

# FOCUSED ION BEAM SYSTEM: HITACHI FB-2100

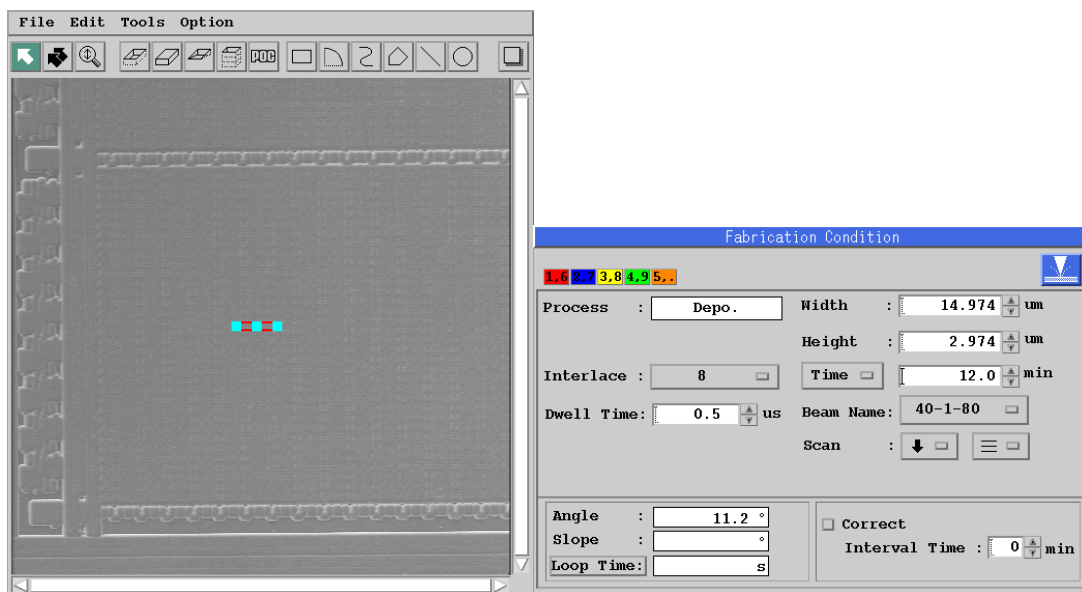
## TEM SAMPLE PREPARATION PROCEDURE

This procedure is a technique of accelerating circumference processing of a micro sampling by the slow scan per page. When you change processing conditions by type of material and depth to process of sample, please refer to this procedure.

