STIR-KOOL SK-12D COLD PLATE

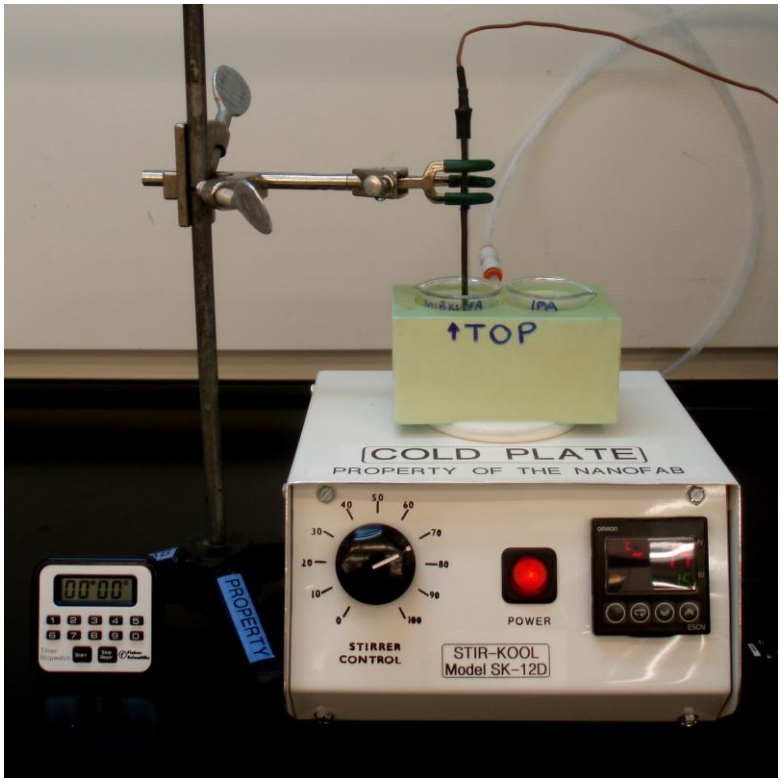

Figure 1 Stir-Kool SK-12D Cold Plate in action

LOCATION: Aisle 3 Fumehood

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SECONDARY TRAINER: Jolene Chorzempa (780-492-4823, jolenec@ualberta.ca)

1. OVERVIEW

The Stir-Kool SK-12D (21485) cold plate by Ladd Research (www.laddresearch.com), shown in Fig. 1., is a very accurate and sophisticated thermoelectric cooler with various cooling schemes and a built-in stirrer. This cold plate can be used for cooling small (< 250 mL) amounts of liquids very rapidly to 40 °C below the tap water temperature. An example use of this device is cold development of exposed electron beam resists for resolution enhancement and reduction in line edge roughness (LER).

2. SAFETY PRECAUTIONS

Please consult multiple MSDS for checking the material properties of any liquid you wish to heat or cool. Always use the designated fumehood for conducting your work. If you plan to bring a chemical to the Aisle 3 fumehood for your process that requires extra protective gear, please consult the Nanofab staff.

If you are bringing any new materials into the NanoFab for use in your process, it is necessary to fill out a chemical import form (available on our website, http://www.nanofab.ualberta.ca) and supply an MSDS data sheet to the training coordinator.

3. COMPONENTS AND FEATURES

The Stir-Kool SK-12D cold plate is kept in a cleanroom box labeled 'COLD PLATE' below the Aisle 3 fumehood. The contents of this box are shown below in Fig. 2:

