To remove resist:

1. Acetone wash - Place the wafer in acetone taken in petridish and ultrasonicate/constantly agitate for 2-3 minutes @ 115^0 C
   Caution: *Take proper care while heating the Acetone petridish with wafer. It's boiling point is 65^0 C, make sure the petridish is not dry. Add more Acetone with proper caution, stay away from Acetone vapor.*
2. IPA(Isopropyl Alcohol) wash
   Caution: *Dip into IPA immediately after taking out from Acetone, otherwise they will leave white spots on wafer*
3. N_2 gun
4. Heat on hot plate @ 190^0 C (2-3 minutes)
   Caution: Petridishes used for acetone and IPA should be cleaned using DI water gun and kept on hot plate for drying completely.

Spin Coating:

1. Use 'manual' mode.
2. Place wafer and turn on vacuum. Make sure O-ring is holding your wafer properly.
   Caution**:** *Don't put the hot wafer directly from hot-plate to spin-coater o-ring. It may melt. Wait for a few seconds before keeping*.
3. Take 25 ml of EL-9 in micropipette
4. Disperse on wafer
5. Run program 1 (6000 rpm – 3 steps). This takes about 45seconds.
6. When program runs completely *(LED's 1, 2 and 3 will not be glowing any more)* release the vacuum by switching to 'Auto' mode.
7. Take out the wafer
8. Post-bake on hot plate @ 190^0 C at least for 2 minutes *(when the red LED in hot plate is not glowing continuously the plate has reached the target temperature)*
9. Repeat the steps for next layer of resist

   Caution: *Uniform PR coating on the wafer depends on wafer cleanliness and shape. Oil on the wafer surface should be removed either by acetone wash or piranha cleaning.*

Resists used:

1. 1st layer: EL-9
2. 2^{nd} layer: PMMA (25% in Anisole)
3. Other resists, C 3 (3% PMMA in Chloro-Benzene 3%) etc
4. *Same concentration of PMMA in Chloro-Benzene gives thicker resist film compared to Anisole.*

To load the sample:

1. With plastic tweezers, carefully place the samples on the sample holder, under the clamp.
2. Keep note of the positions of the wafer with respect to the Faraday cup.
   Caution: *To get this reference position, the sample holder should be placed with its handle on to your left.*
3. Put the polystyrene beads on the bottom left corner of each sample. This is done to do proper focusing and stigmation adjustments later on after loading the sample.
   Caution: *This has to be done carefully, without contaminating the sample. Only a small spot is needed.*
4. Open the load lock door and place the sample holder properly on the transfer rods, with the notch and the grooves rightly positioned.
   Caution: *Handle the sample holder with extreme care. It is made of a metal alloy which can easily break on falling.*
5. Close the load lock door and tighten it.
6. Open "*Navigator1*" on the Left PC.
7. Select "*Via load lock*" (not "*via chamber*")
   Note: System chamber where writing is done is always maintained in vacuum(~1e-7mbar), which should not be disturbed much while loading and unloading the sample. So for pressure balancing, load lock region has to be brought down to a pressure of ~ 1e-6mbar. Once "*Via load lock*" is selected, the turbo will start evacuating the load lock area to this desired pressure. There is no gauge in the load lock and the approximate pressure is inferred from how long the turbo has been running, which is roughly 8 mins.
8. Navigator will navigate you through the various steps involved sequentially, through timely pop-ups.
   Caution: Read each pop-up carefully, perform the action specified and **press "OK" only when the action is completed.** Following are the instructions which will be given by the navigator.
   a. Open the load lock valve
      Note: Look for the green LED glowing. Pull up the knob on top, slightly rotate the rod counter-clockwise and gently pull it out. Once the loadlock valve is opened you cannot stop the process, however you can stop the process at any step prior to this step.
   b. Push the transfer rods inside the chamber
      Note: Push the transfer rods gently inside, without jerks. Once this is done, the sample holder will be automatically transferred onto the stage inside the chamber, which can be seen on the CCD camera display(Right PC). This will take few minutes.
   c. Pull out the transfer rods.
   d. Close the load lock valve.

Note: Once this is done, turbo will be turned off.

e. Reset UV adjustments → press 'yes'

9. Close the "*Navigator*".

Typical parameters:

1. Aperture size: 30 µm
2. System vacuum: 2.31E-7 mbar *(if you are getting E-6 mbar, your vacuum should be better)*
3. Gun vacuum: 9.56E-10 mbar

Note: These can be read out from the camera display on the Right PC. Right after loading the sample, vacuum levels would be slightly disturbed.

Further settings:

1. Stage control ***(L)***
   '*Position*' tab→ select '*Faraday cup*'→ press'*go*'
   Note: This is done for two purposes
   a. Beam current measurement is done at the Faraday cup.
   b. Faraday cup is the reference for our sample positions.
2. '*Drive*'***(L)*** → in commandline enter the height of the stage → 26z(small z)
3. Set EHT ***(R)*** → double click and enter 10 → turn on EHT by clicking on bottom right '*EHT*'→ from 10KV, increase to 20KV in steps 10—12—14—16—17—18—19—20 (--20.5--)
   Caution: *Should never set EHT to 20KV directly.*
   Note: EHT stands for Extra High Tension. This is the accelerating potential of the beam.
   a. Activate beam ***(L)*** *(Tab on top, or* cntrlB)
4. Measure beam current
   a. Switch to '*detector mode*' by clicking on "*toggle*" tab ***(R)***
   b. Turn on '*crosshair*' and do rough focus ***(R)***
   c. Maximize magnification (~974.4K).
   Note: To magnify, select "magnify and focus" tab and then drag to right with left button clicked. Dragging left will zoom out. (*double click on the mag. value showed on right hand PC and change it*)
   d. Go to '*exposure*' ***(L)***
   e. Click '*measure*'

   Note: Beam current has to be steady around 270pA

5. Go to sample
   a. Reduce magnification.

b. Locate the sample holder spring-lock edges.
c. Move to the sample using joystick.