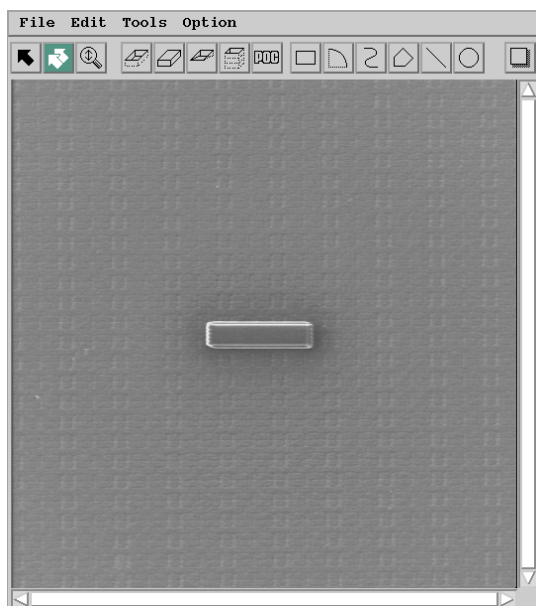
### 1. Fundamental Procedure

#### (1) Deposition

Get image :  $\times 1000$

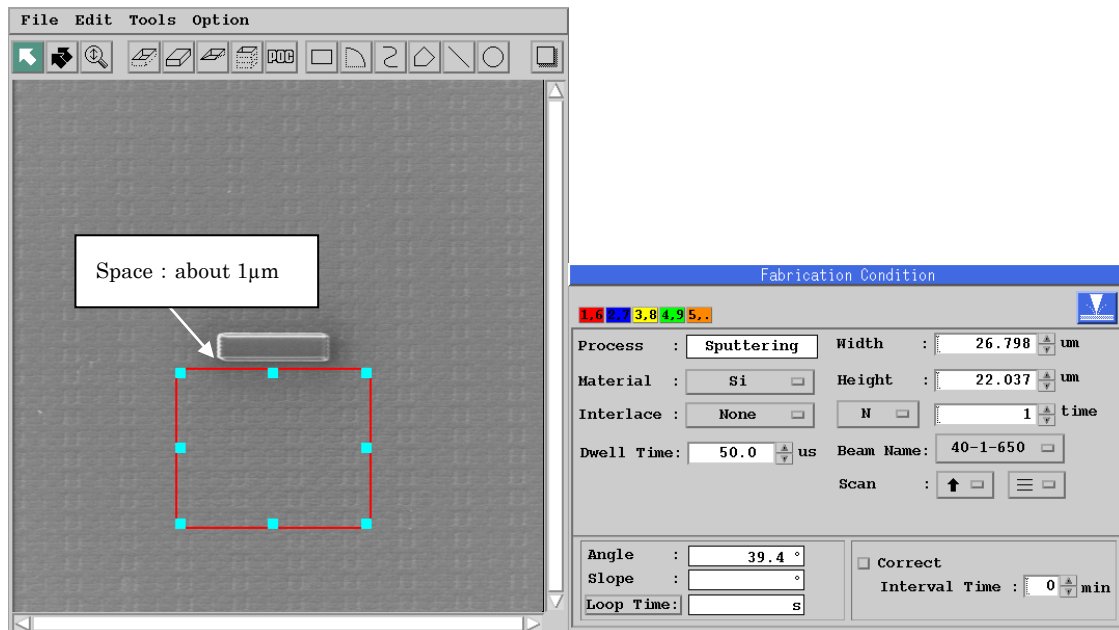


#### (2) Get Image with $\times 2000$



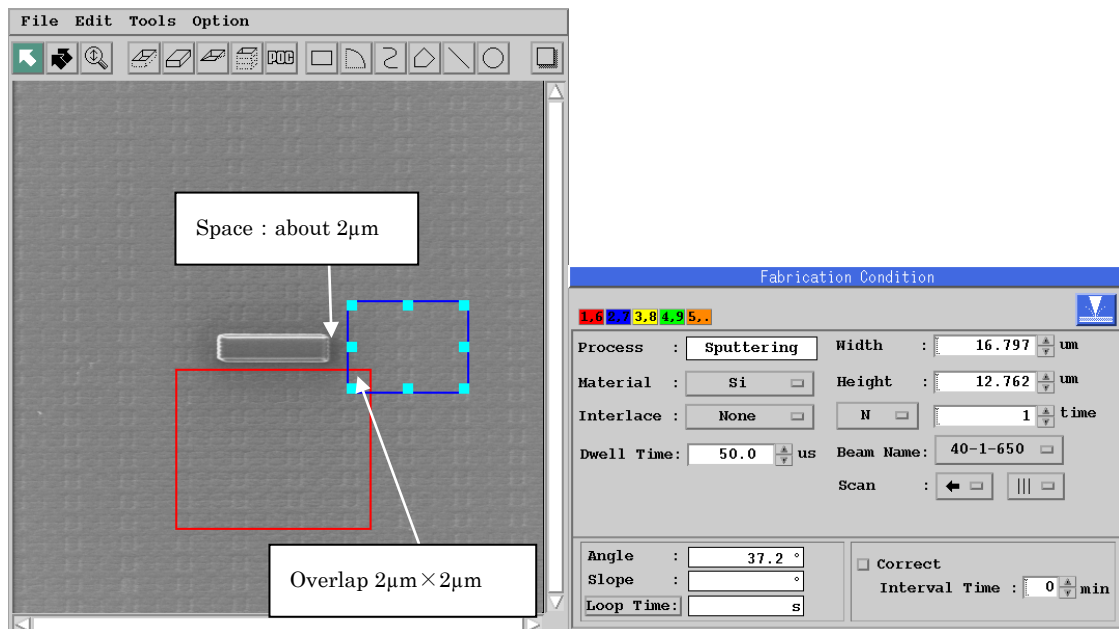
(3) Processing figure setup (lower part)

Create a figure in the position about  $1\mu\text{m}$  away from deposition.



