INDEX

Metallurgical microscope operating procedures

Setting Up the Microscope

1. Place the microscope on a stable, level surface.
2. Plug in the microscope and turn on the power.
3. Lower the condenser lens.
4. Raise the stage until the objective lens is almost touching the slide.
5. Look through the eyepieces and focus the image using the coarse and fine focus knobs.
6. Adjust the field diaphragm to control the amount of light entering the objective lens.
7. Select the appropriate objective lens for the desired magnification.
8. Adjust the condenser aperture diaphragm to control the resolution of the image.

Using the Microscope

1. Place the slide on the stage and secure it with the stage clips.
2. Use the stage controls to move the slide until the area of interest is centered in the field of view.
3. Focus the image using the coarse and fine focus knobs.
4. Adjust the eyepieces to match your interpupillary distance.
5. Take notes or photographs of your observations.

Cleaning Up the Microscope

1. Turn off the microscope and unplug it.
2. Remove the slide from the stage.
3. Wipe down the eyepieces and objective lenses with a lens cleaning cloth.
4. Lower the condenser lens.
5. Cover the microscope with a dust cover.

Additional Tips

- When using high magnification, it is important to use immersion oil on the objective lens.
- Do not force the focus knobs. If you cannot focus the image, there may be something wrong with the microscope or the slide.
- If you are having trouble using the microscope, consult the microscope manual or ask for help from a qualified technician.

Safety Precautions

- Always wear safety glasses when using the microscope.

- Be careful not to touch the hot lamp housing.
- Do not eat or drink in the microscopy lab.
- Keep the microscopy lab clean and free of clutter.

SOP for RAPID THERMAL ANNEAL (RTA)

RTA Startup

1. Log into the tool in your FOM account.
2. In the chase near the RTA turn ON the following services.
3. RTA electrical disconnect panel
4. Compressed air
5. Nitrogen
6. Two (2) RTA water lines.
7. On the front of the RTA turn ON the power.
8. Press in briefly the plastic tube on the left side of the RTA to reset the overheat flashing LED.
9. Turn ON the computer by pressing the button with a star drawn on it.
10. At the prompt:
    a. press any key to continue
    b. Q
    c. type: pcat1106
    d. <enter>
    e. <enter>

SELECTING & MODIFYING RECIPES

1. Click on R to select a recipe.
2. Use the up and down arrows to select a recipe of interest and <enter>.
3. Click on C to edit the selected recipe.
4. Specify the type of step in the recipe. DLY will enter a waiting period, delay or pause, RAMP will ramp up or down to a specified temperature and SS will hold at a specified temperature or steady state for a period of time.
5. The next 3 columns of the recipe specify the time in seconds, ramp rate (°C/sec) and if nitrogen is turned on or off. The system is plumbed for nitrogen only at this time.
6. After modifying the recipe press <F10> and S to save the recipe. Press Y to overwrite the existing file.

RUNNING A RECIPE

1. Lift the process tray handle upwards and gently pull open the tray to reveal the quartz chamber.

2. Place your sample onto the quartz pins.

3. Gently push the sample tray back into the RTA and push down on the handle to lock the door.
4. From the main menu press E and <F1> to run the recipe.
5. While running a recipe the display on the front of the RTA will have a decimal point showing the temperature. Disregard the decimal point to read the actual temperature.
6. When finished press <F10> to return to the main menu.
7. Lift the lock handle and gently pull open the sample tray to retrieve your sample. Return the quartz tray back to the chamber and push down the lock handle.

OVERSHOOT AND UNDERSHOOT

If your recipe is undergoing undershoot or overshoot conditions, then go to the main menu <F10> and click on C to edit the selected recipe. Use the right arrow → to move to the screen to the right and modify the following parameters one step at a time. Test the recipe before changing the next parameter.

Overshoot

i. Increase T-switch
ii. Make the Gain less negative
iii. Make the DGain less negative
iv. Decrease I-cold of it is the first wafer to be processed or as a last resort.