6. Do angle correction and origin correction
   a. Locate right bottom corner of wafer
   b. Blank beam (cntrlB)
   c. Reduced view
   d. Go XY UV tab ***(L)***
   e. Set label 2 position ()
   f. Set beam (cntrlB)
   g. Locate left bottom corner (origin)
   h. Blank beam (cntrlB)
   i. Set label 1 position
   j. Do angle correction
   k. Do origin correction.

   Note: (no need to use 3 points or adjust UV options)

7. Focusing, stigmation correction and aperture align

   Note: The beam generated by the gun, when reaching the sample, would have got scattered. We need to focus it back into smallest circular area possible..ie.. to get a sharp defined beam.

   Minimum spot size → focusing
   Vertical beam → aperture align
   Circular beam spot → stigmation correction

   To do all these, first

   a. locate a single Polystyrene bead by adjusting the magnification, contrast(tab on Right PC), and focus point(by joystick)

   Then,

   b. Blank beam
   c. Adjust working distance to get a circular bead, even when zoomed in and out
   d. Click on ‘stigmation’
   e. Click ‘focus wobble’ button, -----???? (I have written ‘lateral movement, not vertical’. Could not make out what it is.)
   f. Aperture align
   g. Repeat steps [(c) –(f)] until you get best condition, ..ie.. the bead should not stretch or skew when zoomed in and out. It should only go in and out.

8. Freeze the focused location on the ***(R)*** PC display for reference in the next step.

9. Write field alignment

   Note: Write field is the largest area which can be written without moving the stage. If the sample is big, at a time, one write field will be written, after which the stage will be moved to write the next and so on. It is like a ‘stitching together’.

   To align WF:

   a. Open ‘Position list’***(L)***
   b. Click on ‘microscope control’
   c. Select ‘1000*100um’ and set as WF
      Note: Here, if the rotation angle is some large value, reset it to zero and save in ‘align WF’ section.
   d. Go to ‘align WF procedure’
   e. Go to ‘manual’
   f. Drag and drop ‘100u marks’ to position list
   g. Click ‘scan’(shortcut for scan is F9)
   h. Make the focus points on the (L) and (R) PC’s images same. Press ‘cntrl’ and drag the green focus point to the desired location. Zoom buttons can be used to locate the position.
   i. Click ‘continue’
   j. Repeat until the selection is accepted.
   k. Repeat for smaller sized WF.
   l. Close position list

10. Open ‘position list’ and drag and drop the file to be written
11. Set exposure properties
    a. Right click file in ‘position list’
    b. Select ‘properties’
    c. Click ‘layers’ icon on the right
    d. Select the layers to be written and click ‘used’
    e. Set position (position wrt origin from which it will start writing, usually 2,2 is given. Units are default mm, so need not specify)
    f. Click on ‘exposure parameters’
    g. Uncheck all defaults.
    h. Set area step size as ~ 0.0156 (size of the beam spot)
    i. Check ‘equal steps’
    j. Set area dose as ~ 150
    k. Calculate dwell time
    l. Press ‘ok’.
    m. Calculate execution time by clicking ‘times’
12. Run the file by clicking on ‘scan’ tab. (shortcut for scan is F9)

If it is the final run, drag and drop ‘beam shutdown’ javascript from ‘automation’ tab to position list. Select all the files and click ‘scan’

Developer:

1. MIBK-IPA (1:3) for 35 seconds, however developing time depends on the feature size to be written. Smaller the feature size, longer the developing time. then use
2. Stopper-IPA (this time is also very crucial)

Other notes:

1. To see the e-beam on right PC, toggle between ‘optical mode and CCD mode’ using the toggle button provided on right PC toolbar
2. Toggling the function of left button (LB) from ‘magnification’ to ‘Stigmation’
3. Two more useful buttons on right PC toolbar ‘Cross-hair’ and ‘write-field’
4. Once the write file is given for writing, the control will switch from internal to external. Next time if we want to write something again, we need to change this back to internal (tab on top of Left PC.)
5. Due to electron charging of dielectric substrates by the e-beam, polystyrene beads appear moving. If it is glass substrate, polystyrene beads will not be visible only. What will be done in that case to adjust focus and stigmation?

Overlay-Lithography

1. Open GDS file in View mode
   Put labels 1,2 and 3 on Global alignment marks.
2. Go to global alignment mark (1) on the sample and zoom maximum at the Centre and blank the beam
3. Go to 3 points (Exposure parameters) in left PC

(i) Uncheck everything
(ii) Toggle to Local (uncheck again and Reset)
(iii) Read P1 and check P1
(iv) On the sample, zoom out and go to alignment mark (2), Zoom to maximum at the centre and blank the beam
(v) Read P2 and check P2
(vi) Adjust.
Repeat (iv),(v) and (vi) steps for P3.

4.W/F alignment for local alignment marks

(i) Go to GDS file, click on working area tab (on top right corner)
Add new working area which should have 4 local alignment marks
(ii)Open position list drag and drop the file.
(iii) Right click on the properties.
(iv)Select manual mark; select the working area (smaller area)
(v)Position (calculator).Automatically takes the W/F position.
(vi) Scan the file.
(Vi) Do the W/F alignment (Correction)

5.Writting the file

(i) Right click on the properties.
(ii) Select the layer to be written and automatic mark layer.
(iii)Change working area to boundaries and calculate the position
(iv) Click exposure parameter and Adjust
(V) Write.