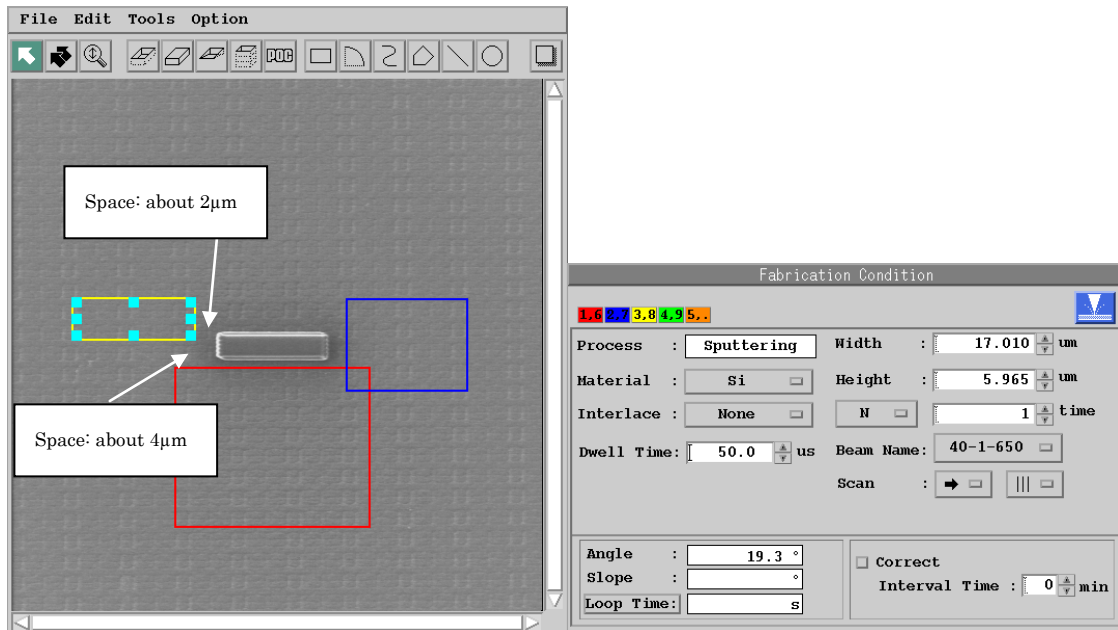
(4) Processing figure setup (right part)

Separate it from deposition about  $2\mu\text{m}$ , and create a figure to overlap about  $2\mu\text{m} \times 2\mu\text{m}$  with a lower processing figure.



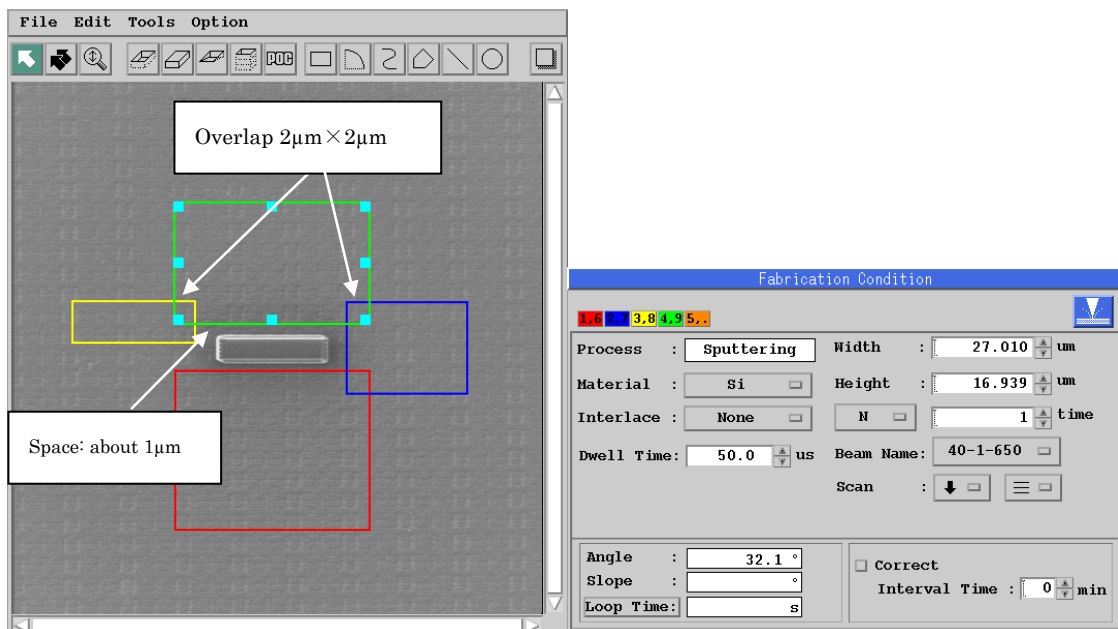
(5) Processing figure setup (left part)

Create a processing figure at the position about  $4\mu\text{m}$  away from the lower processing figure and about  $2\mu\text{m}$  away from the deposition.