Undershoot

i. Decrease T-switch
ii. Make the Gain more negative.
iii. If the temperature oscillates during steady state make the DGain more negative.
iv. Increase I-cold of it is the first wafer to be processed or as a last resort.

After modifying the parameters press <F10> and S to save the recipe. Press Y to replace the file.

Shutdown process to turn off the RTA:

1. Press <F10> to go to the main menu.
2. Scroll to Q to quit the software.
3. At the C:\ prompt turn OFF the computer by pressing the button with a star drawn on it.
4. Turn OFF the power on the front of RTA.
5. In the chase near the RTA turn OFF the following services.
   a. RTA electrical disconnect panel
   b. Compressed air
   c. Nitrogen
   d. Two (2) RTA water lines.
6. Log out of the tool in your FOM account.

SOP for Spin Coater

1. Preparation:

- Gather materials: wafer, coating solution, cleaning supplies (solvent, cleaning wipes), personal protective equipment (gloves, lab coat, safety goggles).
- Ensure proper ventilation: Operate the spin coater in a fume hood or well-ventilated area.

2. Turn on the Spin Coater:

- Locate the power switch and turn it on.
- Allow the instrument to initialize and stabilize, following any manufacturer-specific instructions.

3. Program the Coating Parameters:

- Access the programming menu: Use the appropriate buttons or interface to enter the programming mode.
- Set desired parameters:
  - Spin speed (RPM)
  - Acceleration rate
  - Spin duration
  - Dwell time (if applicable)
  - Vacuum settings (if applicable)
- Apply vacuum : give specific instructions on vacuum operation.

4. Load the sample:

- Grasp the wafer carefully: Hold it by its edges to avoid touching the surface.
- Place it on the chuck: Center it firmly on the chuck, ensuring it's securely attached.
- Close the lid: This helps contain any fumes or splashes.

5. Initiate Spin Coating:

- Press the "Start" button: The spin coater will begin the programmed process.
- Monitor the process: Observe the spin coater for any irregularities or errors.

6. Apply the Coating Solution :

- Dispense the solution: Use a pipette or syringe to carefully dispense a small amount of coating solution onto the center of the spinning wafer.
- Allow the solution to spread: The centrifugal force will evenly distribute the solution across the wafer's surface.

7. Wait for Completion:

- Allow the spin coater to finish: The process will automatically stop once the programmed duration is complete.

8. Clean the Spin Coater:

- Ventilate the chamber: Open the lid and allow any fumes to dissipate.
- Remove the sample: Carefully lift the wafer off the chuck and place it in a designated storage container.
- Wipe down the surfaces: Use appropriate cleaning agents (solvents, wipes) to remove any residual coating solution or debris.
- Dispose of waste: Follow proper waste disposal procedures for chemicals and cleaning materials.

9. Turn Off the Spin Coater:

- Power down: Press the power button to switch off the instrument.

Additional Safety Precautions:

- Wear appropriate PPE: Use gloves, lab coat, and safety goggles to protect yourself from chemicals and potential hazards.
- Handle chemicals cautiously: Read the safety data sheets (SDS) for all chemicals and follow safe handling procedures.
- Ventilate the area: Ensure adequate ventilation to prevent the buildup of fumes or vapors.
- Consult the manual: Refer to the manufacturer's instructions for specific details and safety guidelines.

Pellet Making Machine

Morter

Die Set

Materials:

- Pellet press
- Die set (appropriate size for desired pellet diameter)
- Grinding mortar and pestle
- Spatula
- Balance
- Sample powder
- Binder (optional, depending on sample properties)
- Safety glasses
- Gloves

Procedure:

1. **Prepare the sample:**
   - Grind the sample powder using a mortar and pestle to achieve a fine and homogeneous consistency.
   - If necessary, add a binder to the powder to improve pellet cohesion. The type and amount of binder will depend on the sample properties.
   - Weigh the desired amount of sample powder (typically 100-200 mg) using a balance.
2. **Set up the pellet press:**
   - Select the appropriate die set for the desired pellet diameter.
   - Install the die set into the pellet press according to the manufacturer's instructions.
3. **Load the sample:**
   - Place the weighed sample powder into the die cavity.
   - Use a spatula to gently level the powder and remove any excess material.

