Cjob Setting up exposure jobs

Computer		rooks@lardnar:~/projects/cat	
Computer	<u>F</u> ile <u>E</u> dit <u>V</u> iew <u>T</u> erminal Ta <u>b</u> s <u>H</u> el	p	
rooks's Home	[rooks@lardnar ~]\$ cd [rooks@lardnar cat]\$ [rooks@lardnar cat]\$ ] You have to "cd" Pattern and job	<pre>projects/cat cjob ' to the directory containing your patterns. files must be in the same directory.</pre>	
		Cjob y02	_01t: Copyright © Vi
		<u>F</u> ile <u>V</u> iew Options <u>W</u> indows <u>H</u> elp	
		Job Design	
EBPG Calc		SUBSTRATE         EXPOSURE         LAYOUT         PATTERN         SHAPE         IDENTIFIER	
2			
Layout CAD	I	because we do not want any directory not or relative directory paths to confuse t	names the EBPG.



Drag "substrate to the right, then fill out the dialog box with substrate size and job name.

Secon			Cjob y02_01t: Copyright © Vistec	Lithography (2010)	_ • ×
<u>File V</u> iew	Options <u>W</u> indows <u>H</u> e	elp			
Job Design					0 %
EXPOSU	RE EXPOSURE	Since		Job Editor	
PATTER	N	LAYO		Define Exposure	
IDENTIFI		PATTE		Name: High Tension O 20kV O 50kV () 100kV	Position: x: 0
mm		[		Height O none	) measure map
4-		μm		Performance checks	
2-				<ul> <li>✓ current distribution over main field</li> <li>✓ beam quality over main field</li> </ul>	
0-				Substrate Mapping     Global Markers	
-2-					
-4					

Drag "exposure" onto the "substrate" module. Supply a name. Turn off the perfomance checks.



Drag "layout" onto the exposure box.

We are just moving down the list... substrate... exposure... layout... pattern...

🔤 Job Editor		
LAYOUT 3x1 Define Exposure	Define Layout	
PATTERN SHAPE	osition: x: 0	y: 0 ([µm],[µm])
IDENTIFIER Count Vector [µm]	Dropout	Plugin
μm β x 0 # y 0 Spacing [μm]	#	
dx 0 dy 500		
Repetition 2		Exception
Circular	Dose Update	
Layout Markers		

Fill out the number of repetitions and the spacing. Or, move on to the "pattern" and leave this until later.

The "vectors" are always zero.

Stat	job E	Edit	or			
LAYO	UT foobar.gpf		Define Exposure	Define Pat	ern	
PATTE	RN		Pattern			
SHA	PE I		File		Resolution 0.004[um]	
IDENTI	TER		roopar.gpr	[	J	
			Dose [µC/cm²]	Base Frequency	Main Resolutio	on
μm			500	12.78 MHz	0.001 (µm)	
			Beam		Sub Resolution 0.0005[µm	n ]
			1na_300um_2.beam_100	(	]	
			Defocus [nm]		Beam Step Siz 0.004[μm]	e
					]	
			Pattern Markers			
				A.		
				·		

Drag a pattern onto the layout box, then select the pattern file, dose and beam (that is, current). Notice that the program calculates the clock speed, which must be less than 50 MHz. You don't always get the current you expect, so it's not wise to operate close to 50 MHz.



Let's go back to the layout box "3x1" so that we can specify a dose update.





Job E	ditor
LAYOUT 3x1 PATTERN foobar.gpf SHAPE IDENTIFIER	Edit Layout       Name:     3x1     Position:     x:     0     y:     0       Image: Repetition 1     Dropout     F
μm 3000-	Count Vector [µm] 3 x 0 # y 0 # Spacing [µm] dx 0 dy 1500
200-	□ Repetition 2       Exception 2         □ Circular       ✓ Dose Update         ▼ 1.5       Upon         ○ Scan Order ③ Repetition
	Layout Markers
-200-	

Change dy to 1500  $\mu$ m so that the exposures do not overlap. Note that zoom in/out uses the same convention as Cview and Beamer.

Let's label each exposure with the dose.

Go to the pattern box, and drag an "identifier" onto the pattern.