(6) Processing figure setup (upper part)

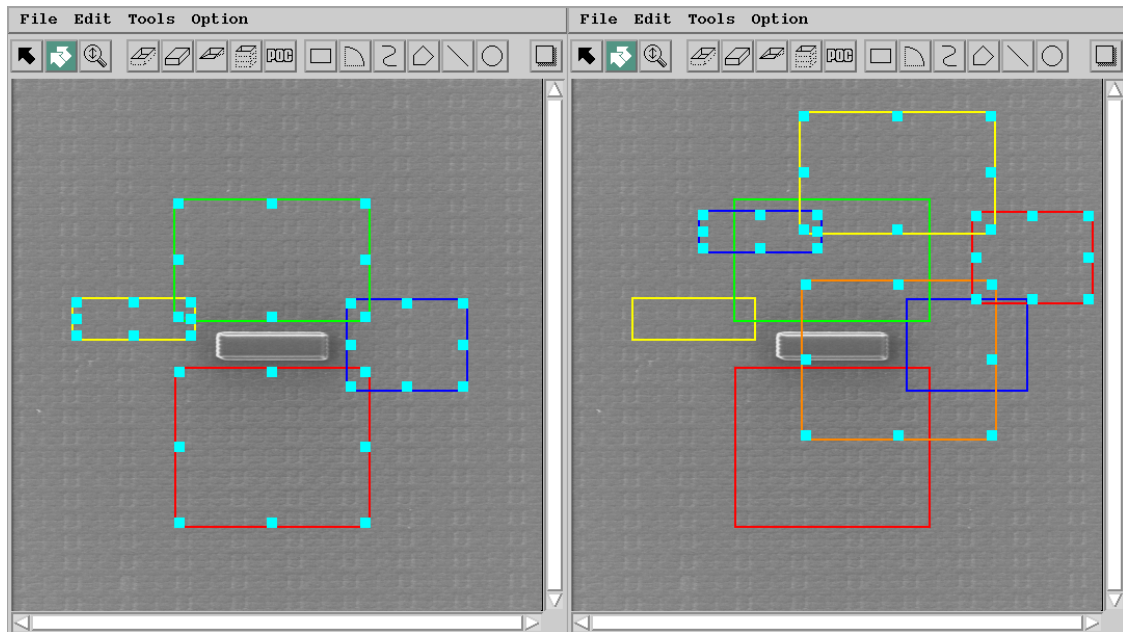
Overlap the processing figure on either side about  $2\mu\text{m} \times 2\mu\text{m}$  of each, and create a processing figure at the position about  $1\mu\text{m}$  away from the deposition.



(7) The copy of a processing figure

Use the Select All command and select all processing figures.

Paste after coping and copy the processing figure.

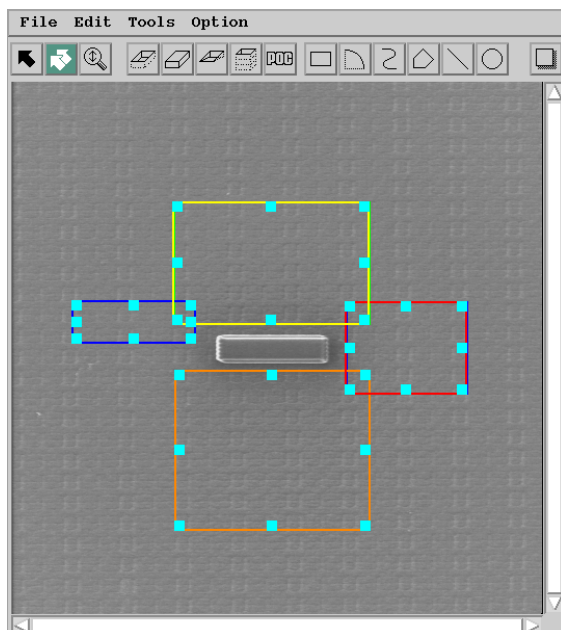


(8) Position adjustment of processing figure copy

Adjust a position to overlap the copied processing figure with the original processing figure.