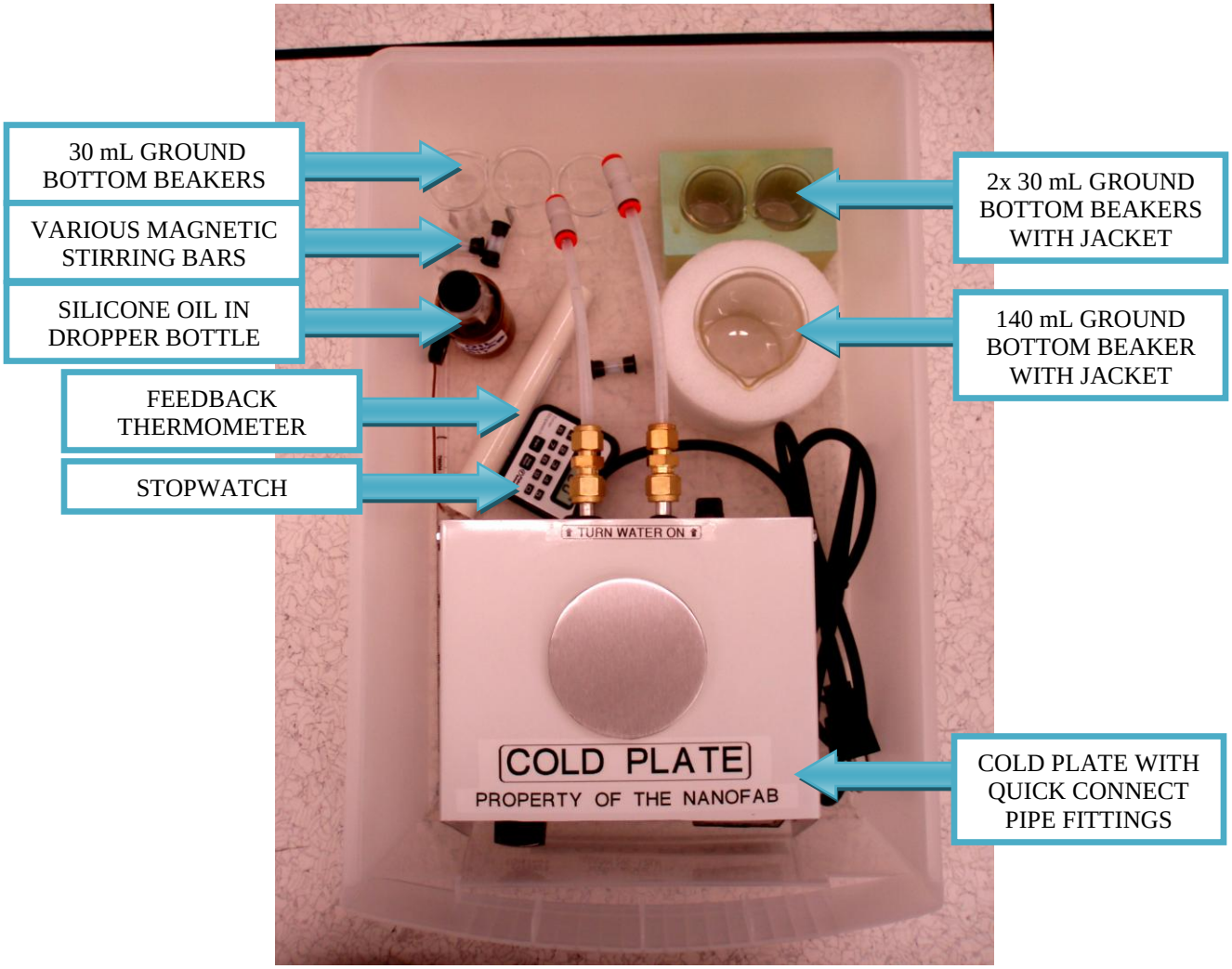


Figure 2 Contents of Cold Plate box

In addition to the above components, there is also a regular thermometer present in the cleanroom box. A lab-stand should also be present on top of the box with the label 'NANOFAB PROPERTY' on the base of the lab-stand.

The Aisle 3 fumehood has been fitted with supply and return valves on the House Demin water. The return connection also has a flow meter installed on it. The pictures below (Fig. 3 & 4) show the orientation of the valves required to start and stop the water supply:

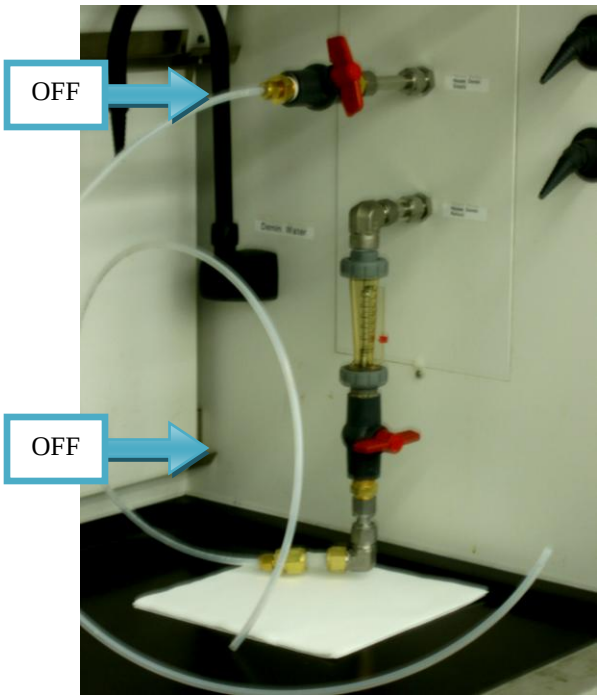


Figure 3 Water flow OFF

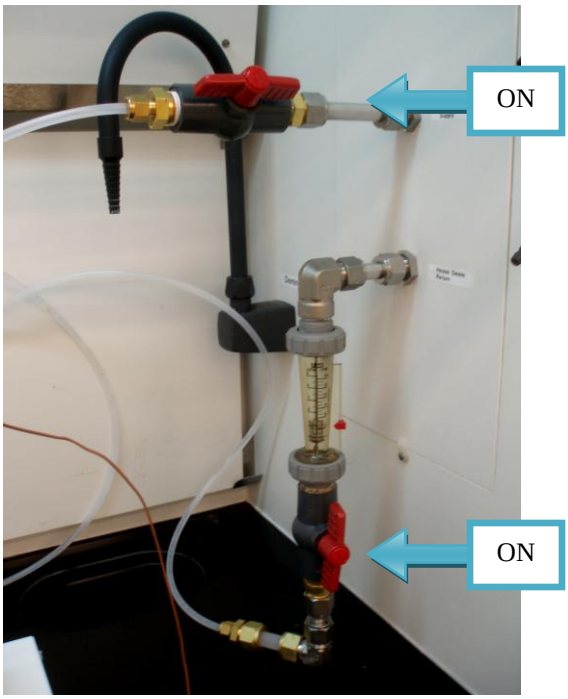


Figure 4 Water flow ON

4. OPERATING INSTRUCTIONS

1. Login to Aisle 3 fumehood (ask training coordinator for OneCard access).

2. Take the necessary contents from the box containing the cold plate and connect the cold plate power cable to the outlets on the right side of the fumehood. Do not turn on the power yet.

3. Firmly insert the supply and return water pipes (shown in Fig. 3) in the quick connect fittings on the back of the cold plate. The water pipes are not inserted properly until you feel a snap!

4. Turn on the return water valve followed by the supply water valve (as shown in Fig. 4). If you have connected the pipes to the quick connects properly, water will flow without any leakage. The bar in the flow meter will rise and show you the flow rate. The flow rate can be read by looking at the widest diameter portion of the bar. Please use a water flow rate between 1 – 3 litres per minute.

5. Place the appropriate foam jacket on the surface of the cold plate. Apply five drops of silicone oil on the surface of the cold plate where you intend to place your beaker(s). Place your beaker(s) on top of the silicone oil and push down until firm contact has been established between the beaker(s) and cold plate. For best contact, there should be no bubbles visible under the bottom of your beaker(s).

6. Place a magnetic stirrer bar in each beaker. Pour the chemicals you intend to cool in the beaker(s).

7. Setup the lab-stand beside the cold plate with the handle above the beaker (The correct height of the handle should be marked – if not, see the next step.)

8. Carefully remove the feedback thermometer from its holder, connect the cable to the bottom right outlet on the cold plate (pins have different widths!), and use the lab-stand handle to hold the feedback thermometer in place (Fig. 5). The bulb of the feedback thermometer should be inserted down approximately to the half-way height of the liquid being cooled. If you intend to conduct a process like cold development of electron beam exposed structures, you will have to leave enough room for a tweezer and your sample to be inserted beside the feedback thermometer.

