN2.
   - Start pumping on 1K pot.
   - Start lowering the insert in dewar.
   - Go slowly upto 1K pot and then lower the insert fast until the 1K pot is below the ring to avoid ice formation.
   - Lower the insert completely in the dewar and tight the dewar o-ring.
   - Wait until all the parts are at 4K, pump back the 4He back to dump.

7. Condense He-3 and He-4.

   - Start pumping on 1K pot.
   - When, R1k $\approx$ 26-27 K Ω, condense He-3.
   - After He-3 condensation, start condensing He-4.
   - After condensing both He3- and He-4, put current ($\approx$ 10 mA) on still for further cooling.
   - When DR is reached to minimum value, press Auto and Normal Circulation for automatic circulation of mixture.

8. Measurements
9. Warm up the dilution refrigerator

   - After finishing with the measurement, put current on mixing chamber and still (I$\approx$ 20 mA).
   - Recover He-3. Compare the pressure in the dump He-3 before cool down and after cool down.
   - Recover He-4. Compare the pressure in the dump He-4 before cool down and after cool down.
   - After recovering both He-3 and He-4, stop pumping the 1K pot.
   - Remove the insert from dear.
   - Put some exchange gas in the DR ($\approx$ 50 mbar).
   - When all parts are at 4K, put exchange gas back to dump.

10. Remove the sample.

    - Close valve Aux and disconnect the ISO-60 pumping line.
    - Put the DR on the table.

- To vent the IVC, disconnect IVC pumping line, open the respective valve from GHS.
- Remove the IVC can.
- Carefully remove the sample using metal tweezers.

11. Results and Analysis

12. Reports
A report encompassing 2500 to max. 5000 words has to be prepared describing the experiments performed and the measurements made. As the language of science generally is english, we highly recommend that your report is written in english. The preferred scientific text processing system for physicists is LaTeX, and we would like to encourage you to prepare your report using LaTeX. Try to structure the report well, if you wish into the following sections:

1) Introduction and Motivation

2) Experiments and Results

3) Conclusion and Discussion

The report will be graded using the published Blockcourse criteria, also available on our webpage.