(Fine adjustment becomes easy by using cursor key).

(Note) Please perform the circumference processing twice.



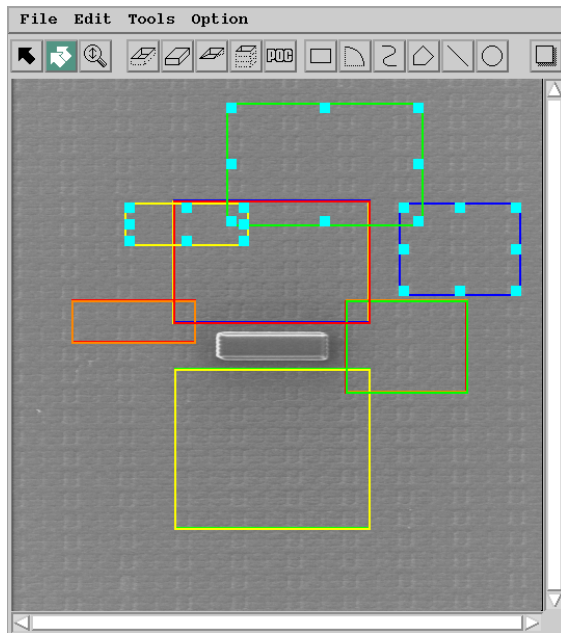
(9) The processing figure copies in upper right and left

When process the bottom to incline the sample, since the right/left and back sides need to be deeper than the front side (lower part), add the processing of upper right and left.



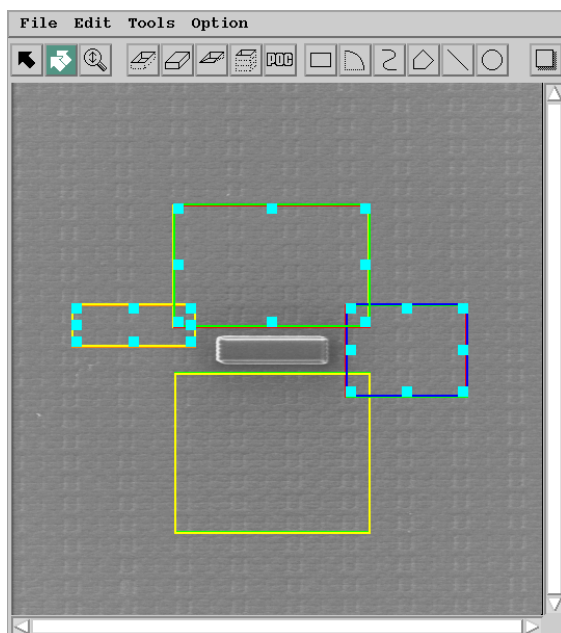
Choose button and click the figures in upper right and left.

Execute the Paste command after the Copy command and copy the processing figure.



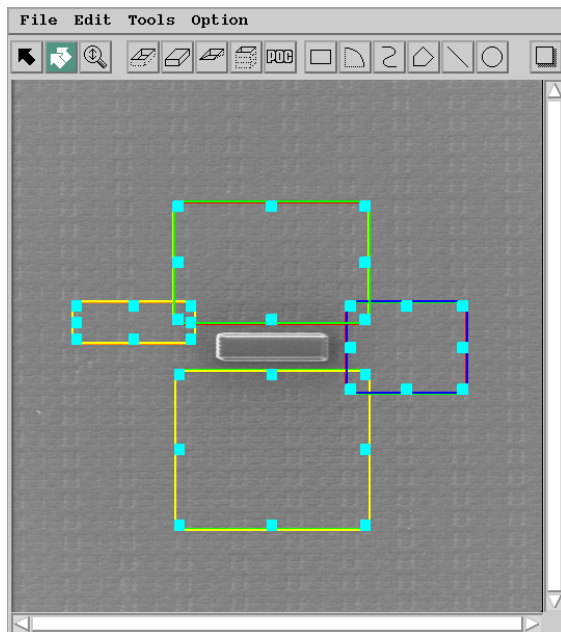
(10) Position adjustment of upper right and left figures

Adjust the position to overlap the processing figures in upper right and left with the original processing figure.



(11) Selection of all processing figures

Select all processing figures using the Select All command.

