TEM Alignment for JEOL 2010F

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Abstract

The report provides initial and necessary alignments for cold field emission gun (FEG) transmission electron microscope (TEM). It also includes the initial settings for the TEM, which gives a sanity check for the state of the system. The report follows the column alignments from top of the TEM to the bottom. The camera setup includes charge couple device (CCD) gain correction and Gatan imaging filter (GIF) tuning. Training for TEM alignment was done on JEOL 2010F TEM located at Sorby Centre - North Campus, University of Sheffield on 29^{th} March and 7^{th} April 2017 (9am - 1pm). Further instrument details can be found here.

1 Initial Setting

It is important to note the initial settings of the TEM. The values indicate the initial state of the system and these should be the settings when one arrives for an experiment.

- In the LP[1], on TEM schematic, following valves should be showing green light. V17, V13, V5B and V2.
- Monitor, HT/μA, Emission should have light.
- On cathode ray tube (CRT) screen on the right should read, 40k Mag, TEM mode, spot size= 1, α3= -3, 200kV, X= 0, Y= 0, Z= 0, Focus= $+0$. If Focus is not at $+0$, then use objective focus knob (RS[1]) to bring it to 0.
- Column Ion Gun should be below 20×10^{-5}Pa. The Column Ion Gun reading is present in the room behind TEM.

[1] **Note:** The following abbreviation mean the side in which a particular control is present. e.g. LP = left panel, RS = right side, LS = left side, RD = right drawer, LD = left drawer, LT = left top and TC = top side of TEM column.

2 Anti-contamination device

Handling any cryogenics with bare hands can be fatal. Before handling liquid nitrogen, it is important to have risk assessment and required training done. The safety equipment such as gloves and goggles are placed near TEM. Always wear them whenever refilling liquid nitrogen into thermocol container.

Remove the heater from anti-contamination device (ACD) by sliding the coils first and then removing the heater assembly. Cover the glass part of the TEM with a coat. Use a funnel and a plastic mug to fill the ACD with the liquid nitrogen (Use ladder to fill). It is important to use safety equipment all the time during this procedure. After filling ACD with liquid nitrogen, leave the funnel there for few seconds. Liquid nitrogen oozes out for a second and then fill again until full. Cover it with the small top. (Note: If small amount liquid nitrogen is left in the thermocol container, then it can be put in to EDXS detector. This is not a mandatory step).

3 Single tilt holder

While handling any sample holder, wearing a clean new gloves is important. Following steps should be followed while mounting the sample on to single tilt holder.

- Loosen the screws of sample holder part.
- Mount the sample (Gold nano particles on Single tilt holder).
- Tighten the screws (do not tighten hard).
- Using a clean tooth pick (or tweezers) clean the holder and oval rings. Look for fibre like strands.

Make sure the holder is clean and free from fibre strands. Unless these causes problem in maintaining vacuum.

4 Inserting sample holder in TEM

- Put the holder in and switch to pump.
- Wait until the pump switch turns green. This process takes few minutes. The progress of the pumps switching can be observed in the TEM schematic (LP[1]).
- Rotate the holder clockwise just a little bit and insert the holder completely in a controlled manner. Do not let the holder get sucked in forcefully as this can damage the holder. This may cause serious problems in maintaining vacuum in the system.
- In the mean time check the `Column Ion Gun` meter in the room behind TEM. This must go $< 20 \times 10^{-5}$Pa.

5 Condenser alignment

- Open `Valve` (LS[1]).
- Reduce `Mag` and move the sample to see illumination.
- Condenser (`C2` or Brightness control), use shift `X` and `Y` to move the beam to centre.
- Spread the beam to make it almost edge of the screen using `C2`.
- Usually use large condenser aperture (TC[1]) for condenser alignment.
  - Select an aperture (TC[1]).
  - Use knobs on aperture assembly to bring it to the centre.

6 Gun lens alignment

1. Anode wobbler
   - Reduce beam size (`C2`) and press `Anode WOBB` (LS[1]).
   - If the beam wobbles, then from RD[1], press `Deflector/Gun`.
   - Use deflector (`DEF`) `X` and `Y` to adjust to make beam go in and out.
   - press `Anode WOBB` again to stop it and go for next alignment.
2. Gun tilt alignment
   - press `spot size` switch (LS[1]) and go to the smallest spot size i.e. 5.
   - Use `Beam shift` (left & right side) to bring it to centre.
   - press `spot size` switch (LS[1]) and go to the largest spot size i.e. 1.
   - Use `Gun shift` (RD[1]) to bring it to centre.
   - Iterate all steps in gun tilt alignment for better alignment.