🥯 Job Edi	itor		
	Edit Pattern	Define Identifier	
PATTERN SHAPE IDENTIFIER	Identifier Identifier Font	Points Style Syr	Positions [µm, µm]
μπ	helvetica Pixel width [μm] Orientation normal Resolution [μm] Dose [μC/cm <sup>a</sup> ] Beam 	24     nor     Mac       Pixel height [µm]     Job       1     Exp       Lay       Placement     Cell       center     Cell       Data       Beam Step Size [µm]     Time       Patt       Base Frequency     Dos       ####     Defocus [nm]	hine Name Dosure Name Index X Index Y
	Lidentifier Markers		

Insert the "dose", and erase the useless " $\mu$ C/cm<sup>2</sup>" bit.

Choose a font size, pixel size, resolution = beam step, dose and beam (current). Note that the current can be very large.

🖦 Job Edil	tor		
	Edit Pattern	Edit Identifier	
	ldentifier		Positions [μm, μm]
IDENTIFIER	%q	Insert	(1200,0)
μm	Font helvetica ♀ Pixel width [µm]	Points Style 25 ♦ normal ♦ Pixel height [µm]	4
60-	2 Orientation normal ♦	2 Placement center	
	Resolution [µm] .02 Dose [µC/cm²]	Beam Step Size [µm] .02 Base Frequency	
	1000 Beam 100na_300um_2.beam_100	25.75 MHz Defocus [nm]	
	Lidentifier Markers		

If the parameters result in a clock > 50 MHz, then the fields will be highlighted in red.

Set the position relative to the pattern's center. Check it out on the main window, and change the position vector if the label does not look good.

Back in the main window, save the job (as a .cjob file) and then export the job (as a .job file).

The .job file is the one that will be used for the exposure.

Sec.	
<u>File View Options V</u>	indows <u>H</u> e
New	Ctrl+N
🖏 Open Job	Ctrl+O
📕 Save Job	Ctrl+S
Save <u>A</u> s	Ctrl+A
I Export Job	Ctrl+J
峇 Print	
*	
nter Close Job	Ctrl+C
🚴 Change Environmer	nt
<u>E</u> xit	Ctrl+X
3000-	
2000-	
1000-	
1000-	
0-	
- 1000	
-2000-	

() ()										Expo	rt Job	· ·		•	•		×	
Look	n:	/home/roo	ks/projects/c	at		•	€ 1	1	:		mm 40-							
	align_1.jot fatoverlay_ highlow.jo	o _layer2.job b								<b></b>	30-			×				
	marks.job overlay1.jo	b									20-							
	overlay1_c overlay1ul	overlay1.job .job									10-							
	overlay2.jc	)b 								•	0-			1000				
•	enchilada <sub>Reso</sub>	a BSS	Main	Sub	Field	Defocus		NO AI	l <b>ignmer</b> n	nt	- 10-							
Y	20.000	20.000	1.000	0.500	600.000		30na_ 50na	_300um	1_2.bea 1 2.bea	•	-			enchilada				×
<<<<>><<<<<>><<<<<>><<<<<>><<<<<>><<<<>><<<<	20.000	20.000	1.000 1.000 1.000 0.500 1.000	0.500 0.500 0.500 0.500	300.000 500.000 600.000 100.000		50na_ 50na_ 100na 500pa	_300um _300um a_300u a_300u 300um	2.bea n_2.bea m_2.bea m_2.be m_2.be 2.bea		rings.gp horizont	Pattern f al_grating.gpf	Count 4	Min Freq 13.938 MHz 2.287 MHz	Max Freq 41.813 MHz 6.860 MHz	Beam on 00:11:47 h 00:04:34 h	+Over head 00:14:56 h 00:04:48 h	
File N	ame:	system_te	st_hsq_salty	/_enchilad	a.job	Ex	posure	e Time	Elboalin	cport	vertical_ dots.gpf wedge1 squares	grating.gpf 0.gpf poke_pec_forward_2.gpf	4 4 1 4	2.287 MHz 0.134 MHz 25.135 MHz 8.342 MHz	6.860 MHz 0.402 MHz 25.135 MHz 25.025 MHz	00:04:33 h 00:00:38 h 00:16:24 h 00:27:07 h	00:06:23 h 00:00:40 h 00:16:38 h 01:20:22 h	1
Filter:		Jobs (*.job	)				нец		C	ancel	ls.gpf		4 Sta	0.426 MHz ige moves betv al Estimated E	1.278 MHz veen patterns:	00:27:12 h 00:00:07 h 01:32:18 h	00:31:53 h 00:00:07 h 02:35-49 h	
	-20-										7///					100%	Done	]

Calculate the expected exposure time from the "Export Job" box. This estimate includes stage move time and shape settling overhead. Over on the EBPG, the exposure will be started with the command

whatever.job 1 0 70mm,77mm

where "1" is the wafer chuck number, "0" is the loader slot number, and the given coordinate is the center point of the exposure job.