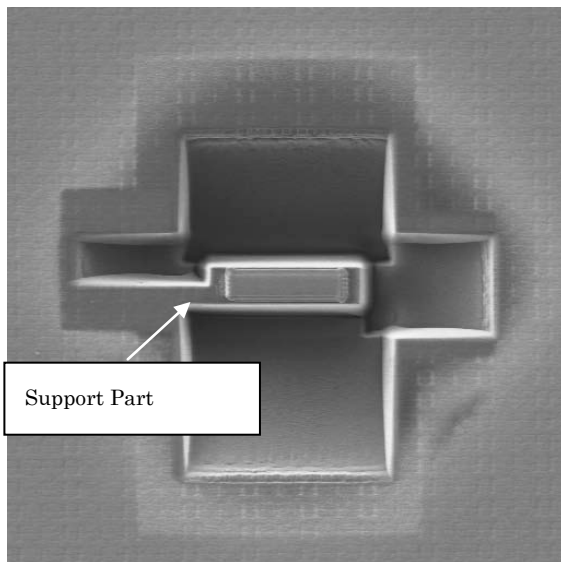


(12) Processing Execution



Process it by clicking the Fabrication Start button.

Processing is performed in order of figure creation.

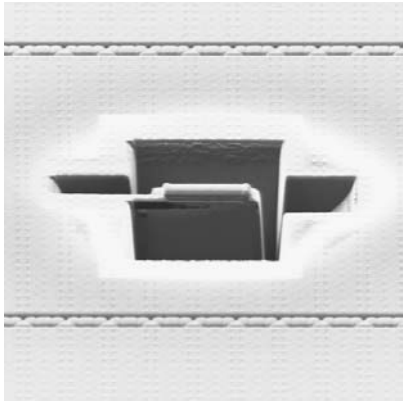


Circumference processing of the micro sampling is now completed. Deposition left side becomes a micro sample support part.

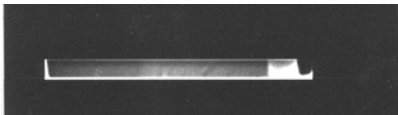
Perform extraction processing of micro sample with the following procedures after the circumference processing of micro sampling completed.

(13) Bottom Processing

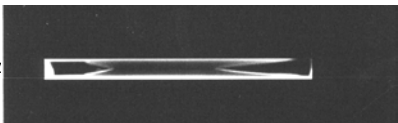
Incline stage and perform separation processing of bottom.



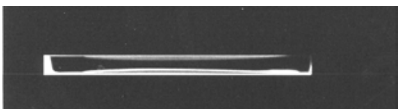
Start



On the way



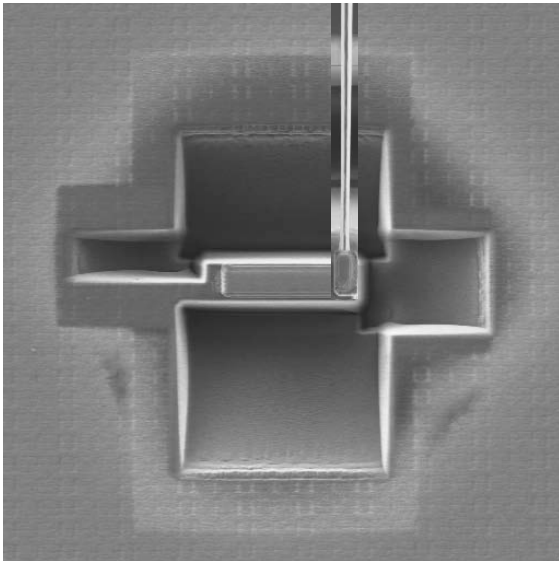
End



Stop the processing (STOP) if the shining line which remains in the upper part of the SIM image when processing in the image monitor turns into almost straight line.

(14) Probe Connection

Set the stage back to horizontally, contact the probe on the right side of micro sample, and fix by the deposition.



(15) Separation

Process the support part which remains at the last, and separate the micro sample from the former sample.