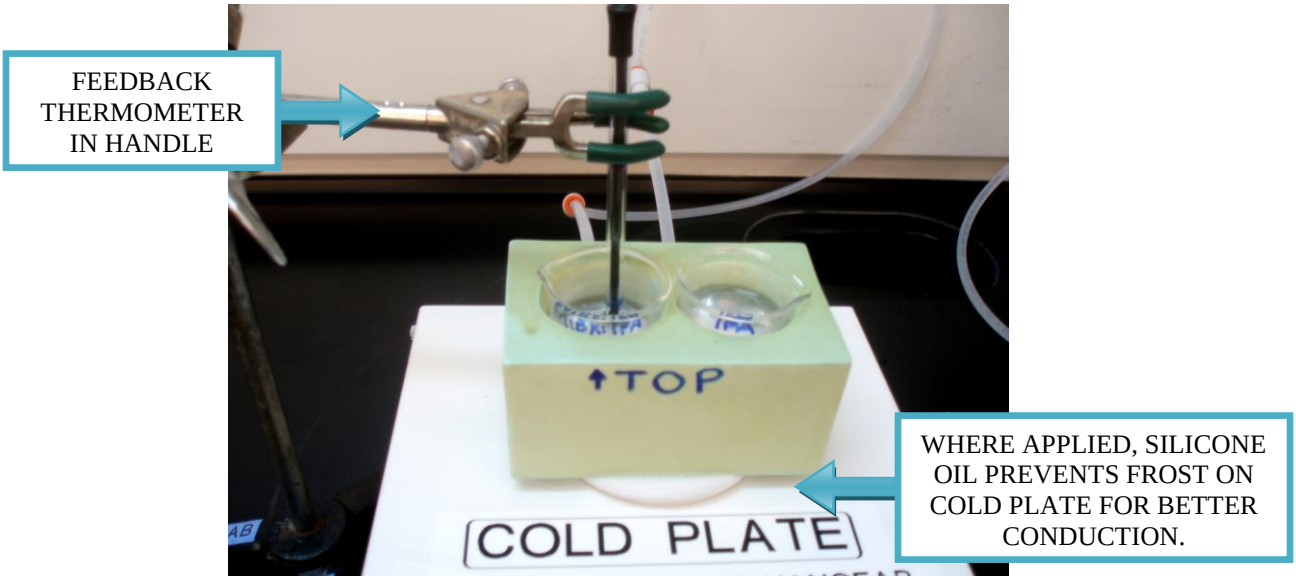


Figure 5 Beaker and feedback thermometer setup

9. Ensure that all connections are made and the water is flowing. At this point, you can turn on the cold plate (red POWER button) as shown in Fig. 6, and increase the STIRRER CONTROL to 70 (suggested value for uniform mixing). The screen will turn on showing the current temperature on top and the desired temperature below. Press the up (▲) or down (▼) buttons until you reach the desired set-point and watch the cold plate do its job! An estimate of the cooling times is given below.

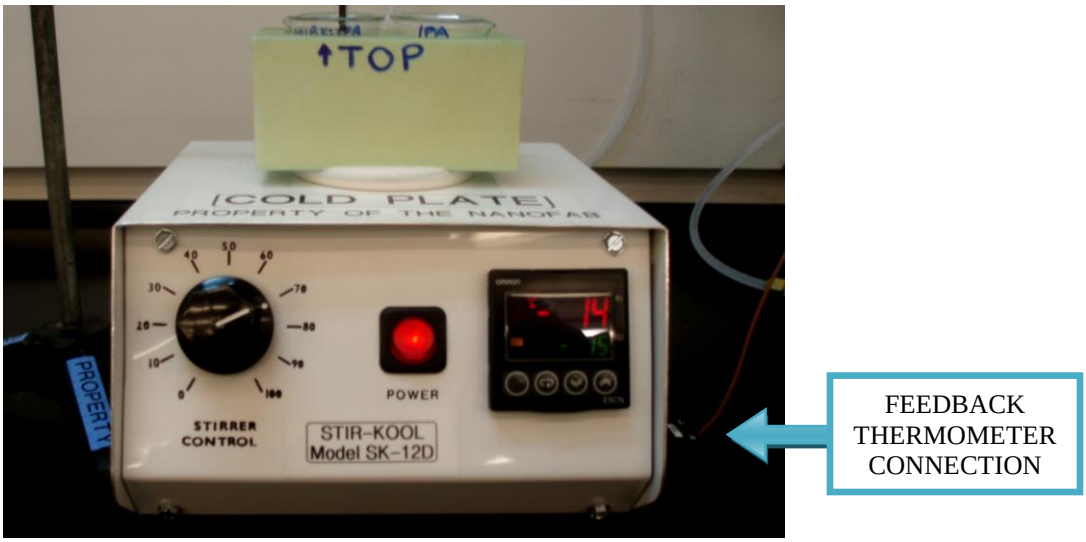


Figure 6 Stir-Kool SK-12D cold plate in action

10. When the cold plate reaches the desired temperature, you will hear a click, and cooling will cease. After a few seconds, the temperature may seem to go back up; however, the system equilibrates in a few minutes. Use the regular thermometer to verify the temperature. Note that the regular thermometer cannot read below -20 °C.