Actually, we will use a little bash script to start the exposure, so you will not have to type in this line.

Alignment jobs

## Alignment example

The pattern is repeated over a wafer.

Alignment marks are first designed on layer 1 and then printed and etched (or liftoff)

Each pattern or "chip" has four marks.

Three of these chip marks will be used for initial "global" alignment

EBPG will first do a global alignment and then local "chip" alignment

But when setting it up with Cjob, it's easier to work on the chips first.



(ence	job E	ditor
LAYO	JT foobar.gpf	Edit Pattern
PATTE SHAI	RN         500           E	Pattern File foobar.gpf Dose [µC/cm <sup>2</sup> ] Base Frequency
μm		500 12.78 MHz
1000-		Beam
800-		1na_300um_2.beam_100        Defocus [nm]
600-	0	Dattern Markens
400-		
200-		
0-		
-200-		
-400-		
-600-		

Start at the bottom: click on the pattern box, where we will set up pattern markers.



Choose an "ident" – that is, the name of the alignment mark.

This marker type has been defined previously on the EBPG.

If you do not see an appropriate mark definition, you can pick any mark and fix it later. There is a simple command on the EBPG for defining new marks. Cjob will see the new mark after it is saved on the EBPG.

Stee		Job Editor	
	foob ar ant	Edit Pattern	
PATTERN	500	<b>Pattern</b> File	Resolution Positions [µm, µm]
IDENTIFIER		foobar.gpf	0.004[µm] (0,0)
		Dose [µC/cm²] Base Frequency	Main Resoluti 0.001[µm]
μm 1500-		Beam 1na 300um 2.beam 100	<b>Sub Resolutio</b> 0.0005[μm]
1000-		Defocus [nm]	Beam Step Si: 0.004[µm]
	$\otimes$	☑ Pattern Markers	
500-	+ +	Ident	Keystone
0-		Markerlist 1         Markerlist 2         N           (-1000,500)         (-1000,-500)         (-1000,-500)           <>	Iarkerlist 3         Markerlist 4           (1000,-500)         (1000,500)           <>         <>
-500-	+ +		
- 1000			

Type in the mark coordinates relative to the pattern's center. Go back to CAD to figure out the coordinates. Good thing you chose sensible, easy values!

Tip: If you include the mark layer along with your pattern layer (in Beamer) then it will be easy to check the alignment mark vectors. Later, go back and delete the mark layer.



Global alignment: go back to the exposure box ("bla") and click on "global markers". Do <u>not</u> define alignment markers in the layout box ("3x1").



You can type in the vectors to the global marks, or you can "pick them up" by clicking on the appropriate chip mark. Actually, you have to click on "Pickup" and then choose the mark with <ctrl> click.

Save and Export the job, as before.

Note the order in which the global marks were specified.

You will need to find those marks in the same order once you are sitting at the EBPG console.

View Options Windows Holp	
The Mew Obrious Windows Help	
New Ctrl+N	
Open Job Ctrl+O	
🗒 Save Job 🔪 Ctrl+S	
Save <u>A</u> s Ctrl+A	
Sexport Job Ctrl+J	
Print	
Close Job Ctrl+C	
& Change Environment	
Exit CtrLX	
300-	
2000-	
	- 불분분분분
1000-	
	33333
-1000-	
	- 현실 현실 현
-2000-	

Over on the EBPG, the exposure will be started with the command

```
whatever.job 1 0 $upper_left $lower_left $lower_right
```

where "1" is the wafer chuck number, "0" is the loader slot number, and the rest are symbols containing the stage coordinates of the global alignment marks. You'll find the marks first, and save their coordinates in these variables.

Actually, we will use a little bash script to start the exposure, so you will not have to type in this line.

Things you cannot do with Cjob

Trap alignment errors Cjob dies upon encountering bad marks

Changing anything other than the dose Focus, for example

Reacting intelligently to problems Such as losing the mark after switching current or asking for user intervention

## Alignment to nearly anything

Keep in mind that the EBPG can do image processing to align to nearly anything. If you can see it in SEM mode, then you can use it for alignment.

Low contrast material, strange shapes, badly broken marks, silicon nitride windows...

Image acquisition and correlation analysis can be used for alignment, but it's not covered here.