7 Condenser lens alignment

- At 40k `Mag`, press `Condeser Stigmation` (LS[1]).
- Use `DEF X` and `Y` (left & right side below `beam shift`) and make it look round.
- press `Condeser Stigmation` (LS[1]) again to go to next alignment.
- press `Bright tilt deflector` (LS[1]).
- Use `DEF X` & `Y` to bring bright spot in the middle of halo.
- press `Bright tilt deflector` (LS[1]) again to go to next alignment.
- Use `Beam shift` to bring it in the centre.

8 Specimen focus

- Check objective focus (DV) is 0 (on CRT RS[1]). If DV is not 0, then use Obj focus (RS[1]) to bring it to 0.
- Adjust condenser knob to see diffraction patter.
- Use Z (LT[1]) to adjust to bring it to a spot.
- Now adjust Condenser beam broad, adjust Z to see contrast.

9 Pivot points

- Bring the beam to a point (Use C2).
- press condenser deflector adjust (COND DEF ADJ) from RD[1].
- press Tilt button.
- Use Tilt X, it will be wobbling.
- Use X shift (RD[1]) to bring it to stationary.
- Follow same steps for Y.
- press Tilt button again to go to next alignment.
- Check if the beam is in the centre, use Beam shift (left & right) to bring it to centre.

10 Voltage centre

- Find an area that we can identify.
- Go to focus (use Z to bring it to focus), with a smaller beam size about 1inch diameter (Use C2).
- At focus, contrast will be very low hence use smaller screen to observe feature.
- press HT (RS[1]). The feature should be moving up and down. It should not be swinging.
- If it is swinging, then press Bright tilt (LS[1]).
- Use DEF X and Y (left & right) to make it move up and down instead of swinging.
- press Bright tilt (LS[1]) and HT (RS[1]) again to go to next alignment.

11 Objective stigmation

- Reduce the `Mag` to 25k (or keep 40k as it is. Not a mandatory to bring it to 25k).
- Sample must be visible on the fluorescence screen. (Better if it is amorphous area).
- Lift the screen (RS[1]).
- If the Gatan software is closed in the computer, then to open the software use following step.
  - Double click on `Gatan Filter Control` from `desktop`.
  - Then open `Gatan DigitalMicrograph`.
- From Gatan software choose `TEM panel` (top) (not `STEM`).
- From `Filter Control panel` (right) insert `TV camera in`.
- Note that on top of the TV, press `GIF` (not `TV`).
- Need to defocus a little bit by pressing `Z` (LS[1]) once or twice.
- Remove `TV camera in`.
- In `Camera view panel`, `setup` must be `search`, `Exposure (s)`= 0.4 and in `settings`.
  - Full image.
  - Binning= 2.
  - `Corrections` must be `Gain normalised`.
- In `Camera view panel`, press `Start`.
- From drop menu, `Process/live/FFT`.
- press Stigmator control (`STIGMATOR`) (RD[1]).
  - press `OBJ`
  - Use `DEF X` and `Y` (RD[1]) to make it round on the screen.

12 Camera setup

- Lift the screen (RS[1]).
- Go to the place where there is no sample.
- From drop menu go to `Camera/prepare gain reference`. Check following settings.
  - `Target intensity` 6000.
  - `Frames to average` 4.

- Click `Yes` to following pop-ups.
  - `Is CCD temperature stable?` – Click `Yes`.
  - `Can gain correction be overwritten?` – Click `Yes`.
- Wait until it finishes. (usually takes few minutes).
- From drop menu `Camera/Remove dark reference`.
- From `Camera acquire panel`, click on `Start acquire`. (it should look blank).
- From `Auto filter panel`, `Commands panel`, Click on `Tune GIF`.

13 Wrap up TEM session

- `Mag` 40k (RS^1) and put the fluorescent screen down.
- press `Valve` (LS^1).
- press `N` (LS^1) to normalize `X` and `Y` values to 0.
- Pull sample holder and rotate anti-clockwise. Put switch to `air`.
- Rotate sample holder again in controlled manner and remove.
- At the end of the session (usually end of the day) put heater in ACD and press `ACD heater` button on LD^1 near TEM pump schematic.