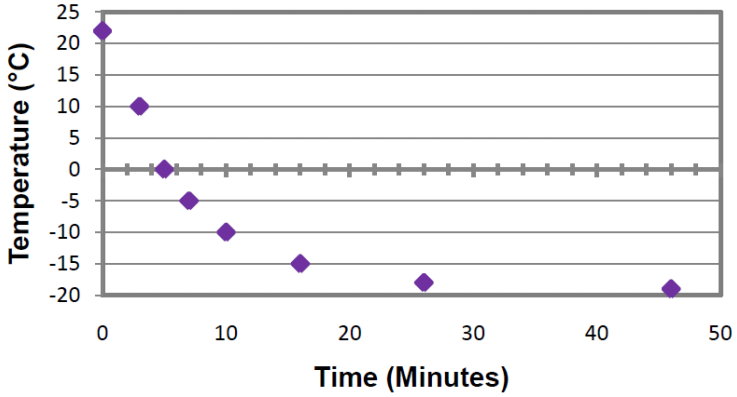
11. At this point, you can use your cooled liquid for your application.

12. When you are done, (i) turn off the power to the cold plate, (ii) turn off the water supply and return valves, (iii) raise the feedback thermometer from your cooled fluid, (iv) remove the magnetic stirring beads from your fluid using a tweezer, (v) remove your fluid, (vi) remove the beakers and begin the dump-rinse process, (vii) remove the foam jacket, feedback thermometer, and finally (viii) disconnect the water pipes from the quick connects by firmly pulling outwards.

13. Before placing back the cold plate, please do the following:
    - Wipe all surfaces in contact with silicone oil i.e., the cold plate surface, feedback thermometer, magnetic stirring beads, ground bottom beakers, and foam jacket.
    - After washing the ground bottom beakers, please return them to the box. Please do not mix these beakers with the beakers in the other aisles.
    - Please do not replace any other materials from the cold plate box.

5. NOTES, COMMON SENSE, AND TROUBLESHOOTING

❖ The graph and table given below provide an estimate for the required cooling time for various set-point temperatures. The data was taken for 30 mL of MIBK:IPA 1:3 using a 3 litres/minute (L/min) flow rate.



Temperature (°C)	22	10	0	-5	-10	-15	-18	-19
Time (Minutes)	0	3	5	7	10	16	26	46

❖ Cooling depends on the following factors:
- Amount of liquid being cooled
  - Larger quantities of liquid will cool slowly
- Flow rate of water through the cooling element
  - Max. 3 L/min. → Please work efficiently and help save water.

- Water temperature
  - House water is at room temperature.
  - Minimum temperature achieved is 40 °C below the water temperature.
- Good contact of beaker with cold plate
  - Use five drops of silicone oil
    - No silicone oil → Frost on plate → Poor thermal conduction.
  - Use the ground bottom beakers
- The liquid properties itself e.g., viscosity etc.

❖ Other notes:
- Depth uniformity of liquid temperature is dependent on good mixing of the liquid. Try to raise the stirring speed as high as possible without levitating the stirring beads, otherwise they will crash into the bulb of the feedback thermometer.
- When verifying the temperature using a regular thermometer, the bulb of the regular thermometer should be at the same level as the bulb of the feedback thermometer for best comparison.
- The feedback thermometer is weak – please handle carefully!
- If the water isn't on, the thermoelectric element can burn! If you notice the cooling taking too much time, or the temperature not going below a certain level, immediately check the water flow.

❖ The Stir-Kool SK-12D cold plate also has a temperature ramping feature e.g., cool to 10 °C in increments of 1 °C after every 5 min. To use such a feature or for other servicing such as recalibration, please contact the NanoFab staff.

If you encounter an unexpected error or require assistance please contact the primary or secondary trainer listed above. Should they not be available, please contact any staff member for assistance.

6. APPROVAL

QUALIFIED TRAINER: Mohammad Ali Mohammad
TRAINING COORDINATOR: Stephanie Bozic