4. **Press the pellet:**
   - Apply pressure to the sample using the pellet press. The required pressure will vary depending on the sample material and desired pellet density. Consult the manufacturer's instructions for recommended pressure settings.
   - Maintain the pressure for a specified time (typically 30-60 seconds).
5. **Eject the pellet:**
   - Release the pressure and carefully remove the pellet from the die cavity using a spatula.
6. **Store the pellet:**
   - Place the pellet in a labeled container for storage and analysis.
7. **Clean the pellet press:**
   - Use a brush or compressed air to remove any residual sample powder from the die cavity and press components.
   - Wipe down the press with a damp cloth.

Safety Precautions:

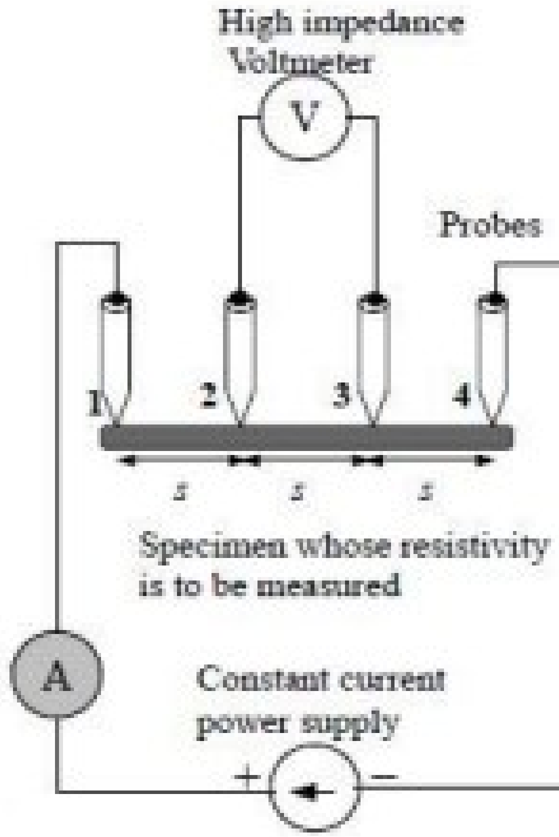
- Always wear safety glasses and gloves when operating the pellet press.
- Do not exceed the recommended pressure limits for the die set and press.
- Be careful not to touch the hot press components.
- Use appropriate personal protective equipment (PPE) based on the specific hazards of the sample material.
- Dispose of waste materials according to proper safety and environmental regulations.

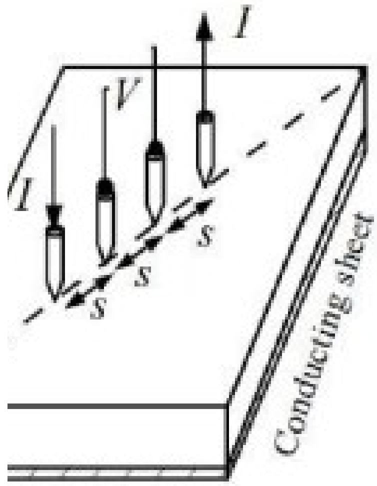
Additional Notes:

- The specific steps and parameters may vary depending on the type of pellet press, die set, and sample material.