## 2. Change Method of Processing Conditions

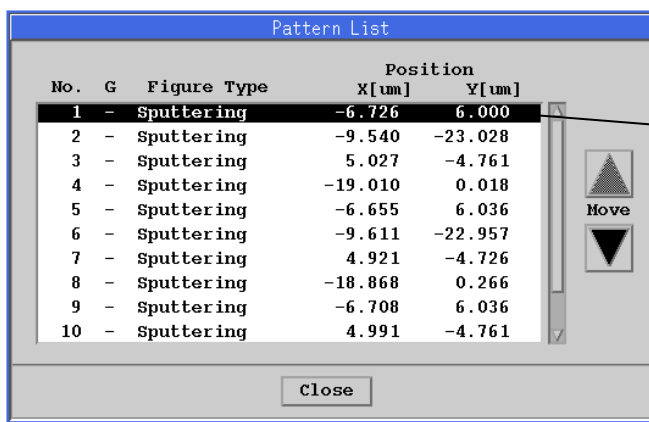
Change processing conditions (Dwell Time and number of times of processing) based on the height of processing material or a TEM observation thin film.

### (1) Change of Dwell Time

Dwell Time can be changed only to every one figure.

Change of Dwell Time becomes easy by using a Pattern List screen.

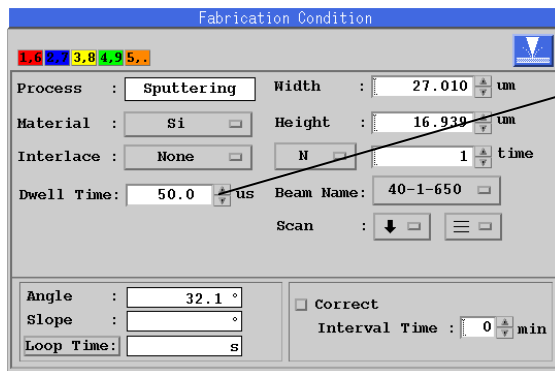
(Open from Pattern List... command in the Tools menu of Area Editor screen).



The Pattern List dialog box displays a table of processing patterns. The table has columns for No., G, Figure Type, and Position (X[um], Y[um]). The first row is highlighted, showing No. 1, G -, Figure Type Sputtering, and Position X[um] -6.726, Y[um] 6.000. A 'Move' button with a triangle icon is located to the right of the table. A 'Close' button is at the bottom.

No.	G	Figure Type	Position X[um]	Y[um]
1	-	Sputtering	-6.726	6.000
2	-	Sputtering	-9.540	-23.028
3	-	Sputtering	5.027	-4.761
4	-	Sputtering	-19.010	0.018
5	-	Sputtering	-6.655	6.036
6	-	Sputtering	-9.611	-22.957
7	-	Sputtering	4.921	-4.726
8	-	Sputtering	-18.868	0.266
9	-	Sputtering	-6.708	6.036
10	-	Sputtering	4.991	-4.761

The Fabrication Condition screen of the figure of No. chosen in Pattern List is displayed.



The Fabrication Condition dialog box shows various parameters for a sputtering process. The 'Dwell Time' is set to 50.0 us. Other parameters include Process (Sputtering), Width (27.010 um), Material (Si), Height (16.930 um), Interlace (None), N (1 time), Beam Name (40-1-650), Scan (down arrow), Angle (32.1 °), Slope (°), Loop Time (s), and Interval Time (0 min). A 'Correct' checkbox is also present.

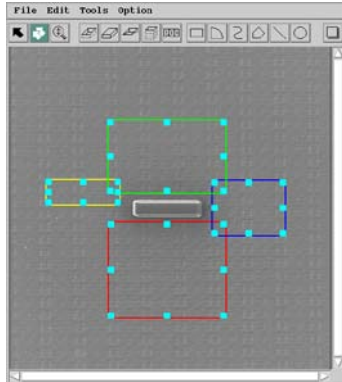
Process	: Sputtering	Width	: 27.010 um
Material	: Si	Height	: 16.930 um
Interlace	: None	N	: 1 time
Dwell Time	: 50.0 us	Beam Name	: 40-1-650
		Scan	: [down arrow]
Angle	: 32.1 °	Correct	: <input type="checkbox"/>
Slope	: °	Interval Time	: 0 min
Loop Time	: s		

Change the value of Dwell Time.

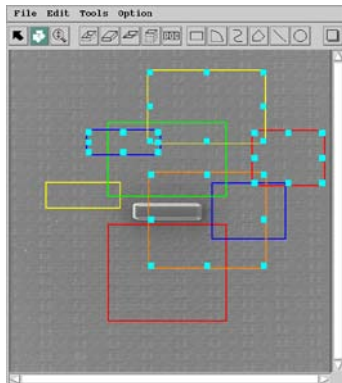
Change after choosing in Pattern List screen for other processing figures too.