- It is recommended to consult the manufacturer's instructions for detailed operating procedures and safety guidelines.
- The use of a binder may be necessary for some samples to ensure pellet integrity. The type and amount of binder should be chosen based on the specific properties of the sample material.
- The size and density of the pellets may affect the results of spectral analyses. Therefore, it is important to use consistent parameters when preparing pellets for comparative studies

Resistivity by Four Probe Method





Resistivity by Four Probe Method

$$\rho = \frac{\rho_0}{f(\frac{w}{s})} \quad (2)$$

The function, f(w/S) is a divisor for computing resistivity which depends on the value of w and S

We assume that the size of the metal tip is infinitesimal and sample thickness is greater than the distance between the probes,

$$\rho_0 = \frac{V}{I} \times 2\pi S \quad (3)$$

Where V – the potential difference between inner probes in volts.

I – Current through the outer pair of probes in ampere.

S – Spacing between the probes in meter.

Temperature dependence of resistivity of semiconductor

Total electrical conductivity of a semiconductor is the sum of the conductivities of the valence band and conduction band carriers. Resistivity is the reciprocal of conductivity and its temperature dependence is given by

$$\rho = A \exp \frac{E_g}{2KT} \quad (4)$$

Where Eg – band gap of the material

T – Temperature in kelvin

K – Boltzmann constant, K – 8.6x10-5 eV/K

The resistivity of a semiconductor rises exponentially on decreasing the temperature.

SOP for Resistivity Measurement Using the Four-Probe Method

Purpose: To measure the resistivity of thin film or semiconductor samples using the four-probe method.

Materials:

- Four-probe apparatus
- Sample to be measured
- Constant current source

- Voltmeter
- Oven (optional, for temperature-dependent measurements)
- Digital panel meter (optional, for simultaneous current and voltage readings)

Procedure:

1. Prepare the sample:
   - Clean the sample surface to ensure good electrical contact with the probes.
   - Ensure the sample is flat and secure on a suitable holder.
   - If measuring at elevated temperatures, place the sample in the oven and set the desired temperature.
2. Set up the apparatus:
   - Connect probes to corresponding terminals on the apparatus.
   - Connect the current source and voltmeter to the apparatus according to the manufacturer's instructions.
3. Position probes:
   - Gently place the probes in a straight line on the sample surface, ensuring equal spacing between them.
   - Apply light pressure to ensure good contact.
4. Apply current:
   - Set the constant current source to the desired value (typically 1-10 mA).
5. Measure voltage:
   - Record the voltage reading displayed on the voltmeter.
6. Repeat measurements:
   - For reliable results, repeat steps 4-5 multiple times at different probe positions on the sample surface.
7. Calculate resistivity:

- Use the following equation, tailored to the specific probe geometry and sample thickness:

$$\rho = (\pi * S * V) / (\ln(2) * I * w)$$

- Where:
  - ρ = resistivity
  - S = probe spacing
  - V = measured voltage
  - I = applied current
  - w = sample thickness

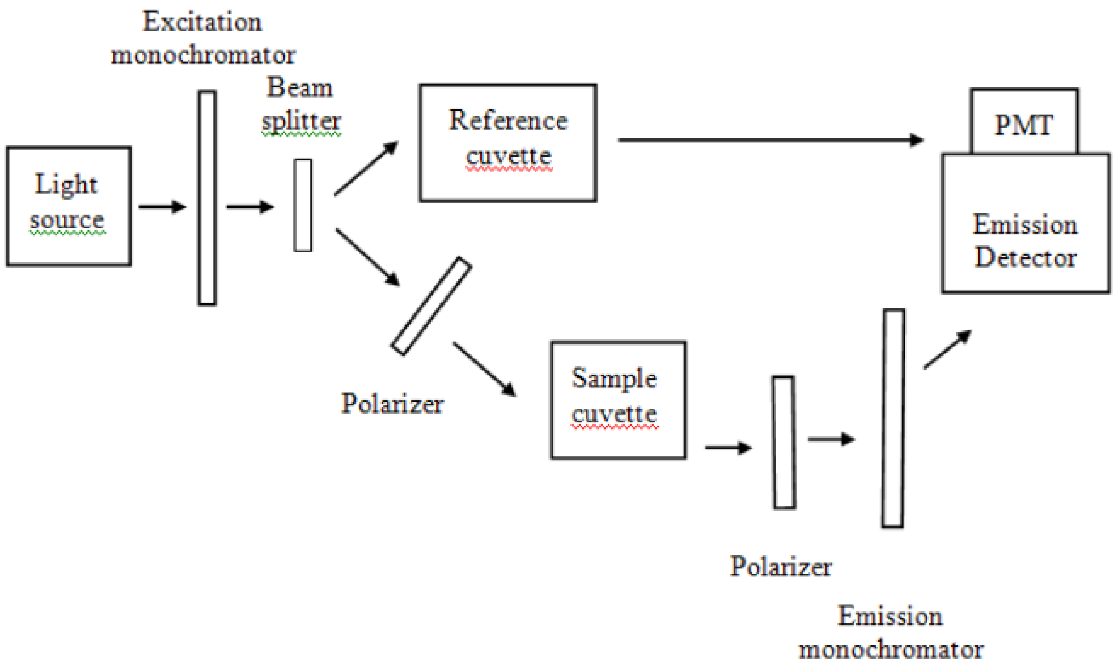
Safety Precautions:

- Handle probes with care to avoid damage.
- Use appropriate current levels to avoid overheating the sample.
- Exercise caution when working with high voltages.
- Follow laboratory safety guidelines for electrical equipment and ovens.

Standard Operating Procedure (SOP) for JASCO FP-8300 Spectrofluorometer

Block Diagram :

2.



Instrument Setup:

- Turn on the power and allow the instrument to warm up for at least 10 minutes.
- Set the excitation and emission wavelengths according to your experiment.
- Choose the appropriate slit widths for excitation and emission.
- Select the desired scan speed and time constant.
- Set the integration time based on the expected signal intensity.
- Choose the appropriate detector (PMT or InGaAs, if available) depending on your wavelength range and sensitivity needs.
- If using temperature control, set the desired temperature and allow the sample chamber to reach thermal equilibrium.

3. Sample Preparation:

- Prepare your samples according to your specific experiment.
- Use appropriate cuvettes or sample holders compatible with the instrument.
- Ensure the cuvettes or sample holders are clean and free of scratches.
- Fill the cuvettes with an appropriate volume of sample and solvent blank.
- Seal the cuvettes properly if necessary.

4. Measurement:

- Place the blank cuvette in the sample holder and run a blank measurement.
- Replace the blank with the sample cuvette and run the sample measurement.
- Repeat the measurements for replicates, if necessary.
- Save the data files with appropriate names and descriptions.

5. Data Analysis:

- Use the provided software to analyze the data.
- Perform background subtraction using the blank spectrum.
- Calculate peak intensities, areas, or other relevant parameters.
- Plot the data as needed for visualization and analysis.
- Export the data in a suitable format for further analysis or reporting.

5. Instrument Shutdown:

- Close the software.
- Turn off the temperature control unit, if used.
- Turn off the instrument power.
- Clean the cuvettes or sample holders with appropriate solvents.
- Dispose of waste materials according to safety regulations.

Note: Always refer to the JASCO's manuals for detailed instructions and safety precautions.

Standard Operating Procedure (SOP) for Split Tube Furnace

General Information:

Split tube furnaces are versatile tools used for various applications requiring a controlled temperature gradient along a tube. They feature heating elements embedded within the furnace insulation, allowing for flexible tube diameter compatibility through adapter usage.

Safety Precautions:

- Always wear appropriate personal protective equipment (PPE) when operating the furnace, including heat-resistant gloves, safety glasses, and a lab coat.
- Ensure the work area is well-ventilated and free of flammable materials.
- Never leave the furnace unattended while operating.
- Do not exceed the maximum operating temperature of the furnace or the tube material.
- Allow the furnace to cool completely before touching any internal components.

Pre-Operation Checks:

1. Inspect the furnace for any damage or wear.
2. Verify that the power cord is properly plugged into a grounded outlet.
3. Ensure the gas supply (if applicable) is properly connected and turned off.
4. Check the controller settings and confirm they are correct for your desired application.

Operation:

1. Turn on the power switch.
2. Open the gas valve (if applicable) and light the pilot burner (if applicable).
3. Set the desired temperature for each zone on the controller.
4. Place the tube inside the furnace, using the appropriate adapter if necessary.
5. Close the furnace door.
6. Monitor the temperature and adjust the settings as needed.

Post-Operation:

1. Turn off the power switch.
2. Close the gas valve (if applicable).
3. Allow the furnace to cool completely before opening the door.
4. Remove the tube carefully.
5. Clean the furnace interior as needed.

Additional Notes:

- Consult the manufacturer's manual for specific instructions and safety guidelines for your particular furnace model.
- Always handle the tube with care, as it may be hot and fragile.
- Be aware of the potential for thermal expansion and contraction of the tube and furnace components.
- Record the operating parameters and results for future reference.

Vacuum Coating unit model 12A4-D
(Hind Hivac system)

The Hind Hivac 12A4D Vacuum Coating Unit is a versatile laboratory tool for depositing thin films using various techniques, including evaporation and glow discharge cleaning. It's commonly used in industries of semiconductors, optics, and material development.

1. Evacuation:

- The unit starts by evacuating the chamber to remove air and other contaminants. This is achieved using a mechanical pump (roughing pump) and a high vacuum pump (diffusion pump or turbomolecular pump).

Vacuum Coating Unit Turbomolecular Pump

- The roughing pump takes the pressure down to a preliminary level (around 10^{-2} to 10^{-3} mbar).
- Then, the high vacuum pump further reduces the pressure to a much lower level (around 10^{-4} to 10^{-7} mbar), creating a high vacuum environment essential for thin film deposition.

2. Deposition:

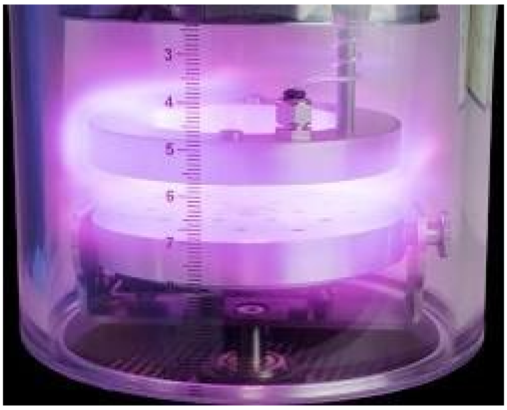
- Once the desired vacuum level is reached, the chosen deposition technique is initiated.
- In the case of evaporation, the material to be deposited (source material) is heated in a crucible or boat until it vaporizes. The vaporized material then travels through the vacuum and condenses on the substrate (object receiving the coating) forming a thin film.

Vacuum Coating Unit Evaporation Source

- Different heating methods can be used for evaporation, such as resistive heating, electron beam heating, and laser ablation.

3. Glow Discharge Cleaning (Optional):

- The 12A4D unit can also be equipped for glow discharge cleaning, a process that removes contaminants from the substrate surface before deposition.
- In this technique, a plasma is created inside the chamber by applying a high voltage to a gas (usually argon). The ions in the plasma bombard the substrate, sputtering away contaminants and improving the film adhesion.



Vacuum Coating Unit Glow Discharge Cleaning

4. Monitoring and Control:

- The 12A4D unit comes equipped with various instruments to monitor the deposition process, such as pressure gauges, film thickness monitors, and deposition rate monitors.

Vacuum Coating Unit Deposition Rate Monitor

- These instruments allow for precise control of the deposition parameters, ensuring the formation of high-quality thin films.

5. Venting and Cleanup:

- After the deposition process is complete, the chamber is slowly vented back to atmospheric pressure using an inert gas (usually nitrogen).
- The unit is then cleaned and prepared for the next deposition run