(2) The addition of the number of times of processing

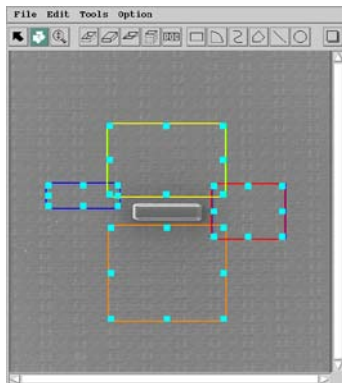
As for the number of times of processing, the processing figure of each four directions is added.



Choose the button and click a vertical and horizontal figure.



Execute the Paste command after the Copy command and copy a processing figure.



Adjust the position of a processing figure and put on the original processing figure.

In the above mentioned case, since the processing turn of the added processing figure becomes the last, move the processing turn before the processing figure of upper right and left of 1. (9) using a Pattern List screen.

Pattern List			
No.	G	Figure Type	Position X[um] Y[um]
1	-	Sputtering	-6.726 6.000
2	-	Sputtering	-9.540 -23.028
3	-	Sputtering	5.027 -4.761
4	-	Sputtering	-19.010 0.018
5	-	Sputtering	-6.655 6.036
6	-	Sputtering	-9.611 -22.957
7	-	Sputtering	4.921 -4.726
8	-	Sputtering	-18.868 0.266
9	-	Sputtering	-6.708 6.036
10	-	Sputtering	4.991 -4.761

Choose No. of the added processing figure and move processing turn using ▲ of the Move button.

### 1) Condition of W-deposition

Beam 40-1-80 for 10 minutes

If high speed is requested, we use 40-1-150 for 3 minutes  
always excepting beam sensitive sample.

### 2) Dwell time

50~60us for Si.

100us for hard materials.

### 3) Condition of W-deposition for attaching the probe

Beam 40-1-30 for 3~4 minutes

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Additional notes for pre-preparation of the sample surface and for thinning the sample once mounted onto the TEM/FIB grid.

#### **1) Pre-preparation:**

-If the sample feature of interest is relatively close to the surface ( $\sim < 1\mu\text{m}$ ) of the bulk sample, or on the surface, steps to protect the target need to be taken prior to FIB W-deposition (since the FIB deposition slightly mills *into* the sample prior to depositing).

Typically, when using a sputter coater, the landing energy of the material being deposited (Pt or Au) is enough to remove a few atomic layers at the surface of the sample. This is observed as the surface having a rough interface when viewed in X-section. It is then necessary, for the pre-prep, that the user should utilize a vacuum evaporator to evaporate a  $\sim 0.5\mu\text{m}$ - $1\mu\text{m}$  layer of Carbon on top of the sample which then acts as a sacrificial layer for the sputter coaters material. Also a thick carbon layer allows you to clearly separate the surface layer from the carbon layer. You can also use a black sharpie to swipe over the area of interest but be careful not to place too thick a layer on top of the feature of interest as it will make finding the correct area difficult.

- 1) Carbon evaporation
- 2) Sputter coat (Au or Pt)
- 3) FIB induced Tungsten deposition over the target site

If the feature of interest is buried in the sample, below a depth of  $1\mu\text{m}$ , you can skip the

Carbon evaporation step and just use a sputter coater to coat the sample with a continuous conductive film (Pt or Au/Pd, or Au is OK).

**2) After cutting the probe free from the sample surface after grid attachment.**

- 1) Mill up to the W-depo layer using 40-1-300 or 40-1-150
- 2) Mill to ~0.6um using 40-1-150 or 40-1-80
- 3) Mill to ~0.2-0.3um using 40-1-30
- 4) For final milling to ~100nm use beam 40-0-30

\*Always observe with 40-0-30 (lower beam current) to minimize beam damage at the sample surface and W-depo layer.

\*During milling of the W-depo layer, only cut the taper. The beam will overcut and mill inwards towards the center.

\*When the sample is 0.2um tilt ~+1° and -1° to clean up the taper to planarize the section.

**Fab. Constants**

Si	- 0.33
Depo	- 1.00
Al <sub>2</sub> O <sub>3</sub>	- 0.12
Fe	- 0.2
GaAs	- 0.6
InP	-1.5
AlTiC	- 0.13

Al<sub>2</sub>O<sub>3</sub> Fab constant is almost the same as GaN